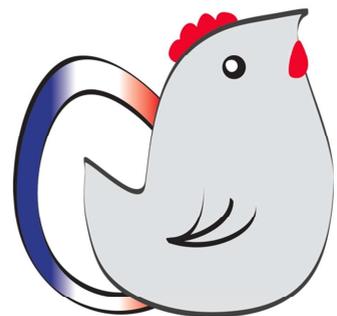
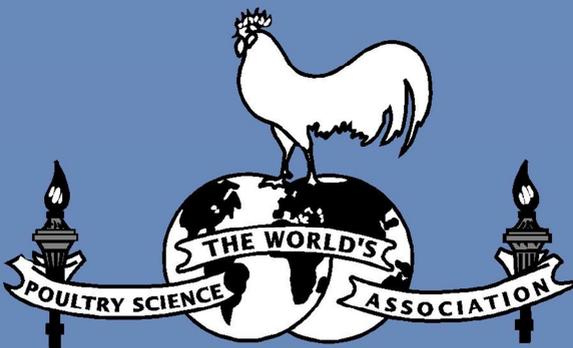


# POULTRY SCIENCE JOURNAL

**XVI European  
Symposium  
on the Quality of  
Eggs and  
Egg Products**

**XXII European  
Symposium  
on the Quality  
of Poultry  
Meat**

education  
organization  
research



Egg Meat 2015

10 - 13 May 2015  
Nantes - France

**Book of Abstracts**  
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XVI European Symposium on the Quality of Eggs and Egg Products**

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**M. Duclos and Y. Nys**

**Hosted by the French Branch of the  
World's Poultry Science Association**



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**Dear friends and colleagues,**

It is a pleasure to welcome you in Nantes for the XXII European Symposium on the Quality of Poultry Meat and the XVI European Symposium on Eggs and Egg Products. We wish you a very successful symposium, taking advantage of the numerous opportunities to establish new friendly relationships, to discuss challenges in your area and to reinforce your collaboration for emerging new projects. This book of abstracts includes the summaries of about 190 accepted contributions originating from 33 different countries. A printed copy of the Book of Abstracts and a USB memory stick containing the Symposia Proceedings with the full texts of the presentation are distributed to all registered participants.

The French Branch of the World's Poultry Science Association (WPSA-France) and Institut National de la Recherche Agronomique (INRA) worked together, in close coordination with Working Groups 4 and 5 of the European Federation of WPSA to organize these joint Symposia under the Egg Meat 2015 banner. We hope that this fourth French edition of Egg-Meat symposia will be as successful as the previous ones organized in Ploufragan (1983), Tours (1993) and Saint-Brieuc (2003).

The scientific program is organized in 4 common sessions and 7 dedicated parallel sessions for each symposium and will highlight current research about product quality in the poultry meat and egg producing chains. In the plenary sessions, quality will be considered in a very broad sense. Outstanding speakers will cover aspects concerning innovation in response to consumer's perception, evaluation of waste and losses in the production chains, and benefits provided by the livestock sector in Europe. Common sessions will also cover food safety issues and the influence of poultry nutrition on product quality. The specialised sessions will cover the most productive fields of research in meat and egg quality, with the participation of invited keynote speaker and selected short communications from the participants. Posters will also be displayed throughout the conference to allow discussion with their authors during coffee breaks.

We address our special thanks to all members of the scientific committee for their contribution to the program and the evaluation of abstracts, and to all members of the organising committees for their involvement into the preparation of the meeting. The French Branch of WPSA expresses its gratitude to the sponsors for their valuable support to the meeting's budget.

We wish all participants a pleasant and fruitful meeting in Nantes.

**Christophe Bostvironnois**, Chairman of Organizing Committee, president of WPSA-France

**Michel Duclos**, Chairman of Scientific Committee "XXII European Symposium on the Quality of Poultry Meat", secretary of WPSA-France

**Yves Nys**, Chairman of Scientific Committee "XVI European Symposium on the Quality of Eggs and Egg Products"

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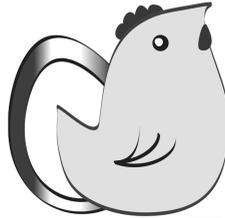
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Egg Meat 2015

*XXII European Symposium on the Quality of Poultry Meat*  
*XVI European Symposium on the Quality of Eggs and Egg Products*

Nantes (France) May 10 to 13, 2015

**Plenary Sessions**

[A1-01]: Common plenary session (ID: 100177)

[Netherlands]

## **Consumer perception of poultry products and consequences for innovative production schemes**

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In market oriented product development, identification of consumer needs and demands is essential. The Theory of Planned Behaviour (Ajzen, 2006) provides a framework for analysis of buying motives, buying intentions, buying behaviour and product satisfaction afterwards. A consumer survey of 13477 consumers in the 27 EU Member States identified the most important motives consumers take into account when purchasing poultry meat: sensory cues ('the meat looks fresh', 'the meat looks tasty', 'the meat is displayed hygienically'), price ('the price is reasonable', 'the price is affordable') and origin ('the meat is produced in my country'). Animal welfare and environmental motives were less important ('the meat is organic', 'the meat is animal welfare certified', 'the meat is produced according to environmental standards'). Consumers all over the EU had positive intentions towards animal friendly and environmental friendly meat types. But there was a gap between intentions and behaviour: only a small proportion actually purchased these meat types. Higher prices and lack of awareness explain this difference. Less than half of the consumers were aware that these meat types were available (organic (49%), animal welfare certified (44%), nutrition claims (35%), slaughtered according to religious rites (25%), environment/climate certified (15%)). However, awareness differed between countries, with EU15 consumers being generally more aware. Finally, taste, freshness and availability of meat produced in the home country drove product satisfaction levels for consumers. This study shows that for marketing of new innovative production schemes in the poultry meat market, consumers have to become more aware of the choice options, since a large group of consumers isn't aware of the choice options. Next to that not all consumers are aware of the consequences of their own behavioural choices on poultry production. And the gap between intention and behaviour shows that consumers don't recognize choice options in the stores.

**Keywords:** consumer behaviour intentions motives production schemes

[A2-01]: *Food safety issues in poultry products (Meat)* (ID: 100182)

[United Kingdom]

## **Campylobacter in the poultry meat production chain**

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Campylobacter is the most commonly reported food-borne bacterial gastrointestinal disease in people worldwide. It is estimated that there are nine million cases of human campylobacteriosis per year in the EU. Molecular and epidemiological studies indicate that broiler chickens are an important source for human infections. Campylobacter are ubiquitous bacteria, frequently associated with the contamination of broiler flocks. Campylobacter-colonised broiler chickens can harbour very high numbers of these bacteria in their intestines and are the primary source for contamination of the carcasses during slaughter. Handling, preparation and consumption of broiler meat may account for 20%-30% of the human cases while 50%-80% may be attributed to the chicken reservoir. A harmonised EU baseline survey carried out in 2008 found an overall EU prevalence of Campylobacter-colonised broiler batches of 71%, and 76% of broiler carcasses were found contaminated with Campylobacter. This study showed great variation in prevalence between Member States and the level of carcass contamination varied widely between countries and between slaughterhouses within countries. A large number of factors related to poultry farm and poultry abattoir environments and to poultry production and processing management practices have been associated with Campylobacter contamination of broiler flocks at various levels of the production chain. These factors are likely to be intimately inter-linked, resulting in a complex epidemiology of Campylobacter in broiler flocks which remains poorly understood. Despite the large body of research on the epidemiology and control of this organism, there is little clarity in terms of validated practical control measures. It will be necessary to better understand the multiple interactions between this organism, the poultry environment and the chicken host during transmission along the food chain in order to develop effective preventive and control strategies. A review of current knowledge of the epidemiology and control of Campylobacter in the poultry production chain will be presented.

**Keywords:** Campylobacter, poultry, epidemiology, control, production

[A2-02]: Food safety issues in poultry products (Egg) (ID: 100183)

[Belgium]

## **Risks of spoilage and Salmonella contamination of table eggs**

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Consumers and food business operators are more and more aware of food safety issues. Food safety can broadly be divided into microbiological and chemical food safety. Microbiological contamination of eggs has important implications. For table eggs, internal contamination may occur, leading to spoilage and in the case of a pathogen to human disease and food safety risks. Eggs are one of the main sources of contamination cited in relation to human salmonellosis, with *Salmonella* Enteritidis (SE) being the most frequently isolated *Salmonella* serovar. There are two possible routes of bacterial infection of table eggs: either vertically or horizontally. In the vertical transmission the egg content is directly contaminated as a result of bacterial infection of the reproductive organs, i.e. ovaries or oviduct tissue (transovarian route). In the horizontal transmission the micro-organisms penetrate through the eggshell. SE seems to have special capabilities to colonize the hen's reproductive tract and to survive in the egg albumen compared to other *Salmonella* serovars and bacteria. Several studies support also the idea that the vertical contamination route may be more important for SE. The causative agent of strong-evidence human outbreaks caused by eggs and egg products in the EU in 2012 is SE, with 66.7% of the cases. Different factors play a role in the risks for spoilage and *Salmonella* contamination of eggs. Some of those factors will be discussed, starting with different physical and chemical defence mechanisms that protect egg contents from microbial invasion and multiplication. Egg freshness, egg cooling, eggshell condensation, amount of bacterial load on the shell, bacterial species, housing system, extending the self-life of eggs, ... are important factors. Finally risk factors for SE contamination of laying hen farms and the impact of the *Salmonella* control programs in the EU, with or without compulsory vaccination against SE, will be discussed.

**Keywords:** Table eggs, *Salmonella*, spoilage, microbiological contamination, risks

[A3-01]: Sustainability of poultry production systems (ID: 100172)

[France]

## **Food losses and waste in the poultry production chain: from farm to retail**

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In the context of “2014 - European Year against Food Waste” and the EU project FUSIONS, a study has been conducted in a first attempt to define, describe and quantify food losses and waste from harvest to retail in various food supply chains in France. The overall aim was to close knowledge gaps, launch a research dynamic and, concretely, identify ways of food loss and waste reduction. The present communication focuses on meat of Gallus species, i.e. meat of chicken and culled laying hens. Differently from currently acknowledged definitions from the FAO or the EU-project FUSIONS, food losses were defined as product discard from human consumption due to sanitary reasons: birds died between harvest and stunning and carcasses totally or partially condemned on the slaughter line. Food waste was defined as any part of the animal which is edible or could, after processing, be eaten by humans yet which is used for other purposes, such as for pet food. Based on scientific or technical information and on expert interviews, the study drew in diagrams the different technical tracks from the live animal to the end product, with the various associated by-products coming out along the slaughter and processing lines, and their valorization. Determinants for food losses and waste were found to be either technical, such as technical characteristics of processing tools, economical, such as the market demand side, regulatory or organizational, such as shelf management at retail with respect to products' expiry dates. Quantification of food losses and waste is difficult to perform due to the confidential character of business data. Issuing from the representation of the different slaughter and process steps with quantification of each sub-part of the carcass, a calculation sheet has been implemented in order to estimate the share of food losses and waste according to various hypotheses. Hypotheses formulated for that purpose are, for example, the percentage of carcasses devoted to cutting, and the percentage of giblets valued for human consumption. The stages of marketing and retailing remained however poorly documented. This preliminary study needs to be discussed with a larger professional audience and challenged by further research on this topic of increasing public attention.

**Keywords:** Food losses and waste, chicken meat, laying hen meat

[A3-02]: *Sustainability of poultry production systems* (ID: 100189)  
[France]

## **Envisioning the portfolio of benefits provided by the livestock sector in Europe: navigating from trade-offs to synergies?**

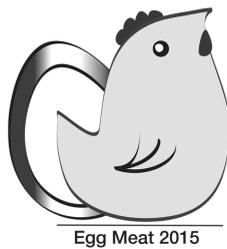
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Livestock farming systems provide multiple benefits such as the provision of protein-rich food for humans from inedible resources resulting in farm income and contributing to food security and employment. They also help maintain High Nature Value farmlands which are critical for the provision of ecosystem services. But livestock farming systems also exert negative impacts such as environmental pollution, competition between food and feed, emergence of zoonosis, animal welfare, and ethical issues related to changes in socio-cultural values. Improving livestock sustainability therefore requires more than just controlling its environmental footprint. There is a pressing need to fill the knowledge gap with regards to the multiple benefits provided by livestock to society, notably the often neglected social benefits. Solutions must be built on a comprehensive consideration of environmental, social, and economic benefits and costs along with their synergies and trade-offs. We propose a framework for the assessment and the recognition of the social, economic and ecological benefits provided by livestock. It combines expert knowledge and literature review for the identification of portfolios of benefits. A set of evidence-based indicators is used to quantify each benefit and to analyze how different benefits co-occur or not in time and space. A first exploration is conducted on a nation-wide gradient in different European countries. Four major types of portfolios are discussed, suggesting strong contrasts across European regions in terms of the nature of benefits that jointly appear together and their level of provision. The spatial distribution of portfolios is nonrandom; some benefits are regularly matched to others or not. By deepening our understanding of the socio-economic, ecological and political determinants of the portfolios of benefits we can improve livestock sustainability. Tools are needed to inform stakeholders and society on livestock benefits and help livestock actors to better understand and manage diversified portfolios of benefits.

**Keywords:** livestock, sustainability, footprint, benefits



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**Reviews and oral communications  
on the quality of Eggs and Egg products**

[E1-01]: Shell quality (ID: 100166)

[Spain]

## **Factors determining eggshell structure organization and its influence on eggshell properties**

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The eggshell is a thin mineral layer constituted by columnar calcite (CaCO<sub>3</sub>) crystals and a pervading organic matrix. The main function of the eggshell is to protect the egg content against mechanical impacts and microbial contamination while allowing the exchange of water and gases needed for the development of the chick embryo. Eggshell integrity is fundamental for the food safety of eggs as eggs with a poor eggshell quality can be more easily contaminated with bacteria and pose an important risk to consumers. On the other hand, damaged and cracked eggs, which needs to be discarded, cause significant economic losses to producers. Thus, there is a great interest in studying factors determining eggshell quality. It is well established that thickness of the shell is the main factor contributing to its mechanical properties (i.e., breaking strength). However, the organization of the eggshell at different length scales contribute significantly to its mechanical properties as well. Eggshell microstructure defined by the size, shape and crystallographic orientation of the calcite crystals determine in many cases the eggshell breaking strength. For instance, the guinea fowl eggshell, formed by the intricate interlacing of calcite crystals, is much tougher than eggshells of similar thickness from other birds (chickens) formed by straight columnar calcite units. We will revise our current understanding of the factors defining eggshell microstructure development and organization and discuss how eggshell microstructure can be an useful trait in genetic assisted selection programs aimed to improve the safety and quality of eggs.

Keywords: eggshell quality, calcite, food safety,

[E1-02]: Shell quality (ID: 100148)

[France]

**Avian eggshell formation: Presence of amorphous calcium carbonate associated with changes in some organic matrix proteins during initiation of mineralisation**

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We have studied eggshell formation mechanisms in order to identify functional candidates involved in the process of mineralization and which contribute to the reinforcement of eggshell quality. Eggshell is a biomineral made of 95% calcium carbonate (calcite) and 3.5% organic matrix (proteins and proteoglycans). This structure is the consequence of controlled interactions between both mineral and organic matrix constituents resulting in a highly ordered structure with unique mechanical properties. Using in situ physical technics, we observed that calcium carbonate was primary deposited on transient Amorphous Calcium carbonate (ACC or disorganized calcite) as a more soluble and reactive form, leading to the hypothesis that some eggshell matrix proteins might play a pivotal role to stabilize the ACC, to influence the crystal polymorph and therefore the shell ultrastructure. In this study we have used a quantitative proteomic approach at 4 pivotal stage of shell mineralization and identified 175 proteins with variation of abundance during the calcification process. Functional analysis has allowed the characterization of 77 putative functional proteins of the shell calcification.

Keywords: Eggshell, formation, amorphous calcium carbonate, matrix proteins, mineralization

*[E1-03]: Shell quality (ID: 100043)**[Australia]*

## **Effect of body weight uniformity on eggshell ultrastructure of hens in a cage production system**

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Understanding the ultrastructure of eggshells has reinforced the view that the mechanical properties of the eggshell cannot be defined by relative shell weight or shell thickness. The current study was conducted to investigate the relationship between body weight uniformity and ultrastructural properties of the mammillary layer of the eggshell. Birds came from flocks of the same age sourced from the same hatchery but raised in two different rearing sheds which were in different locations and had different stocking densities. Birds (approximately 100 per rearing shed) were weighed at the ages of 6 and 15 weeks while still in the deep litter rearing sheds and then at 19, 26, 37, 50 and 60 weeks of age while housed in conventional cages. A total of 200 eggshells were processed for observation of the ultrastructure of the mammillary layer from the two rearing flocks at 26, 35, 50 and 60 weeks of age. Body weight increased with increasing hen age for both groups. Body weight was not significantly different between the two flocks, for all ages combined although body weight was lower for shed A until 26 weeks of age. Body weight uniformity was similar between the two flocks ranging from 70 to 87% for flock A, and from 71% to 89% for flock B. Egg production was recorded on-farm for both flocks combined so it was not possible to compare the two. There were no significant differences between the two rearing groups for the incidence of ultrastructural features of the mammillary layer. As hen age increased, the incidence of ultrastructural features known to be associated with poorer shell quality increased: mammillary cap size, cap size, late fusion, alignment of mammillae, type A bodies, type B bodies, aragonite. The incidence of ultrastructural features that have been shown to be associated with good shell quality, such as early fusion and confluence decreased as the flock age increased. Interestingly, we found a new feature in the shell ultrastructure. Further analysis needs to be conducted to determine the composition of these new features.

**Keywords:** body weight uniformity, shell ultrastructure

[E1-04]: Shell quality (ID: 100051)

[Belgium]

## **The effect of different ratios of fine and coarse limestone particles on eggshell quality of aged laying hens in a split feeding system**

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Recently, there has been an increasing interest to extend the production period of laying hens in order to improve egg production sustainability. However, one of the major obstacles the sector has to face is the deterioration of egg quality in aged flocks. The aim of our study was to investigate whether eggshell quality of aged hens (73-83 wks) can be improved by providing different ratios of fine- (FL) and coarse limestone (CL) when it is required for eggshell formation. Two feed distribution systems were used: conventional (C) and split (S; calcium only provided in the afternoon) and diets contained three different limestone ratios: 50FL:50CL, 30FL:70CL and 0FL:100CL. Production and egg quality traits were monitored throughout the experiment. Laying rate was affected by limestone particle size and feed distribution system: when birds were fed 0FL:100CL in the S system, laying rate was lower ( $P=0.035$ ) than that in the C, 0FL:100CL group. Egg mass, feed conversion ratio and feed intake were not affected by the treatments. Limestone particle size and feed distribution affected broken eggs % ( $P=0.045$ ): when fed 30FL:70CL in the C system, birds produced more broken eggs than those in the S system, receiving the same limestone particle ratios. Feeding 0FL:100CL in the C system resulted in less broken eggs than the same ratio in the S system. When 50FL:50CL was fed in the C system, broken eggs % was half than that in the S system. These interactions highlight that both limestone particle size and time of calcium supplementation are important in layer nutrition. Aging of hens and feed distribution had an interacting effect on eggshell quality as expressed by shell index and shell thickness. Both traits declined throughout the experiment, but at 83 wks of age hens in the S system produced eggs with less and thinner shell ( $P=0.039$ ) than hens in the C system. Supplying different ratios of FL and CL to aged laying hens resulted in different performance depending on the feed distribution systems. The split distribution system did not result in improved eggshell quality of aged laying hens.

Keywords: laying hen, egg quality, limestone, split feeding

*[E1-05]: Shell quality (ID: 100077)*

[China]

**Effects of dietary degossypled-cottonseed protein level on laying performance, egg quality and free gossypol residue of laying hens****He, T. (1), Qi, G.H. (2), Wu, S.G. (3), Zhang, H.J. (4), Yue, H.Y. (5) and Wang, J. (6)**

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An experiment was conducted to evaluate the effect of dietary degossypled-cottonseed protein (DCP) on the laying performance and egg quality of laying hens while maintaining the same ratio of digestible amino acids and dietary protein level. A total of 432 40-wk-old Hy-Line W36 hens were allocated to six dietary treatments with six replicates of 12 birds each. The control was fed a corn-soybean meal basal diet, and the other four additional diets include 50g, 98.3g, 144.2g, 189 g DCP/kg, respectively (25%, 50%, 75%,100% dietary protein content which soybean meal provided were replaced by DCP). The sixth group was fed corn-soybean meal basal diet with free gossypol (FG) supplementation (inclusion rate equivalent to FG content of total 189 g DCP/kg group). The experiment lasted for 12 weeks. The results showed that: 1) There was no significant difference in egg production or FCR between the dietary treatments, but feed intake was decreased by DCP in the 189 g/kg DCP group. Egg weight was significantly decreased in the second half of the trial in the 144.2 or 189 g/kg DCP treatments. 2) Shell quality parameters (breaking strength and shell thickness) were not affected but eggshell weight and internal quality was significantly poorer in the 189g DCP/kg group in the second half of the trial (46-51wks). 3) No significant differences were found in production performance and egg quality between the control and FG group. 4) FG residue in blood, liver, eggs was not detected in all groups. In conclusion, the decrease in laying performance and egg quality in 189 g/kg DCP group might not be induced by the presence of FG. Dietary DCP supplementation up to 98.3 g/kg had no negative effect on laying performance and egg quality. The optimum protein substitution of DCP for soybean meal is 50%.

**Keywords:** Laying hens, degossypled-cottonseed protein, egg production performance, egg quality

*[E1-06]: Shell quality (ID: 100078)*

[China]

## **Effect of Dietary Protein Sources on the production Performance and Egg Quality of Laying Hens from 33-45 Weeks of Age**

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The shortage of feed resources, especially high-quality protein feed ingredients such as soybean meal (SBM), has been a limiting factor to poultry production, and is becoming increasingly challenging. Exploitation and evaluation of non-traditional ingredients is of great importance for sustainability of the laying hen industry. The objective of this study was to examine the effect of alternative feed protein sources on the production performance and egg quality of laying hens. A total of 216 33-wk-old Hy-Line laying hens were randomly divided into three dietary groups. Three diets based on either corn-SBM, corn-degossypolized cottonseed protein (DCP) or corn-canola meal (CM), were formulated at a fixed dietary energy concentration (2,655 kcal of AME/kg) and CP content (16.5%). The profile of different essential amino acids (standardized ileal digestible) in relation to Lys remained similar in all the diets. Each group consisted of 6 replicates of 12 hens each. The feeding trial lasted for 12 weeks. No difference were observed in egg production, average daily feed intake, average egg weight, egg/feed ratio and the percentage of broken and shell-less egg among all groups during the feeding trial ( $P > 0.05$ ). Birds fed a diet containing DCP showed lower average daily egg mass compared with those fed the SBM diet at 7-12 wk and 1-12 wk ( $P < 0.05$ ). Compared to the SBM diet, DCP diet decreased albumen height and Haugh unit but improved yolk color ( $P < 0.05$ ) at 12 wk. DCP diet reduced albumen weight ( $P < 0.05$ ) and albumen proportion ( $P = 0.056$ ) at 12 wk, and a lower yolk weight and yolk proportion ( $P < 0.05$ ) were observed in the CM group. In conclusion, replacement of SBM with CM or DCP in diets supplied to laying hens might have an adverse effect on production performance and egg quality.

**Keywords:** Laying hens, dietary protein sources, egg production performance, egg quality

[E2-01]: *Feeding, production systems and egg quality* (ID: 100179)

[Germany]

## **Nutrition of hens in extended production cycles**

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Due to ongoing genetic improvement in layer type breeders, farmers and nutritionists are facing an increasing persistency and lifetime production period of the hens. It is shown in practise that layers nowadays can produce eggs of good quality at a duration of longer than ninety weeks of lifetime. Optimal egg shell quality will be the one and only reason to sign off a layer flock with highly extended lifetime production period. Well working calcium metabolism and health status are of highest priority to ensure saleable egg shell quality under the pre-mentioned circumstances. Basic preconditions will be optimal pullet rearing, management during transfer from rearing to layer house and well-adopted nutrition at the start of the production period which means professional utilisation of nutritional tools during pre-lay period and at the start of production. The most important nutritional tool supporting calcium metabolism and egg shell quality is high quality limestone with fine and coarse structure; well balanced when the flocks are aging. As the liver functions as a very important organ in general and for egg production as well, liver health is an additional tool to boost even the egg shell quality, which is regularly proven in practise. Feeding and nutrition targeting gut health proof as further tools when it comes to supporting the egg shell quality based on an optimal nutrient and mineral absorption from the gut. Following the varying demand for calcium over the day is another idea to support the egg shell quality, which has mainly been developed in practise and under hot climate circumstances and might end up in the modern strategy of split feeding. Split feeding describes the supply of two diets, which are differing to a great extent, especially with regard to the content of calcium in the first and second half of the day and will be recommendable under high sophisticated management only. Control of egg weight throughout extended production cycles of layer flocks is an overall nutritional approach as oversized eggs will always cause downgraded egg shell quality. Last but not least it needs to be mentioned that avoiding heat stress as well as possible will be a basic request to positively influence the egg shell quality in extended lifetime production cycles of layer flocks.

Keywords: Extended production, genetic, layer breeders, egg weight

[E2-02]: *Feeding, production systems and egg quality* (ID: 100009)

[France]

## **Effect of Different Dietary Sources of n-3 Fatty Acids on the Laying Performance and Technological, Nutritional and Sensorial Quality of Eggs**

**Baeza, E. (1), Chartrin, P. (2), Lessire, M. (3), Meteau, K. (4), Chesneau, G. (5), Guillevic, M. (6) and Mouro, J. (7)**

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The aim of this study was to increase the content of n-3 fatty acids (FA) of eggs without affecting their sensorial and/or technological properties or the laying performance of hens. Laying hens 477 were distributed into 5 groups (n=40) corresponding to 5 different diets for the laying period: control (T), containing extruded linseeds exhibiting high level of fibres (GLE), extruded linseeds exhibiting low level of fibres (GLDP), microalgae, or an association of 75% GLDP and 25% MA (GLDP+MA). The dietary enrichment with n-3 FA had no effect on the laying performance, the body weight of hens and the viscosity of egg white. The yellow part of eggs produced by hens fed with diet containing microalgae was more red and darker than that of eggs from the other groups suggesting the presence of red pigments in the microalgae preparation. However, the colour difference was low and not perceptible by the human eye. Actually, the colour measurement with DSM scale of yellow egg by panellists of sensorial analysis did not put in evidence a diet effect on this parameter. The lipid content of eggs was not affected by the diets. The eggs of hens fed diets containing linseeds and/or microalgae had greater n-3 FA content (X 2.5 to 2.9 in comparison with group T). The linseeds mainly increased the content in linolenic acid (X 3.0 to 3.4 in comparison with group T) and the microalgae increased the content in LC n-3 FA (X 4.1 in comparison with group T). The dietary enrichment with n-3 FA had no effect on the sensorial quality of eggs cooked in the shell except for the criterion "abnormal flavour" which score was higher for MA group compared to the other groups and corresponding to a fish flavour.

Keywords: hen, laying performance, egg, lipid, fatty acids

[E2-03]: *Feeding, production systems and egg quality* (ID: 100080)

[China]

### **Effect of dietary Schizochytrium (*Schizochytrium limacinum*) powder and oil on n-3 polyunsaturated fatty acid composition of egg yolk**

Yue, H.Y. (1), Chen, X.L. (2), Wu, S.G. (3), Zhang, H.J. (4), Qi, G.H. (5) and Wang, J. (6)

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The study was conducted to investigate the difference of schizochytrium powder (SP) and the oil extracted from SP (SO) on n-3 polyunsaturated fatty acid (n-3 PUFA) composition of hen eggs. The original schizochytrium strain was attained from the ocean, and was then artificially bred for better quality suitable for human health care product production, and SP is the intermediate product in this process. A total of 216 25-wk-old Hy-Line Brown layers were randomly allotted to 3 treatments with 6 replicates per treatment and 12 birds per replicate. The control group (Con) was fed a diet with no schizochytrium products, the diet of the SP group contained 2.0% SP, and the SO diet had 0.91% SO. The 3 diets were then adjusted using soybean oil to balance the energy and ethyl ether extract. The feeding trial lasted 6 wks. The dietary docosahexaenoic acid (DHA) content was 0.06%, 7.39%, and 7.46% of total FAs in Con, SP and SO groups, respectively; the dietary linolenic acid (ALA) content was 5.13%, 4.22% and 4.87%; and the content of dietary eicosapentaenoic acid (EPA) in all diets was negligible. The results showed no differences on laying performance among all groups ( $P > 0.05$ ). The DHA content in the yolks was 12.23% and 12.72% in SP and SO groups, respectively, which did not differ from each other ( $P > 0.05$ ), but were both higher than the Con group (5.89%,  $P < 0.05$ ), whereas the content of ALA and EPA did not differ among all groups ( $P > 0.05$ ). The yolk content of total n-3 PUFA was 16.93% and 16.69% for SP and SO groups ( $P > 0.05$ ), which were both higher than Con (9.69%,  $P < 0.05$ ). The cell wall in SP was not disrupted, thus, it was assumed that feeding SO could improve the utilization of the PUFAs in the cell. However, the current results did not support this hypothesis, and one possible reason is that the hens can thoroughly digest the schizochytrium cell at the level of 2.0% and release the oil in it.

Keywords: Laying hen, egg, schizochytrium, polyunsaturated fatty acid

[E2-04]: *Feeding, production systems and egg quality* (ID: 100005)

[Italy]

### **Effect of a tannin from chestnut wood (*Castanea sativa* Miller) on cholesterol and fatty acids of eggs.**

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The addition of a chestnut hydrolysable tannin (commercial name: SaviotaN®), into the diet of broiler chickens induced a significantly better balance of absorbed dietary nitrogen (Antongiovanni et al., 2012) and exerted an efficient control on gut pathogenic agents, such as *Coccidia* and *Clostridia* (Tosi et al., 2013). Moreover, since tannins are known to interfere with lipid metabolism, the present work was carried out to verify whether the product could influence the lipid profile of egg yolk. The trial, to be considered as a pilot one, was performed with 40 laying hens, 20 belonging to the dwarf breed Mugellese (Mu) and 20 to the Leghorn (Le) breed, just because available at the moment by our research premises. The birds, aged 50 weeks, were randomly allotted to 4 groups of 10 hens each: 2 groups were fed a common mixed feed and worked as the control groups (groups MuC and MaC); the other 2 groups received the same feed, treated with 2 g tannin per kg feed (groups LeT and LeT). The trial lasted 8 weeks, after a 4 weeks preliminary adaptation period. During the 8 weeks of the experiment, 70 eggs from each group were randomly collected and analysed for cholesterol and fatty acid profile. Weights of eggs, thickness of shells and colour of yolks were measured as well. Weights, thickness and colour were not affected by the treatment, but cholesterol resulted significantly depressed: -9% in MuT and -17% in LeT. Among the saturated fatty acids (SFA), stearic acid (C18:0) was depressed in LeT only (-13%), whereas palmitic acid (C16:0) was depressed in MuT (-1 %) and enhanced in LeT (+ 8%). Among the monounsaturated acids (MUFA), both palmitoleic (C16:1) and oleic (C18:1) resulted increased with treatment: +36% palmitoleic in LeT only; +7% oleic in MuT and +9% oleic in LeT. The polyunsaturated acids (PUFA) which resulted positively affected by the treatment were linolenic (C18:3 n3): +50% and eicosatrienoic (C20:3 n3): +17%, both in LeT only.

Keywords: chestnut tannin, yolk egg, fatty acid, cholesterol

[E3-02]: Egg nutrients for consumer's health (ID: 100181)

[France]

### **Egg ovalbumins revisited: investigating the specificities of ovalbumin, ovalbumin-related protein X and ovalbumin-related protein Y**

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The ovalbumin gene family in *Gallus gallus* is composed of a cluster of three genes, ovalbumin, ovalbumin-related protein Y (OVAY) and ovalbumin-related protein X (OVAX) genes located on chromosome 2 (1,2). Considering their high similarity in coding sequences, these genes are likely to have arisen by duplication from a common ancestor gene (1, 2). The expression of these genes in hen oviduct is under estrogen control but their relative hormonal responsiveness is slightly distinct and their resulting expression in chicken oviduct differs in the order of ovalbumin: OVAY: OVAX = 100: 10: 1 (3). All three proteins are glycosylated: ovalbumin, possesses one glycosylation site on Asn-293, OVAY is predicted to be glycosylated on Asn-293 (4), whereas OVAX contains three glycosylation sites (5). Ovalbumin, OVAX and OVAY belong to the serine protease inhibitor (serpin) family which members share a common tertiary structure as well as a consensus sequence of 11 residues near the C-terminus of the protein. Ovalbumin is one of the few members of this family that does not express any protease inhibition activity. As for OVAX, recent data have shown that this protein could not inhibit trypsin, chymotrypsin nor cathepsin G proteases (5). OVAY has been predicted to inhibit serine proteases by comparison of its protein sequence with inhibitory serpins (6) but this hypothesis remains to be validated. In contrast to ovalbumin and OVAY, OVAX has a high affinity for heparin, a negatively charged glycosaminoglycan. This property can be explained by the presence of a cluster of positive residues exposed at the surface of the molecule, as suggested by the tridimensional structure model of OVAX. This cluster is thought to be involved in the antimicrobial activity of OVAX (5). Ovalbumin is the major egg white protein (about 50 mg/mL of egg white) with still undefined function. The physiological function of OVAY is not known but data from the proteome comparison between fertilized and unfertilized eggs have revealed a possible role of this protein in embryonic development (7). Considering the antibacterial activities of OVAX, this protein might play a role in egg defense. This review gives an update of the specificities and the predicted diverging functions of these three homologs, which might explain why these three genes have been conserved in the *Gallus gallus* genome during evolution (8).

Keywords: egg, ovalbumin-related proteins, structure, function

[E3-03]: Egg nutrients for consumer's health (ID: 100018)

[France]

## Claims, value and internal egg quality in table eggs from supermarkets in the area of Saint-Brieuc, France.

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The objective of this study was to evaluate table eggs bought in six supermarkets in the area of Saint-Brieuc (France). The eggs were acquired on the same day. Eggs were originated from furnished cages 35%, organic 25%, free-range 24% & label rouge 16% systems. Thirty eggs of each brand, registering labels and prices were evaluated for Haugh units, yolk colour (DSM YolkFan and colourimeter  $L^*a^*b^*$ ), egg faults like mottled eggs, meat & blood spots, colour spots. Analyzing a total thirty-one different brands only medium eggs, the best date use was selected to be comprised in a ten days period. The statistics were run with Minitab 16. Significant differences were revealed when  $P < 0.05$ . The average egg was priced at 0.24€ +/-0.09, with average yolk colour 11.6+/-1.4 (YolkFan), Haugh unit 77.1+/-8.9, meat and blood spots 1.5+/-0.7 (1 No spot 2 small 3 big). Mottled eggs represented 3.3% of all eggs and yolk colour spots 5.8%. 80% of brands were making claims, mainly about housing and mode of production, a few about nutritional claims, GMO-free or environment friendly. 35% of brands were branded by retailers. Egg price was significantly depending on the supermarket and production system. In general freshness was good with Haugh unit higher than 70 and significantly higher in Label Rouge eggs. It was found more meat and blood spots in organic eggs. Yolk colour was significantly depending on the shop, the brand and the housing system. The colour was higher and more homogeneous in cage eggs compared to alternative systems eggs. Cage and label rouge presented the highest YolkFan™ value when compared to organic and free-range eggs. The homogeneity of the yolk colour inside the box improved significantly when the colour intensity increased. There was a good correlation between colour measurements:  $YolkFan^{TM} = 11.5 + 0.0169 L^* + 0.376 a^* - 0.0687 b^*$  with  $R^2=85\%$  ( $P < 0.01$ ).

Keywords: Egg, yolk colour, price, label, supermarket

[E3-04]: *Egg nutrients for consumer's health* (ID: 100126)  
[Denmark]

## **Organic egg quality – from the scientific and the consumer point of views – a Danish study**

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In a recent experimental study, the effect of providing egg-laying hens with forage material in the organic egg production on various egg quality parameters was evaluated. A follow up study was performed on the consumer behavior in buying eggs and expectations to egg qualities from different production systems with specific focus on organic eggs. The experimental study showed that providing forage material (maize silage, alfalfa silage, grass-herb silage, hemp silage, or vegetables) versus no forage material to the egg laying hens had an overall effect on the egg yolk colour parameters (L, a, b), the content of xanthophylls (lutein and zeaxanthin) in the egg yolk, egg albumen dry matter and albumen gel textural properties. Furthermore, a sensory evaluation of boiled eggs resulted in an overall significantly higher score for positive flavour descriptors of eggs from hens provided forage material compared with eggs from hens not provided forage material regardless of the type of forage material. The findings from the experimental study were related to a consumer (n=1060) study with representation of consumers buying cage eggs (n=200), barn eggs (n=317), free-range eggs (n=142) and organic eggs (n=401). The overall most important parameters when buying eggs were production system and freshness of the eggs. For organic egg consumers, the parameters ecology, animal welfare and local production had high importance (37-73%), while the egg yolk colour was only important for 6% of these consumers. Only few consumers (21%) had heard of or had knowledge about lutein, however, among these there were awareness of that lutein is a pigment, that it is good for the eyes/the vision, and that it is an antioxidant. Eggs are regarded healthy by most consumers (79%), which were related to the high protein content. A group of 32% of the total amount of consumers expect organic eggs to have a different taste in the direction of 'more taste, more filling and more fresh'. The downside to the buying of organic eggs is that 68% of the consumers find them expensive.

**Keywords:** Organic egg quality, forage material, maize silage, alfalfa silage, vegetables, consumer

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[E3-11]: Egg III Extra session (ID: 100069)

[Indonesia]

**Identification of supply chain performance factors for layer chicken agribusiness in Rajawali poultry shop with partnership system.**

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One of the many strategies developed to increase the competitive advantage of a layer chicken agribusiness is integrated supply chain management. This research was conducted on March 1st - June 30th, 2014. A case study in Rajawali Poultry Shop doing a system of partnership. The aims of this study were to analyze factors affecting company performance and the increase of competitiveness of Rajawali Poultry Shop, to analyze supply chain application, and to create strategic implication for performance improvement in order to increase the competitiveness. This research was conducted through three stages: (1) gathering data and information related to supply chain activities (2) analyze data resulted from the key driver in supply chain management; (3) analyze data related to supply and transportation performance; using primary and secondary data. Research variables include supply chain system, supply activities, production activities, transportation activities, and marketing activities. This research used primary data, which were obtained by doing observation on supply chain activities, and secondary data, which were obtained from the company's historical data and other publication related to this research. Fishbone diagram (Ishikawa) was used to identify the factors affected. Meanwhile, the supply chain performance was analyzed by using supply-demand approach, inventory management approach, and transportation activity approach. Result indicated that Rajawali's key success factors in running agribusiness with partnership model were capital ownership and continuous input supply. Company performance analysis shows that the company should consider being focus in production strategy in relation with supply allocation, concentric diversification strategy with the use of alliance, and intensive strategy as a form of market diversification effort and product differentiation.

**Keywords:** competitiveness, factors affected, capital ownership, input supply

[E3-12]: Egg III Extra session (ID: 100085)

[Indonesia]

## **Analyzing of Comparative Value Added “Rendang Telur and Rendang Suir Itik” From Small Firm’s as Result From Advanced Processing Poultry Product**

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Rendang is traditional minang food, West Sumatra, Indonesia. The raw materials of rendang are beef and spices. Nowadays, rendang is produced from other raw materials, such as chicken/duck eggs (which is called ‘Rendang Telur’) or meat from duck (‘which is called Rendang Itik Suir’). The objective of this research was to analyse and compare the Value Added through processing of poultry products into “Rendang Telur” “or “Rendang Suir Itik”. The performance of Small Firms producing those products can be measured from the achieved value added. Most of the performance is measured by financial ratio analysis, ratio of profitability (such as ROA, ROI, ROE, etc.). In the present study, the performance of the firm is measured by value added resulting from product processing. The measurement of Value Added (VA) was the difference between output and input (OUT – IN). Output (OUT) is revenue from operational of firm and Input (IN) is All of cost that can be earn revenue, example cost of manufacturing but exclude direct labour. This research method uses descriptive and comparative analyses, which will be conducted on small firms producing rendang telur and rendang suir itik. The research data, obtained from the small firm's financial statements and field research which will be analysed using comparative analysis. The results of this research are value added rendang suir (63,49% ) given higher percentage than rendang telur ( 36,37%), and break even point (BEP) rendang itik is 180 pack (each pack is 0.25kg) that’s lower than rendang telur 320 pack.

**Keywords:** Small Firm Performance, Value Added, Break Even Point

[E4-01]: *Impact of genetics and breeding on egg quality* (ID: 100184)

[Spain]

## **Effects of housing systems for laying hens on egg quality and safety**

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Many production factors can affect the different aspects of commercial egg quality (i.e. age of hens, genetics, feeding, temperature, and egg freshness) and thus care is needed when the effects of housing systems are compared. If the management and feeding conditions are adequate, no relevant consequences are found in the majority of scientific studies, although in non-cage systems a greater variability in several egg quality parameters is often observed. Also, despite widespread popular beliefs, nutritional value or egg flavour does not show significant differences in practice. At present, there is much more and better scientific information on the impact of housing systems on the hygienic quality and safety of the egg. In furnished cages, the proportions of dirty and broken eggs have improved, but they vary according to many details of their design and especially with the rate of use of nests and design and operation of egg collection systems. The eggshell microbial contamination has been found as slightly greater than in eggs produced in the old conventional cages. In non-cage systems, there is a trend to obtain a greater proportion of dirty eggs, but very related with the incidence of floor-lay. Levels of cracked & broken eggs seem to be lower than those recorded in cages, but this can be related to differences in design and speed of egg collection systems in facilities which are quite smaller than those using laying cages. The bacterial load of the eggshell may be 10 times greater, but still within acceptable levels, and it is influenced by the dust level in the atmosphere, which is generally greater in aviaries. However, it may be great differences between farms within the same housing system. Salmonella prevalence is at present lower in these systems than in cage facilities, due, among other factors, to the different dimension and structure of the alternative sector and the earlier and usually greater use of vaccination against Salmonella. The presence of dioxin/PCB's and other chemical residues may constitute a real risk for free-range and organic farms, if they are located on contaminated lands or near to contaminant industries.

**Keywords:** egg quality, egg safety, hen housing systems

[E4-02]: *Impact of genetics and breeding on egg quality* (ID: 100057)

[China]

## **Genome-wide association study for eggshell quality traits in an F2 chicken resource population.**

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Damaged eggshells result in losses of eggs. However, the genetic architecture underlying variation in eggshell quality remains elusive. Recent advances in next-generation sequencing technologies enable the availability of 600 K Chicken SNP array that could contribute to identify causal variants. Here, we measured eggshell quality traits, including eggshell weight(ESW), eggshell thickness(EST) and eggshell strength(ESS), at 11 time points from onset of laying to 72 wks of age and conducted comprehensive genome-wide association studies (GWAS) in 1,534 F2 hens derived from reciprocal crosses between White Leghorn (WL) and Dongxiang chickens (DX). ESWs at all ages exhibited moderate SNP-based heritability estimates (0.30~0.46), while the estimates for EST (0.21~0.31) and ESS (0.20~0.27) were relatively low. Eleven independent univariate genome-wide screens for each trait totally identified 1059, 1026 and 1356 significant associations with ESW, EST and ESS respectively. All the significant loci were in a region of chromosome 1(GGA1) spanning from 57.3 to 71.4Mb, which together can account for 8.4~16.5% of the phenotypic variance for ESW from 32 to 72 wks of age, 2.9~6.3% and 3.1~6.1% for EST and ESS from 40 to 72 wks of age. After linkage disequilibrium (LD) and conditional analysis, we found the identified SNPs in this region were in extremely strong LD status. Identification of this promising region will greatly advance our understanding of the genetic basis underlying eggshell quality and provide a potential breeding tool for the improvement of eggshell quality.

Keywords: GWAS, eggshell quality traits, GCTA heritability, chicken

[E4-03]: *Impact of genetics and breeding on egg quality* (ID: 100165)

[Pakistan]

### **Egg quality parameters in four closebred flocks of Japanese quail at three ages selected for higher body weight in 4th generation using different selection strategies**

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Present study was conducted at Avian Research and Training Centre, UVAS, Lahore to evaluate effect of different selection strategies in four closebred flocks (CBF) at three ages on egg quality parameters during 4th generation. For this, 540 Japanese quails already selected for higher body weight from four CBF (Major, Kaleem, Saadat and Zahid) at three ages (10, 12 and 14 weeks) were subjected to 3 selection strategies (i.e., pedigree, mass selection and random bred control). A total of 108 birds of higher body weight were picked up with full pedigree record whereas 324 birds with higher body weight were selected to be the parents of next generation and consider it as mass selected. However, in random bred control group, 108 birds were selected without following any selection. The effect of selection strategies in parents of Japanese quails at 3 ages from 4 CBF were measured on its egg quality traits. Data were analyzed according to Completely Randomized Design under Factorial arrangements using GLM procedures. Comparison of means were separated out through Duncan's Multiple Range test with the help of SAS 9.1. Significant effect of selection and closebred flocks was observed on yolk index and haugh unit score. Age had significant effect on egg weight, yolk index, haugh unit and shell thickness. It is concluded that pedigree based selection with different age groups and closebred flocks improved egg quality traits.

Keywords: Selection, CBF, Age, Egg quality traits, Japanese quail

[E4-04]: *Impact of genetics and breeding on egg quality* (ID: 100017)

[France]

## **Performance of laying hens in early lay and relation with antioxidant and carotenoid status of the eggs**

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Early lay period is considered as a key period to maximize performance of hens over the whole production cycle. Carotenoids have interesting antioxidants properties. The objective of this study was to monitor the performance of laying hens in early lay in various housing systems while measuring the carotenoid and antioxidant status of the eggs during the same period. Nineteen farms were selected in the western production area of France in 2012. Nine farms were equipped with furnished cages, four farms were organic and eight farms were free-range production. The performance criteria (daily feed intake, eggs laid per hen, average egg weight and viability) were recorded on each farm from 18 to 30 weeks of age. Ten eggs were sample from each farm at 22, 26 and 30 weeks of age. Pooled eggs were assessed for beta-carotene equivalent content measured with the iCheck® Egg Photometer and antioxidative status according to the Tbars measurement. The performance of laying hens depended on the housing system. In free-range systems, hens had a higher and more variable feed intake. The cumulative viability of organic and free-range farms were lower and more variable than those of furnished cage farms. There was a decrease in oxidative status of eggs when hens aged, regardless of the housing system. The carotenoid content also decreased when the hen aged and was different according to the housing system. Correlations between performance and egg markers could be detected. When the egg weight increased, the carotenoid content and the antioxidant status of eggs were higher. The carotenoid content in yolk was positively correlated to performance criteria.

**Keywords:** Early lay, hens, carotenoids, housing, antioxidant status

[E4-05]: *Impact of genetics and breeding on egg quality* (ID: 100087)  
[France]

### **Transfer to eggs of alpha-HBCD ingested by laying hens**

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Hexabromocyclododecane (HBCD) is a brominated flame retardant composed of three isomers (alpha, beta and gamma) used as an additive, notably in some insulation materials. This persistent organic pollutant may be recovered in animal products, including eggs. Concentrations are usually below 1 ng/g lipids, but atypical samples display very high concentrations reaching several hundred ng/g lipids, mainly as alpha-HBCD. Such concentrations may originate from the accidental ingestion of insulated materials by hens. The aim of the current study was to describe the fate of ingested alpha-HBCD in hens, in order to better characterize the risk of egg contamination. Forty-two laying hens (Novo Brown) weighing 1544±98 g were placed in individual cages. They were exposed to alpha-HBCD for 18 weeks by means of a feed containing 41 µg alpha-HBCD/kg, or for 11 weeks followed by 7 weeks of decontamination. Six hens, kept as control, were given a feed devoid of alpha-HBCD throughout the experiment. The kinetics of contamination and decontamination of eggs were followed. The isomers alpha, beta and gamma were analyzed in feed and in eggs by LC-MS/MS, after fat extraction and purification. Throughout the experiment, hens ingested daily 71.3±4.7 g feed/kg body weight and laid 0.97±0.03 eggs weighing 57.8±4.0 g each. These values were not influenced by the exposure to alpha-HBCD. The isomers beta and gamma were not detected in any egg sample, indicating the absence of isomerization of the alpha form. In eggs collected from the control hens, alpha-HBCD was quantified at the background level of 0.08±0.02 ng/g lipids. During the exposure period, the concentration of alpha-HBCD in eggs increased rapidly to reach 220 ng/g lipids at the end of the experiment. At this stage, it was estimated that 21% of alpha-HBCD ingested daily was eliminated through eggs. The concentration of alpha-HBCD in eggs was divided by 2 within the first two weeks of decontamination. Thereafter, it decreased more slowly and was divided by 1.3 within the five remaining weeks of decontamination. It was estimated that the daily ingestion of 160 µg of polystyrene containing 3% alpha-HBCD for 18 weeks would result in eggs containing 220 ng alpha-HBCD/g lipids.

Keywords: Alpha-HBCD, Hen, Transfer, Egg, Health quality

[E4-06]: *Impact of genetics and breeding on egg quality* (ID: 100046)

[France]

### **Brominated Flame Retardants in French eggs**

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Brominated Flame Retardants (RFB) are primarily used as additive flame retardants in insulating materials. These lipophilic compounds can bioaccumulate in animal tissues leading to human exposition via food ingestion. Although their concentration in food is not regulated yet, these persistent organic pollutants are suspected to act as endocrine disruptors. The present study aimed to quantify two families of RFB (hexabromocyclododecane, HBCDD and polybrominated diphenyl ethers, PBDE) in eggs and to identify potential sources of RFB in laying hens' environment. In 2014, an epidemiological study was carried out in 60 egg farms (30 in cages, 16 free-range farms, 7 in organic farms and 7 aviaries) in France. When the hens were older than 50 weeks, 12 eggs were sampled and pooled in omelet. Eight PBDE-congeners and 3 HBCDD-stereoisomers were quantified in egg fat using respectively Gas Chromatography – High Resolution Mass Spectrometry (GC-HRMS) and High-Performance Liquid Chromatography – tandem Mass Spectrometry (HPLC-MS/MS). At least one PBDE-congener was detected in 33 samples out of 56 (59%) but the total concentration for the 8 congeners was lower than 1.2 ng/g fat. At least of one stereoisomer of HBCDD was detected in 14 samples (25%) but the concentration remained lower than 0.5 ng/g fat. The results were similar to those obtained in the French monitoring studies in 2012 and 2013. Eggs from one farm, equipped with an old poultry house built by the farmer, displayed a concentration of  $\alpha$ -HBCDD equal to 3.4 ng/g fat, comparable to the highest levels previously observed in France. Analyses from feed and dust sampled in the farm may contribute to identify the source of contamination.

**Keywords:** egg, laying hen, brominated flame retardant, persistent organic pollutant

[E5-01]: Microbiology and safety of eggs and egg products (ID: 100187)

[France]

## Source and control of bacterial contamination in the French egg processing industry

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With 215 eggs consumed per person in 2013, France remains one of the largest consumers of eggs in the European Union. Over a third of this consumption is in the form of egg products. Egg products from 'first processing' are defined as resulting from the breaking of table eggs, giving rise to the recovery of whole egg or separated egg yolk and egg white, with the possible addition of salt, sugar and hydrocolloids. They are mainly delivered in the form of refrigerated liquid egg, but also as frozen or dried powder products. They are widely used for various food applications, suitable as ingredients for the food industry, artisans, and catering. Unlike shell eggs which are protected by the physical barriers of the eggshell and the shell membranes and by the efficient antimicrobial activities of egg white, egg products are very sensitive from a microbiological point of view. That is the reason why a particular attention is paid on the microbial control of bacterial contamination along the different steps of egg processing. Liquid egg products are systematically pasteurized and stored at chilled temperatures. These processes allow controlling pathogenic bacteria, including *Salmonella Enteritidis*, which remains the main bacterium involved in foodborne diseases associated with egg and egg product consumption. However, the mild heat processes carried out for respecting the conformation of egg proteins are too low for eradicating heat-resistant bacteria, and particularly when these bacteria present the specific ability to settle in the industrial equipment in the form of biofilms. In addition, psychrotrophy may represent an advantage for this flora to grow in the egg products, leading to spoilage events during storage, and particularly in the case of compromised cold chain integrity. A focus will be made on this emerging flora which control would help reducing food wastes in the future.

Keywords: egg product stabilization, heat-resistant bacteria, biofilms, psychrotrophy, spoilage

[E5-02]: Microbiology and safety of eggs and egg products (ID: 100192)

[Belgium]

### **Salmonella Enteritidis persists in the laying hen oviduct by suppressing flagellin-induced inflammation**

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Egg borne *Salmonella* Enteritidis has been the cause of a pandemic of human food poisoning. Eggs become internally contaminated following colonization of the hen's oviduct. Using a *Salmonella* microarray we showed that genes encoding flagellar structures were downregulated in the oviduct. In a transposon library screen for identification of genes that contribute to oviduct colonization, it was found that mutations in genes related to flagellar motility result in increased oviduct colonization. Flagellin is a pathogen associated molecular pattern (PAMP) known to bind to Toll-like receptor 5 (TLR-5), activating a pro-inflammatory cascade. It was hypothesized that *Salmonella* Enteritidis downregulates its flagellin-expression in the oviduct to avoid an inflammatory response, thereby increasing its persistence in this tissue. Transcription of selected cytokines and chemokines was determined in primary chicken oviduct epithelial cells following in vitro inoculations with purified *Salmonella* Enteritidis flagellin. Flagellin stimulation of oviduct epithelial cells resulted in upregulation of the chemokine CXCLi2 and the pro-inflammatory cytokine IL-1 $\beta$ , confirming the inflammatory potential of flagellin. When *Salmonella* Enteritidis flagellin was injected in the oviduct of anaesthetized laying hens, it caused a severe inflammatory reaction. In conclusion, *Salmonella* Enteritidis flagellin induces the epithelium to orchestrate a mucosal inflammatory response in the oviduct of laying hens. *Salmonella* Enteritidis thus benefits from downregulating flagellin expression in the oviduct to avoid inflammation and thus increase persistence.

Keywords: chick, *Salmonella*, oviduct, flagellin, inflammation

[E5-03]: Microbiology and safety of eggs and egg products (ID: 100075)

[Australia]

## **Dynamics of Salmonella typhimurium shedding from early to peak lay in laying hens**

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Globally, Salmonella is a common cause of food-borne human gastroenteritis. It can be transmitted through consumption of contaminated eggs and chicken meat. In Australia, Salmonella Typhimurium (S. Typhimurium) is the most frequently reported serovar in egg related food poisoning. Shedding of Salmonellae in chicken faeces can be intermittent and may increase the chances of egg shell contamination. The present experiment was conducted to study the shedding of S. Typhimurium definitive type 9 (DT9) in eggs and faeces of laying hens, challenged before onset of lay. In addition, co-infection with an additional serovar, S. Mbandaka, was also examined to determine if there was an effect on the shedding of DT9. At 14 weeks of age, hens were orally inoculated with 10<sup>9</sup> colony forming units (c.f.u.) of either DT9 or a combination of S. Mbandaka and DT9. Faecal samples were collected on day 1 post-infection (p.i.) followed by 1, 2, 4, 6, 8, 10, 12, 14 and 16 weeks p.i. All faecal samples were processed for enumeration of Salmonella by MPN (most probable number test) method. All eggs laid during 6, 8, 10, 12 and 14 week p.i. were also collected. A total of 320 faecal and 895 egg samples were analysed for the presence of Salmonella spp.. Salmonella counts in faeces ranged from 1.53 to 48.53 MPN/g for birds infected with DT9 only and 0.78 to 44.80 MPN/g in the birds infected with DT9 and S. Mbandaka. The frequency of egg shell contamination ranged from 9.52 to 21.74% for DT9 and 10.89 to 33.33% in the co-infected group. Both groups had the highest rate of Salmonella shedding on egg shell at the onset of lay (6 weeks p.i.). Over the course of the experiment, Salmonella was not detected in egg internal contents in either group. The above findings suggested that there was intermittent and prolonged shedding of Salmonella in the faeces and that the occurrence of egg shell contamination was higher during early lay.

**Keywords:** Salmonella, laying hens, dynamics, shedding, eggs.

[E5-04]: Microbiology and safety of eggs and egg products (ID: 100090)

[Brazil]

## Resistance profile and virulence of isolates of *Salmonella* sp. From commercial layer houses

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The occurrence of bacterial resistance to antimicrobials is a clear risk to human and animal health and a great effort has been done by national and international organisms in order to control this microorganism. Feed chain is considered an important way to disseminate resistance in man and animals. Resistance profile for *Salmonella* sp. needs to be controlled in order to help in the treatment of the diseases and to evaluate the possible occurrence of multi-resistant strains. In this study we aimed to investigate the resistance profile of isolates from *Salmonella* sp. and to assess the presence of virulence gene *spvC* and the resistance genes *intl1*, *sul1* and *blaTEM* in *Salmonella* isolates antigenically characterized as Agona, Livingstone, Cerro, Schwarzengrund, *Salmonella enterica* subs. *enterica* O:4,5, Anatum, Enteritidis, Johannesburg, Corvallis and Senftenberg. We submitted these isolates to a sensitivity test to some antimicrobials: sulfamethoxazole (25µg), trimethoprim-sulfamethoxazole (25µg), enrofloxacin (5µg), tetracyclin (30µg) sulphonamides (300µg), ciprofloxacin (10µg), amoxicillin and clavulanic acid (3µg), ampicillin (20µg), ceftiofur (30µg), gentamicin (10µg), oxytetracyclin (30µg), neomycin (30µg), doxycyclin (30µg) and apramycin (15µg). The highest resistance percentages observed were to sulfamethoxazole (91,0%), sulphonamides (51%) and ceftiofur (28,9%) and 0% to ciprofloxacin. Only *Salmonella* Johannesburg and *Salmonella* Corvallis have shown resistance for only one antibiotic and other serovars were resistant for at least two antimicrobials, and we observed that *Salmonella* Schwarzengrund were resistant for 13 of them. The gene *spvC* was detected only in the serovar Enteritidis. The gene *intl1* was present in six of the ten serovars analyzed and the gene *sul1* in three of them, always in association with *intl1*. The gene *blaTEM* was not identified. We can conclude that resistance to antimicrobials done simultaneously with the research of genes of virulence and resistance towards antibiotic genes *Salmonella* sp. isolates in commercial layer farms consists in an important investigation tool to determine genetic profile for these bacteria.

Keywords: antimicrobials, *Salmonella*, *sul1*, virulence genes

[E5-05]: Microbiology and safety of eggs and egg products (ID: 100115)

[Spain]

## **Relative importance of egg natural defences (cuticle, albumen proteins) against egg bacterial contamination**

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Hen eggs are one of the most consumed foods due to their great nutritional value and relative low cost. Nevertheless, they are commonly associated with food borne diseases due to bacterial contamination (e.g., *Salmonella enteritidis*, *Escherichia Coli*). The egg has its own physical and biochemical barriers that prevents bacterial penetration and which are collectively known as “egg natural defenses”. The first line of defence is the eggshell, a thin mineral structure that protects the egg contents against mechanical impact, dehydration, and microorganism contamination. The eggshell is covered by a very thin organic layer, the cuticle, which plugs the entry to the shell pores and regulates the eggshell permeability thereby presumably preventing bacterial penetration. If microorganisms manage to penetrate this first barrier of defence, they will next encounter the shell membranes and then the albumen, both of which exhibit potent anti-microbial activity. To evaluate the relative importance of the the cuticle and egg white proteins were exposed to *Salmonella* and *E. coli* by immersing the egg in bacteria suspensions during 3 min. The thickness, degree of coverage, morphology and chemical composition of the cuticle of eggs which were either contaminated or uncontaminated following inoculation were analyzed using scanning electron microscopy (SEM) and attenuated total reflection-Fourier transform infrared spectroscopy (ATR-FTIR). Ultra performance liquid chromatography (UPLC) was used to quantify the antimicrobial proteins in the albumen of contaminated and uncontaminated eggs. The results showed that the functionality of the cuticle against bacterial penetration was highly dependent not only on the thickness and degree of cuticle coverage but also on its maturity and chemical composition. Eggs with an immature and/or with a cuticle depleted in proteins were more easily contaminated as they are not able to resist bacterial penetration. Non-contaminated eggs also had significantly higher concentrations of antimicrobial albumen proteins (i.e., lysozyme) in their albumen than contaminated eggs, being the first more effective in preventing the contamination of the egg content. These results confirm the importance and effectiveness of egg natural defenses against bacterial contamination.

Keywords: Cuticle, albumen proteins, *Salmonella*

[E5-06]: Microbiology and safety of eggs and egg products (ID: 100106)

[United Kingdom]

## **Cute Egg – An investigation of tools to quantify and improve the quality of the eggshell cuticle**

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Commercial poultry production relies on the artificial incubation of eggs. Conditions in the incubators are as ideal for rapid microbial growth as they are for the growth and development of the embryo and keeping micro-organisms out of the egg can be a challenge. Opportunities for horizontal transmission occur during the collection and transportation of eggs and the vertical transmission from breeder hens to production flocks has been identified by EFSA as the most likely route of transfer of antibiotic resistant *E. coli* and *Salmonella* spp. (Bain et al., 2013). The cuticle is a glycosylated protein layer which covers the surface of the egg. We have previously presented evidence that the cuticle forms the first line of defence to the penetration of bacteria and that cuticle deposition can be quantified by staining eggs and measuring the change in % reflectance at 640nm. Using this rather cumbersome methodology, we established that cuticle deposition is a heritable trait ( $h^2$ , 0.27) and therefore has the potential for improvement by genetic selection. The Cute Egg study addresses the physiochemical, physiological and genetic parameters that characterise the cuticle and develops a new, simple, one step fluorescence-based measurement tool for cuticle assessment. In the validation of this new tool, we use attenuated total reflection-Fourier transform infrared spectroscopy (ATR-FTIR) to correlate findings between the reflectance method and the new fluorescence method. This ATR-FTIR approach, whilst destructive of the sample and therefore not an end use tool, provides added information regarding the structure, morphology, and chemical composition of the eggshell cuticle [Rodríguez-Navarro et al., 2013]. The amount of water, proteins, sulfate, phosphate, carbonate, polysaccharides, and lipids can be determined by this ATR-FTIR from the absorption peaks associated to a characteristic molecular group. Resulting data indicates that both the age and water content of the eggshell significantly affects the type and amount of protein measured at the interface of the instrument. Thanks to this validation step, we can now apply our new one step measurement to estimate reliable heritability for cuticle coverage in both meat and egg laying strains of poultry. The results generated show a repeatability of 0.758 amongst bird and will provide important information leading to accurate genetic selection for improved cuticle coverage reducing the risk of pathogens entering the egg.

**Keywords:** Eggshell, cuticle, glycoprotein, fluorescence, ATR-FTIR

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[E7-01]: *Technological properties of eggs as food ingredient* (ID: 100110)

[Italy]

## **The effects of novel pasteurization technologies on egg product functionalities**

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Egg products are protein ingredients with multiple functional properties such as gelling, foaming, binding adhesion and emulsification. Because of such properties, these ingredients are desirable in many foods, such as bakery products, meringues, meat products and cookies. Pasteurization of liquid egg products is commercially performed in conventional high-temperature-short-time equipments that can negatively affect product functionalities. The recent development of alternative processing technologies, such as high hydrostatic pressure, ultraviolet radiation, pulsed electric fields, high pressure homogenization, microwave-assisted pasteurization, and ohmic heating, offers the potential to inactivate microorganisms, reduce loss of essential nutrients, and maintain functional properties. The aim of this review is the discussion of results reported in the literature about the effects of these novel pasteurization technologies on egg product functionalities. Moreover, preliminary results of an ongoing research aiming at the study of the ohmic heating effects on gelling and whipping properties of liquid whole egg will be illustrated.

Keywords: Egg products, functional properties, pasteurization technologies

[E7-02]: *Technological properties of eggs as food ingredient* (ID: 100045)

[Germany]

## **Improvement of emulsifying properties of hen's egg yolk fractions by combined enzymatic and heat treatment**

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Hen's egg yolk is used as emulsifying agent in a great variety of food products like mayonnaise or salad dressings. It is composed of two main fractions, the water soluble plasma fraction which mainly consists of low-density-lipoproteins (LDL) and the granula fraction with high-density-lipoproteins (HDL) and a smaller amount of LDL. The two fractions can be separated by centrifugation in the supernatant plasma and the sediment granula. The emulsifying properties of the two fractions are very different. Former investigations have shown that the two fractions emulsifying properties can be influenced by salt concentration, pH value and enzymatic treatment with phospholipase A2 (PLA2). The enzymatic treatment causes transformation of phospholipids (PL) of LDL micelles to lyso-Phospholipids, which show increased heat stability and higher solubility in water afterwards. It is further known that egg requires pasteurization for long term storage stability. However, the heating intensity is limited to low  $\theta/t$ -conditions due to high dry matter level in egg yolk. During heat treatment negative changes like denaturation or aggregation would occur above critical limits. The aim of the studies was to influence the functional properties of the egg yolk granula and plasma by combining an enzymatic pretreatment with a defined heating process. Therefore, tests are carried out at  $\theta/t$  - combinations in the area of pasteurization and above at characteristic milieu conditions and pH values. The results show that without enzymatic pretreatment the particle size of the plasma fraction increases depending on heating temperature and time and as consequence the viscosity increases even towards the formation of a gel structure. In contrast the pretreatment of the plasma fraction with PLA2 allows higher heating temperatures, whereas the particle size only shows a slight increase and the product still stays in a fluid state. Similar results can be found for the granula fraction. So it is possible to obtain a targeted functionalized and microbially safe product for specific applications.

Keywords: egg yolk fractions, emulsifier, phospholipase A2, heat treatment

[E7-03]: *Technological properties of eggs as food ingredient* (ID: 100094)

[Turkey]

## **FT-NIR Application as An Alternative Tool for Evaluation of Ozone-Treated Eggs Freshness during Storage**

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Eggs' nutritional composition is characterized by a high content of proteins and lipids, being considered one of the most complete food products for the human diet. The quality assessment of fresh eggs and egg products is performed using destructive and time-consuming methods, therefore the use of fast tools becomes necessary. Near Infrared (NIR) spectroscopy is considered a very reliable, fast, fully automated, reliable and nondestructive for determining functional groups (C-H, N-H and O-H bonds) and monitoring the changes of organic matter and water in foods.

The eggs were exposed to various ozone concentrations (2, 4 and 6 ppm, 2 and 5 min) at room temperature. Eggs were scanned in FT-NIR spectroscopy with using a Bruker multi-purpose analyze, equipped with an InGaAs detectors working in the 800–2500 nm to quantify of fresh eggs at end of storage.

There were clear differences between the typical average absorbance spectra corresponding to the ozonated eggs and also control at the end of the storage. The absorbance spectrum stays relatively flat from 800 to 1300 nm. A prominent peak appears at 1410 nm (OH vibration of water), and a combination band at 1940 nm (involving OH stretching and OH deformation) coincides with the water absorption peak, which is due to absorption by water and carbohydrate. The wavelength region from 2000 to 2400 nm had particularly noticeable organic matter spectral differences. There are shifts in absorption to lower or higher wavelengths, and these shifts seem to be in relation (state of water in food) to the hydration potential of the respective solutes. At the end of the storage, absorption peaks dropped for control and 2,4 and 6 ppm when compared with other treatments.

The present study demonstrates the potential application of the FT-NIR in determination of internal qualities of eggs freshness. NIR spectroscopy is a very extremely reliable, nondestructive and rapid technique for the prediction of qualitative chemical and physical properties of fresh eggs.

**Keywords:** FT-NIR spectroscopy, eggs, gaseous ozone, storage.

[E7-04]: *Technological properties of eggs as food ingredient* (ID: 100145)

[Brazil]

## **Physical and chemical modifications and functional properties of white eggs as a function of time and conditions of storage**

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In this study we investigated changes in quality, chemical composition and functional properties of eggs from Lohmann hens at 50 weeks of age. A total of 240 eggs weighing between 55 and 65g were stored at ambient condition and under refrigeration for 28 days. We used a completely randomized design with 10 treatments in a 2x5 factorial scheme (two temperatures and five storage times), six replications and four eggs per experimental unit. To determine the quality we evaluated egg, albumen, yolk and shell weight, yolk index, Haugh unit, albumen, yolk and shell percentage and, albumen and yolk pH. Chemical composition was evaluated for crude protein, total fat, total solids, ash, and moisture for both albumen and the yolk. Functional properties studied were formed and drained volume of the foam, volume of oil used to form the emulsion, early destabilization of the emulsion and yolk colorimetry. Eggs stored under refrigeration maintained good quality during the 28 days of the experiment while eggs kept at ambient condition showed lower quality after seven days of storage. The egg weight decreased with increasing storage period with lower values for eggs stored under ambient conditions. The pH of yolk and albumen of chilled eggs remained lower than that of eggs stored under ambient conditions. Eggs stored under ambient conditions showed worse values for UH, but the days of storage influenced it negatively at both temperatures. The yolk index of refrigerated eggs was always higher than that of eggs stored under ambient condition, chilled eggs presented initial increase of yolk index compared to fresh eggs. The increase of storage period caused the decrease of the total solids in the yolk and increase in the albumen. The greatest loss of moisture of albumen verified at ambient condition, which led to higher rates of total solids occurrence. Regardless of the temperature, there was a decrease in the foam volume after 14 days. The storage under refrigeration favored foam stability, reduced volume of oil used to form emulsion and intensifying the color of the yolk. The storage of eggs under industrial cooling allows the use of older eggs.

Keywords: Egg yolk, egg white, foaming, storage, total solids

[E7-05]: *Technological properties of eggs as food ingredient* (ID: 100156)

[France]

### **Antibacterial activity of egg albumen during incubation**

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The aim of the present work was to analyse the change of egg white antibacterial activities during egg incubation. Embryonic (E) and unfertilized (U) eggs were incubated for several periods of time, from 0 to 12 days, and the resulting egg whites were analyzed for their pH, protein content and for their antibacterial properties against 5 pathogenic strains. The changes in egg white pH values differed between U and E eggs. Egg white concentrations remained stable during incubation for U eggs but significantly increased for E eggs. At constant protein concentration and for an identical duration of incubation, egg white activities against *Listeria monocytogenes* et *Streptococcus uberis* were similar between E and U groups. A progressive decrease in these activities was however observed depending on the incubation time, regardless of the egg group (U or E). A discrete change in the profile of egg white proteins is also observed during incubation but no difference was noticeable between both groups (E versus U). To conclude, the antibacterial activity of egg white proteins progressively decreased during egg incubation. This observation could result from the alteration of specific antimicrobial proteins. Taken together, these data support that the egg white antibacterial defence is altered during egg incubation, suggesting that new compensatory protection systems might be set up during embryonic development to overcome this apparent weakening.

**Keywords:** Egg white, antibacterial activity, egg incubation

[E7-06]: *Technological properties of eggs as food ingredient* (ID: 100108)

[Brazil]

**Better inner quality of commercial eggs, compared to fertilized eggs, stored in room temperature during different periods.**

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There are lots of factors can induce the egg quality like bird physiology, laying period, cage type and its capacity, eggs gathering frequency, birds age, nutrition, handling, facilities, birds sanity, local temperature, storage period and humidity and temperature during this storage period. The aim of this study was to evaluate the inner quality of commercial eggs (unfertilized laying hens), fertilized eggs of laying breeders and fertilized eggs of broiler breeders, submitted to different storage periods. 216 red eggs of 40 weeks old were used, being 72 eggs of laying hens (Isa Brown), b.72 fertilized eggs of laying breeders Hy-Line W36 and 72 fertilized eggs of broiler breeders Cobb. It was used a 3x5 factorial arrangement (tree kind of eggs and five storage periods) with 12 repetitions for the physical characteristics. The evaluated parameters in these periods (0, 7, 14, 21 and 28 days) were: eggs weight, Haugh unit and yolk index. The commercial eggs present, initially (0 day), better inner quality (greater values for yolk index and Haugh unit) and lower quality losses during the storage period, as well as the weight loss is lower in these eggs than the others during the same periods.

Keywords: pH, Haugh unit, yolk index, laying hen, breeders

[E8-01]: *Advances in egg processing technologies* (ID: 100191)

[Slovakia]

## **Eggshell membrane: an unique waste biomaterial with multidisciplinary applications**

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Eggshell membrane (ESM) is a unique biomaterial, which is generally considered waste. However, it has extraordinary properties which can be utilized in various fields and its potential applications are therefore being widely studied these days. Within the presentation, the examples of multidisciplinary applications of the ESM will be given. The author has published a review paper on this topic recently (Baláž 2014). Particular attention will be devoted to the utilization of the ESM as a biotemplate for the synthesis of nanoparticles, as a sorbent of heavy metals and dyes, as the main component of various biosensors and in medicine. Moreover, the preparation and utilization of soluble eggshell membrane protein (SEP) will be also mentioned. In the last part of the presentation, the research activities of the authors' scientific group dealing with eggshell biomaterial in general will be mentioned, as they may be of great interest for the symposium community. Also concrete examples will be given, e.g., the utilization of planetary-ball-milled eggshell as an adsorbent of heavy metals from wastewaters, or the utilization of the ESM for the mechanochemical synthesis of semiconductor nanocrystals (Baláž 2013a,b). This work was supported by the Slovak Grant Agency VEGA (project 2/0027/14). Baláž M. 2014. Eggshell membrane biomaterial as a platform for applications in materials science. *Acta Biomaterialia* 10, 3827-3843.

**Keywords:** Eggshell membrane, waste, adsorbent of heavy metals, semiconductor nanocrystals

[E8-02]: *Advances in egg processing technologies* (ID: 100198)

[Japan]

## **Applications of anti-pathogen egg yolk antibody (IgY) in Japanese food industry**

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Almost 35 years have passed since Dr. Polson reported a preparation of antigen-specific IgY from egg yolk of immunized hen in the *Journal of Immunological Methods*. Since then, eggs have gained much attention for an economical and convenient source of specific antibodies to be used in not only the immunodiagnostic field but also passive immunization against infectious diseases.

Around 1985 I have developed a purification method of IgY using food grade poly-anions such as sodium alginate or lambda-carrageenan as a lipoprotein precipitant. As the result, I have researched properties of IgY and its applications in the food industry for almost 30 years. I have mainly focused on the use of IgY for prophylactic purpose of preventing pathogens from adhering onto cells at the infection site.

So far, I have reported preparation of specific IgY against bacterial pathogens such as *S. mutans*, *P. acnes*, *H. pylori*, *E. tarda*, and *A. salmonicida*. In addition, specific IgY against viral pathogens such as Human Rotavirus, Rabies virus, Influenza virus and Koi Herpes virus have also been prepared in my IgY research projects. Most of these IgY were shown in animal test to be effective in prevention of infectious diseases caused by corresponding pathogens. Some of them have also been proven its preventive effect in human volunteer tests so as to be applied in bioactive processed foods.

One of my IgY projects has shown preferable productivity of the IgY by use of hen immunization method over that of the serum IgG in the conventional rabbit immunization method. For example, an immunized hen yields about 40g IgY per year through her eggs, however IgG to be produced by an immunized rabbit is only 1.4g or so. So, the productivity of IgY from hen eggs is nearly thirty times greater than that by rabbit based on the weight of antibody produced per head per year. Moreover, production of IgY from hen's egg does not require sacrificing animals. Therefore, IgY has been considered as a perfect antibody source for use in an oral passive immunization.

In this eggmeat2015, I will introduce practical applications of anti-pathogen IgY, such as anti-*S. mutans* IgY for prevention of dental caries, anti-*H. pylori* IgY to fight stomach ulcer, anti-rotavirus IgY against infant diarrhea, and so on. Some specific IgY have already been utilized as a functional ingredient for tablet sweets or yogurt and have been sold well for more than 10 years in the Japanese food market.

**Keywords:** IgY, egg yolk antibody, passive immunization, *S. mutans*, *H. pylori*

[E8-03]: *Advances in egg processing technologies* (ID: 100159)

[Germany]

## **Modification of egg white protein hydrogels by treatment with salt and ethanol solutions in the production process of highly porous protein aerogels**

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Egg white is known for its excellent gelling behavior. It consists of several proteins with differing physicochemical properties. Hydrogel formation can, therefore, easily be influenced by adjusting the pH-value and ionic concentration. This induces different network structures, when egg white protein hydrogels are dried. Unlike common drying methods such as drying at ambient conditions or freeze drying, solvent extraction with supercritical CO<sub>2</sub> causes almost no damage to the protein network structure. The resulting aerogels have as outstanding characteristic a specific inner surface of up to 500 m<sup>2</sup>/g. They feature the possibility of impregnating this surface with sensitive or sensory unpleasant substances to protect the encapsulated core material from extreme pH-values, oxidation, light and other detrimental effects. Producing aerogel microcapsules asks for the formation of hydrogel micro particles. One way to do so is to emulsify an egg white protein solution in oil and induce the gelification by heat. In order to perform the supercritical drying, the water in the hydrogel has to be exchanged entirely to CO<sub>2</sub>-soluble ethanol. A high specific inner surface can only be reached, when swelling and shrinkage is reduced to a minimum. Such changes of the volume damage the hydrogels protein network and reduce the specific inner surface. In this study changes in structure and texture were investigated caused by different salt and ethanol solutions. Results show that immersing the particles in pure water leads to an expected increase of up to 3 fold the original weight. An addition of small amounts of CaCl<sub>2</sub> reduces the swelling to a minimum. Ethanol leads at concentrations above 60% to a reduction in size and an increased hardness of the gels. The composition of egg white allows the formation of any number of aerogel structures. This opens a complete new field of application for egg white as microencapsulation material.

Keywords: gel, microencapsulation, aerogel, supercritical fluids

[E8-04]: *Advances in egg processing technologies* (ID: 100049)

[Germany]

## **Enabling pasteurization of liquid egg white by pre-fractionation of the heat-sensitive proteins**

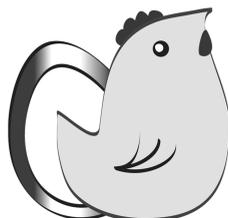
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Based on its excellent functional properties, egg white (EW) is an often used protein source in food industry. Nowadays, it is mostly distributed as powder because of the difficulties to pasteurize it in its liquid state. The USDA pasteurization requirements for albumen recommend at least 56.7°C for 3.5 min or 55.6°C for 6.2 min. But these temperature-time-combinations are not intensive enough to prevent microbial growth. However, it is not possible to use more intensive pasteurization conditions, because EW includes two heat-sensitive proteins (ovotransferrin, lysozyme). So, the objective of this work was to improve the pasteurizability of liquid EW by the fractionation of these proteins. The hypothesis was that by removal of them, the remaining EW can be pasteurized with more intensive temperature-time-profiles, and therefore, be distributed in its liquid form without microbial risk. The heat-sensitive proteins lysozyme and ovotransferrin can be long-term pasteurized in their dry state as usual and be distributed as protein powder with the focus on their specific bio-functionalities. To realize this pre-fractionation, the viscosity of EW needs to be decreased, firstly. This was successfully done by a high-pressure-homogenization treatment (~70 mPas to 3 mPas). Afterwards, the fractionation of lysozyme and ovotransferrin was carried out with membrane-adsorption-chromatography in pilot-plant-scale. The special construction of the used membrane-adsorber leads to a convective flow through a channel of 250 µm instead of a transport through pores. Thereby, significantly higher flow rates are possible and there is no need to pre-filter the substrate as for common chromatographic processes. Afterwards, the resulting depleted EW was characterized concerning its protein denaturation as well as its gelling behavior to detect the highest possible temperature-time combination for future EW pasteurizations. In summary, it was shown that the fractionation of heat sensitive protein components is a suitable method to ensure the pasteurization of susceptible substrates.

**Keywords:** egg white, fractionation, heat-sensitive proteins, pasteurization



Egg Meat 2015

*XXII European Symposium on the Quality of Poultry Meat*  
*XVI European Symposium on the Quality of Eggs and Egg Products*

Nantes (France) May 10 to 13, 2015

**Reviews and oral communications**  
**Common session**

[EM-01]: Combined Egg and Meat (ID: 100185)  
[France]

### **Managing poultry meat quality by nutrition**

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Poultry products are mainly consumed as cut and processed products. Therefore, it is no longer enough for broilers to have high slaughter yields and desirable carcass conformation. Good esthetic and functional characteristics must be taken into consideration to satisfy the demands of both processor and consumer. Meat quality is under a complex control including genetics, rearing and slaughter factors. These factors influence the chemical composition of the meat but also the post-mortem muscle metabolism which determine a large number of technological and sensory qualities. This review focuses on the recent advances showing that nutrition can be an effective tool to control muscle development and meat quality in poultry. In particular, the intake of protein, which largely determines muscle growth and yield, may also affect several molecular pathways with significant consequences on muscle post mortem metabolism and meat quality. Indeed, the amino acid supply during the finishing period or just before slaughter can shape the energy reserves of the muscle with a significant impact on meat quality, including color, processing yield and susceptibility to oxidation. Beyond the control of muscle metabolism, protein intake will also be crucial in controlling the molecular pathways that influence muscle fiber growth and integrity. Thus, recent studies show that in modern heavy strains, improving meat yields by nutrition can also lead to poor meat quality, which results in a lower protein/fat ratio and in the most severe cases in the onset of degenerative defects. Therefore, it is essential to rethink poultry nutrition by taking into account new standards, such as functional, nutritional and storage ability of the meat, but also by developing studies to better understand which molecular pathways can be efficiently modulated by nutrition during animal growth to improve final meat quality.

**Keywords:** Carcass conformation. Good esthetic, functional characteristics, meat quality

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[EM-02]: Combined Egg and Meat (ID: 100186)

[Canada]

## **Eggs: Maximizing the nutrition of laying hens to improve human nutrition around the world**

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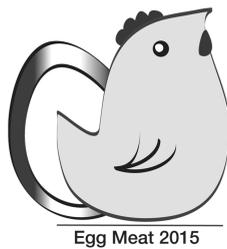
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Eggs are one of the most recognized and accepted foods by consumers around the world. They are generally acknowledged as naturally rich in proteins and certain vitamins and minerals. With production increasing worldwide by 14 million tonnes or 25% between 2000 and 2010, can the eggs contribute further to human nutrition? Regular eggs can contribute to meeting the basic human needs in terms of proteins and other nutrients in the developing world where protein consumption is low and often of plant-origin. The work required to maximize their potential is massive, taking into consideration the needs to concurrently boost production and promote consumption in a number of countries. A model based on Private-Public Partnership has been developed to build capacities within national producers' organizations to achieve improvement in egg production and egg consumption in Southern Africa. Eggs can also provide additional nutrients through dietary modulations of the rations fed laying hens. The science behind the enrichment of nutrients in the egg has been well demonstrated and it is fairly easy and cost effective to produce eggs enriched in vitamin A, folic acid, vitamin E, selenium and omega 3 polyunsaturated fatty acids (n-3 PUFA). A number of nutritional and health benefits have also been clearly demonstrated in sound clinical studies. For instance, the consumption of eggs enriched in n-3 PUFA have shown to contribute to lower serum triglyceride levels and higher HDL-cholesterol, both related to a reduced risk of fatal ischemic heart disease. Unfortunately, the potential of these functional eggs for human nutrition and health is still not yet realized due to a number of reasons related to the nature of the egg itself, the skepticism of consumers, the promotion and advertising required and the lack of support from the health professionals.

Keywords: Eggs, Nutrition, Hunger, Health





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**Reviews and oral communications  
on the quality of Poultry Meat**

[M1-01]: Poultry meat quality defects (ID: 100178)

[Finland]

## **WOODEN BREAST, a myodegeneration in relation to animal performance and growth**

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Wooden Breast (WB) is a severe meat quality defect found in the breast fillets of broiler chicken. Affected tissue is characterized by substantial hardness that is consistently accompanied by marked bulging and paleness; also white striations are regularly seen as is exudation of the surface. The histopathological features of chronic WB have been documented as well. The increasing occurrence of pathological muscle conditions has long been suggested to be related to the very rapid growth of modern broilers as well as to successfully met selection targets of high muscle yields. Addressing these relationships with pens as experimental units requires however a relatively large number of observations for a sufficient statistical power. For this purpose, we put together the data of our four recent experimental setups, and carried out statistical analyses wherever applicable and scientifically sound. The joint data consisted of a total of 81 pens of originally randomly assembled groups of high-yielding broilers. The WB evaluation scores as well as other measures recorded on all slaughtered birds were then connected to the groups by calculating pen averages of the outcomes. The group-measurement-based variables consisted of the recorded live weights and feed consumptions as well as the ones driven from those two, i.e., the average daily weight gains (DWG) and feed efficiency ratios (FCR). A class variable of WB-severity with three categories based on the palpated hardness scores, referred to as the mild, the moderate, and the severe, was incorporated into the statistical model already consisting of other critical explainers, such as experiment, sex, hybrid, and initial chick weight. The results indicate that especially towards the end the moderate WB was the one with disturbed growth. The results raise a question of what kind of growth the increased weights are in the case of the severe WB ultimately indicative of? Especially since the pen average outcomes of ultimate pH values were indeed the lowest ( $p < 0.05$ ) for the mild (5.81) in comparison to the moderate (5.99) and the severe (6.15). An unexpected finding was also this: the groups that eventually were to exhibit the severe form of WB in greatest numbers were accommodating chicks of the lightest initial weight.

Keywords: Chicken, wooden breast, growth, performance

[M1-02]: Poultry meat quality defects (ID: 100019)

[Italy]

## Composition and texture of wooden breast meat

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Recently, selected commercial modern chicken hybrids exhibited different muscle abnormalities. In the last few years, several observations about the incidence of new muscle abnormality termed as “wooden breast” have started to come from the poultry producers. Wooden breast is characterized by visually hard, outbulging, pale, and often accompanied with white striping. This study aimed to assess the implications of wooden defect with/or without white striping on proximate and mineral composition, protein patterns (SDS-PAGE) and textural traits of the meat. Overall findings showed that presence of wooden or both wooden/white striping defects had a significant impact on all quality traits that have been evaluated during this study. In this regards, wooden/white striping and wooden had significantly higher fat (1.98 vs 1.25 vs 0.87%,  $P<0.001$ ) and moisture (75.1 and 75.3 vs 74.1%,  $P<0.001$ ), collagen (1.18 vs. 1.26 vs 1.09%,  $P<0.001$ ), and lower protein (20.4 vs 21.4 vs 22.8%,  $P<0.001$ ) contents in comparison to normal meat. In addition, abnormal meat exhibited a sharp increase in the hardness of raw (high compression test) and cooked meat (texture profile analysis) in respect to normal meat. On the other hand, both muscle abnormalities had higher levels of calcium and sodium. However, SDS-PAGE analysis showed that one of enzymes that is used as an indicator for muscle damage which is band of calcium-ATPase did not appear in normal fillets while was present in abnormal fillets. In conclusion, this study revealed that the incidence of wooden abnormality has adversely changed the chemical composition (high fat and low protein content), water binding capacity (high cooking loss) and textural properties (high hardness) chicken breast meat. All these changes may lead to some economic consequences on the poultry industry. Moreover, the findings of mineral composition and SDS-PAGE analysis pointed out the presence of some histological and biochemical disorders accompanied with the abnormalities.

Keywords: Wooden breast, composition, texture, SDS-PAGE, calcium, sodium

[M1-03]: Poultry meat quality defects (ID: 100113)

[Turkey]

## **Incidence and intensity of deep pectoralis myopathy in broilers under commercial conditions in Turkey**

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Deep pectoralis myopathy (DPM) causes economic losses in commercial broiler industry. It is characterized by necrosis and atrophy of the deep pectoralis muscle and can be detected at cut-up and deboning line at the processing plant. The incidence of DPM cases ranged from 0.10 to 17 % in studies from different countries. This study aimed to determine the incidence of DPM in broilers reared under commercial conditions and slaughtered average 2.4 kg in Turkey and its effect on lightness of m. pectoralis major. The study was carried out in two major processing plants in Turkey. The incidence of DPM was evaluated on 134,840 broiler breast meat from 64 mixed-sex flocks. Average slaughter weight was 2.4 kg and ranged from 1.75 to 2.95 kg and was classified as <2.0 kg, 2.0–2.2 kg, 2.2–2.4 kg, 2.4–2.6 kg and >2.6 kg. Breast muscles were examined at the deboning line to determine DPM incidence. Muscles with apparently no DPM were considered to be “normal”. Early stages were classified as “1” with red and hemorrhagic lesions and “2” muscles with coagulative necrosis, fibrous tissue texture and pink to plumb. Muscles with green necrotic area were classified as “3” (late stage). The incidence of DPM [(number of birds with DPM/number of birds dissected) x 100] and influence of body weight were investigated. Lightness was measured at 24 h postmortem on m. pectoralis major samples classified as “normal” and “3”. Average DPM incidence was 0.73 % and ranged from 0.04 to 2.6 %. The incidence of late stage was 23 % of muscles with DPM while 61 % of early stage was scored as “1”. The incidence of late stage DPM was higher in broiler >2.6 kg ( $P<0.05$ ). The highest early stage DPM was for <2 kg broilers. Muscles classified as “late stage” DPM was lighter than “normal” ( $P<0.05$ ). These results suggest that DPM is not only recognized in heavy broilers (>3 kg), but lesions also occur in light broilers. Although the overall incidence was low in this study, it is important when considering its effect on lightness of the most valuable carcass part.

**Keywords:** Broiler, deep muscle myopathy, slaughter weight, lightness

[M1-04]: Poultry meat quality defects (ID: 100096)

[United States]

## **Meat Quality and Protein Functionality Attributes of White Striped Broiler Breast Meat**

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The white striping (WS) condition is known to influence the composition of broiler breast meat and to have a negative impact on consumer appeal. The objective of this study was to evaluate the influence of WS on meat quality and protein functionality attributes in breast fillets (pectoralis major) from large broilers. Breast fillets were removed from the deboning line of a commercial processing plant and classified based on degree of WS (normal, moderate, severe). Fillet size, color, and pH were measured at 24 h and fillets were frozen at -20°C. Fillets (8 per WS classification) were thawed at 4°C and the cranial two-thirds of each fillet was minced in a food processor and utilized for evaluation of salt-induced water uptake (measure of water-holding capacity), cooking loss, protein solubility, and the ability to form emulsions. The average weight of fillets exhibiting moderate and severe WS (413 g and 396 g, respectively) was greater ( $P<0.05$ ) than normal fillets (341 g). Muscle pH and CIE color values ( $L^*a^*b^*$ ) of the breast fillets were not influenced ( $P>0.10$ ) by WS. Average salt-induced water uptake percentage was higher in normal fillets (69.5%) than in moderate (64.3%) and severe (60.8%) fillets but these differences were not significant ( $P=0.4066$ ). Cooking loss ranged from 22.9% to 30.7% but was not influenced by the degree of WS. Sarcoplasmic ( $P=0.5562$ ), myofibrillar ( $P=0.2195$ ), and total ( $P=0.4868$ ) protein solubility measurements were not different between normal, moderate, and severe WS fillets. The protein profiles of sarcoplasmic and myofibrillar protein extracts exhibited minimal differences using SDS-PAGE analysis. The ability of the myofibrillar proteins to form an emulsion was greater ( $P=0.0082$ ) in normal compared to severe WS fillets. Overall, data from this study suggest that the white striping condition in broiler breast meat does not substantially alter protein functionality attributes related to meat quality.

Keywords: broiler, breast meat, white striping, protein functionality, meat quality

[MI-05]: Poultry meat quality defects (ID: 100119)

[France]

## What are the rearing factors that favor oxidation of turkey meat?

**Bourin, M. (1), Baéza, E. (2), Mika, A. (3), Godet, E. (4), Chartrin, P. (5), Santé-Lhoutellier, V. (6) and Berri, C. (7)**

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The turkey industry is currently confronted with problems of oxidation, which result in the apparition of zones of discoloration on red meat products. This defect increases over time and can lead to the withdrawal of products. Yet, factors at the origin of these defects have not been clearly identified even if the generalized heaviness of animals could be an aggravating factor. Forty four turkey flocks were considered in this study issued from 4 French slaughter plants. For every flock, various parameters related to the animal, its rearing system and meat traits were recorded. Occurrence and severity of oxidation defects were visually determined at day 6 and 15 post-mortem on 50 packages of 4 turkey skewers by flock. Samples of meat were also taken to determine several physicochemical and biochemical traits: TBA-RS (lipid oxidation), haem iron, oxygen and lipid contents and determination of the fatty acids composition (saturated, AGS; mono-unsaturated, AGMI; polyunsaturated, AGPI; n-6/n-3). Our study highlights multifactorial determinism of turkey muscle oxidation. Indeed, several factors related to animal or its finishing diet and to physicochemical or biochemical meat traits play a role in the occurrence and severity of oxidation spots. According to our results, oxidation would be favored in males slaughtered at older ages whose daily average gain, fattening during the finishing period and meat haem iron content were increased and meat ultimate pH decreased. The production of acid and oxidized chicken breast meat has already been associated with physiological status favoring the energy storage as lipids or muscle glycogen to the detriment of the protein synthesis. Therefore, it can be suggested to reevaluate the energy and amino acid balance of the turkey finishing diets or reducing the age at slaughter to limit energy storage as lipid or glycogen in carcass or muscle

Keywords: Meat, Turkey, Oxidation

[M2-01]: *Genetic control of meat quality* (ID: 100124)

[United States]

## **Using Genetics, Genomics and Metabolomics approaches for Understanding the Molecular Basis of Wooden Breast Syndrome**

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A novel myopathy, referred to as Wooden Breast syndrome, has recently emerged which preferentially affects the breast muscle of broiler chickens. Birds affected with this myopathy have palpably tough breast muscle and reduced wing movement. This syndrome has the potential to significantly impact the poultry industry worldwide, as quality traits of the breast meat from affected chickens are regarded as undesirable by consumers. Although the underlying etiology of this myopathy is currently unknown, it is likely that increased growth rate and breast muscle weight of the modern broilers has inadvertently contributed to the occurrence of this muscle disorder and to other muscle disorders, such as white striping. To study potential causes of this disorder, we have begun to link phenotypic characteristics of the birds to metabolic and genetic attributes for the syndrome. Phenotypic data from over 2,600 birds were used to correlate incidence and expression of the Wooden Breast syndrome with characteristics such as body weight, breast muscle weight, pHu, and abdominal fat percentage. For these studies, pectoral muscle samples were taken at market-age (47 days) from both affected and unaffected birds across multiple commercial pure lines and crossbred broiler populations. High-throughput technologies such as RNA-sequencing and metabolomics profiling were used to determine the major biological mechanisms that contribute to this syndrome. From the RNA-sequencing results, over 1000 significant differentially-expressed genes were identified between affected and unaffected birds. This gene list was used to perform functional analysis using Ingenuity Pathway Analysis (IPA) and to correlate with previously reported gross and microscopic tissue lesions. Metabolite abundance was also determined from breast muscle samples of both affected and unaffected chickens. Overall, 142 biochemicals were determined as significantly different in the affected chickens compared with unaffected chickens. These metabolites were assigned to metabolic pathways, and the overrepresented pathways were examined. Furthermore, glycogen content of the breast muscle samples was measured and compared between affected and unaffected chickens. This work enhances understanding of the mechanisms and pathways underlying Wooden Breast syndrome in commercial broiler chickens.

**Keywords:** Broiler Chickens, Meat quality, Wooden Breast, RNA-seq, Metabolomics

[M2-02]: Genetic control of meat quality (ID: 100041)

[France]

## Genetic parameters of white striping in relation to body weight, carcass composition and meat quality traits in broiler chickens

Al Nahhas, N. (1), Berri, C. (2), Chabault, M. (3), Chartrin, P. (4), Boulay, M. (5), Bourin, M. (6) and Le Bihan-Duval, E. (7)

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White striping (WS) is an emerging meat quality defect of increasing importance for the industry. The genetic determinism of this defect is still unknown so, the purpose of the present study was to shed some light on the heritability ( $h^2$ ) of WS and its genetic correlations ( $rg$ ) with other traits of interest. The analyzed database contained 10451 records measured on two lines of broilers selected divergently on the ultimate pH (pHu) of breast muscle (pHu+, pHu-) for 6 generations. WS scores were recorded only on the last two generations ( $n=1348$ ) as 0 (NORM), 1 (MOD) and 2 (SEV). The incidence in the measured population was 36.7% of MOD and 14% of SEV totaling to 50.7% and it was higher in the pHu+ line than in the pHu- line (65.8 vs. 35.15% respectively,  $P < 0.0001$ ). A strong genetic determinism for WS ( $h^2 = 0.65 \pm 0.08$ ) was evidenced. WS was significantly correlated with body weight ( $rg = 0.33 \pm 0.15$ ), breast meat yield ( $0.68 \pm 0.06$ ), but not with the percentage of thigh + drumstick or abdominal fat. In both lines, increased body weight, muscle mass and yield were significantly associated with increased severity of WS. Significant  $rg$  were observed between WS and breast ( $0.21 \pm 0.08$ ) and thigh ( $0.32 \pm 0.11$ ) pHu and cooking loss ( $0.30 \pm 0.15$ ) but not with drip loss and curing cooking yield. Globally, severely affected breast fillets exhibited a paler color and higher drip and cooking losses. In conclusion, genetics seems to be a major determinant of WS. This condition appears to be more affected by the rate of muscular development and meat yield than by body weight. In addition, its impact on meat quality is limited but not negligible.

Keywords: Genetic parameters, white striping, broiler

[M2-03]: Genetic control of meat quality (ID: 100052)

[France]

## **Identification of biomarkers of meat quality by high throughput analyses of muscle transcripts and serum metabolites of two lines of broilers divergently selected on breast meat ultimate pH**

**Beauclercq, S. (1), Hennequet-Antier, C. (2), Nadal-Desbarats, L. (3), Moroldo, M. (4), Le Bihan-Duval, E. (5) and Berri, C. (6)**

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The processing ability of chicken meat is very variable, which could impact on the competitiveness of the poultry industry. As in pig, high variations in ultimate pH lead to defects of appearance, conservation and processing yields. To understand the biological and genetic mechanisms involved in the control of poultry meat quality, two chicken lines were divergently selected on the breast meat ultimate pH (pHu): the pHu- and the pHu+ lines. Their average pHu diverges of 0.5 pH units in the breast Pectoralis major (PM), which corresponds to a 20% difference of muscle glycogen (pHu- > pHu+). The present study aims at identifying biomarkers of meat quality by using high throughput approaches for the profiling of the muscle transcriptome (8x60K custom Agilent microarray) and for the characterization of metabolome in muscle and serum (proton and phosphorus NMR analysis on muscle and proton NMR on serum). The analysis by Gene Ontology of the differentially expressed genes between muscles from the pHu- and the pHu+ lines indicates an over-representation of genes involved in 6 processes, i.e., the sarcomere organization, the positive regulation of phosphorylation, the pyruvate metabolism, the glycolysis, and the coenzyme and phosphorus metabolism. Most of the genes involved in the glycolysis pathway were over-expressed in the pHu- compared to the pHu+ line. The serum of the pHu- chickens was characterized by higher glucose level and lower concentrations in byproducts of purine degradation compared to the pHu+ line. These observations could help at a better understanding of the molecular pathways underlying the differential ability of the pHu- and pHu+ line to store glycogen in their muscle. By defining a set of pertinent biomarkers, our goal is to build a predictive model of the breast muscle ultimate pH to optimize the quality of poultry meat in relation to breeding and rearing factors.

**Keywords:** Meat quality, Ultimate pH, Biomarkers, Transcriptomic, Metabolomic

[M2-04]: Genetic control of meat quality (ID: 100058)

[China]

## **The related response of Beijing You chickens to the divergent selection for muscle intramuscular fat and inosine monophosphate content**

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The flavor and taste of meat from indigenous slow-growing chicken breeds are superior, largely because of the amount of intramuscular fat (IMF) and other flavor-enhancing compounds like inosine-5'-monophosphate (IMP) deposited as they grow. Breeding selection for IMF and IMP content has been proposed to improve chicken meat quality. In the present study, the correlated response in traits including growth traits, carcass characteristics and sexual maturity were investigated using the 510 roosters of the 7th generation of divergent selection lines for IMF and IMP. All birds were contemporaneous and reared under the same conditions. The feed intake and body weight of each individual were measured weekly until they were slaughtered at 17 weeks of age for the measurement of carcass traits. The results showed that average daily weight gain, daily feed intake in IMF+ line birds were significantly higher than those in IMF-. The FCR of IMF+ was 8.6% higher than for IMF- ( $P < 0.05$ ). There was no significant difference for carcass, breast muscle, leg muscle, abdominal fat weight or percentage between IMF+ and IMF- lines. However, these traits in IMP+ lines were significantly higher than IMF+ or IMF- lines. The testis weight of IMF+ lines birds was significantly higher than IMF-. The results of the present study demonstrated that selection for high muscle IMF content may advance sexual maturity, reduce feed efficiency, while the selection for high muscle IMP leads to desirable changes in carcass traits.

Keywords: intramuscular fat, inosine acid, meat quality, divergent selection, carcass

*[M3-01]: Muscle biology (ID: 100023)*

[Germany]

## **Changing the incubation temperature during embryonic myogenesis influences the weight performance and meat quality of male and female broilers**

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Eggs of a commercial broiler genetic were initially incubated at 37.8 °C followed by a change to 38.8 °C (group H) and 36.8 °C (group L) between embryonic days 7 to 10 (time A) and 10 to 13 (time B). The further incubation was carried out at 37.8 °C until hatching. The hatched chicken were weighed and sexed and then fattened until day 35 and weighed weekly. Before slaughter the animals were weighed again and after slaughter the carcass parameters and different meat quality parameters were determined. The effect of treatment, time and sex, and the interactions of these factors were considered. No significant impact of “time” on the parameters was found. But “treatment” and “sex” significantly ( $p < 0.05$ ) influenced the carcass and quality parameters. The interaction of these factors only influenced the carcass traits. Immediately after hatching, group L broiler were heavier, but they showed a slower growth rate compared to group H chicken. At slaughter day, live, carcass and leg weight of group H broiler were higher compared to group L animals. The pH-values, drip loss, and  $L^*$  of the group H broiler breast muscles (MPS) were higher and the grill loss and  $a^*$  lower than the results of the group L MPS. The live, carcass, MPS and leg weight, the leg yields and the grill loss and lightness values of the male broiler were higher and the drip loss resulted lower compared to the female birds. Male group H broiler only showed lower carcass weight and MPS yields compared to the group L males, whereas the female group H birds had higher carcass and MPS weight and lower leg yields than the female group L animals. The study shows that an increasing incubation temperature during early embryogenesis positively influences the growth and carcass traits of the broiler accompanied with a partly negative impact on important meat quality parameters. The growth effects were sex-dependent, as significant weight differences could be found in female broiler. The present results indicate that incubation temperature influences molecular mechanisms in the muscle and other tissues with an impact on growth after hatch.

**Keywords:** Broiler, weight, incubation temperature, quality

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[M3-02]: Muscle biology (ID: 100143)

[France]

### **Beta-carotene act as a regulator of skeletal muscle cells through BCMO1**

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The enzyme beta, beta-carotene-15, 15'-monooxygenase (BCMO1) cleaves provitamin A carotenoids into active vitamin A principally in liver and intestine. The BCMO1 gene is expressed at low level in the muscle tissue, including in myoblasts, but little is known about its function. In the chicken muscle, we observed that various *bcmo1* expression levels are associated with different carotenoids contents. To investigate the potential role of BCMO1 on skeletal muscle, we assessed the impact of beta-carotene (BC), the prototype substrate of the BCMO1 enzyme, supplementation in vitro on proliferative primary avian myoblasts. Proliferation was evaluated by BrdU incorporation and by flow cytometry. The BrdU incorporation index was reduced and the proportion of G0/G1 cells increased following BC supplementation. Cell differentiation was evaluated by immunolabelling of sarcomeric myosin heavy chain (MHC). The proportion of sarcomeric MHC expressing cells and the differentiation index increased following BC supplementation despite the proliferative environment. The effects of BC were inhibited in the presence of DEAB, an inhibitor of retinaldehyde dehydrogenase. These results are in accordance with the hypothesis that the BCMO1 enzyme is active in myoblasts and can contribute to the retinoic acid production from BC. These data suggest that provitamin A could be used as a potential nutritional regulator of skeletal muscle growth.

Keywords: BCMO1 enzyme, myogenesis

[M3-03]: Muscle biology (ID: 100044)

[France]

## Condemnation rates and reasons for broiler meat in France

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The European hygiene package requires the condemnation of any unsafe food. However, few data identified and quantified the rates of, and the reasons for, condemnation, though establishing a link between lesions and sanitary and zootechnical issues in farm is of major importance. We present an overview of condemnation rates and reasons of broilers in France. The experiment was carried out on a sample of poultry slaughterhouses for one year in 2013. Among the 12 voluntary slaughterhouses, 5 of them slaughtered standard and free-range broilers, their size being representative of French slaughterhouses. Total and partial condemnations were recorded on a standardized form and stored in a database following the national reference system of lesions. Partial and total condemnation rates (TCR and PCR) were calculated and a multivariate analysis was performed to assess the impact of five factors. Condemnation rate is estimated to 1.04, with a TCR of 0.89 and a PCR of 0.15 (n = 6,731 inspected batches). Condemnation rates depend on the slaughterhouse ( $p < 0.01$ ), the animal gender (mean condemnation rates being 0.60 and 0.25 for males and females respectively,  $p < 0.01$ ) and season ( $p < 0.01$ ). Data do not show any effect of production type. The most frequently reported reasons for condemnation are cachexia (40.5% of condemned animals) and generalized congestion (28.4%). The type of production is significantly associated with the reason for condemnation, cachexia being a more frequent reason for free-range broilers than for standard ones (69.3% and 24.1% of condemned animals, respectively). Condemnation rates can be considered as low. They are similar to former figures obtained in France, partial condemnations being excluded of previous studies, whereas an increase of condemnation rates was expected thanks to an improvement of veterinary inspection and the harmonization of recording methods. Cachexia and generalized congestion are still the main reasons for condemning broiler carcasses. Similar studies should be led for other poultry species to reflect and improve the sanitary situation of poultry production.

Keywords: condemnation, broiler meat, poultry, slaughterhouse

*[M3-04]: Muscle biology (ID: 100086)*

[Turkey]

## **Effects of Preslaughter Physiological Stress Induced By Dietary Corticosterone on Broiler Blood Biochemistry and Meat Quality**

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Physiological stress is one of the concerns facing the broiler industry. The aim of this study was to determine preslaughter physiological stress induced by dietary corticosterone (Cort) 3 d before slaughter on blood biochemistry and meat quality of broilers. For this purpose, a total of 825 Ross 308 mixed-sex chicks were used. All chicks were reared under standard broiler management condition until 35 d. At 35 d, sex was determined and broilers from each sex were divided into two groups. Half of broilers were held under standard management and feeding conditions (Control) while the other half were fed a diet supplemented with 15 mg/kg corticosterone (Sigma, C2505) for 3 days (Cort-diet). Blood samples were collected before slaughter for Cort, glucose, triglycerides, uric acid, and albumin analyses. All birds were transported to commercial slaughter house after feed withdrawal. At 20 min of slaughter, left breast muscle was sampled for glycogen analyze and stored -80 C. After air chilling, breast muscle was excised from the carcass, individually packed and stored at +4 C for 24 h. At 24 h post-mortem, ultimate pH (pH<sub>24</sub>) was measured and colour [lightness (L\*), redness (a\*), and yellowness (b\*)] was evaluated. The pectoralis major muscles were frozen for subsequent determination of thawing loss. Dietary Cort supplementation significantly increased blood Cort, triglycerides, glucose, uric acid and albumin concentrations. There was no sex effect on blood parameters. However, a significant diet and sex interaction was observed for blood Cort levels, because females fed Cort diet had higher blood Cort levels than males. Sex did not significantly affect meat pH<sub>24</sub>, and redness, while males had lower L\* and b\* values than females. The Cort diet resulted in higher glycogen concentration, lower pH<sub>24</sub>, lighter and more yellow meat, and higher thawing loss than control diet. These results indicated that a 3-d stress before slaughter affected blood biochemistry and meat quality without depletion in muscle glycogen.

**Keywords:** Broilers, corticosterone, stress, meat quality, blood biochemistry

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[M3-05]: Muscle biology (ID: 100131)

[Pakistan]

### **Deteriorative effects of norfloxacin residues on quality of broiler meat**

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Quinolones are commonly and conventionally used in poultry to treat various bacterial diseases. However, the residual effects of norfloxacin in meat of broiler birds have not been largely addressed. Therefore, we aimed to investigate the effect of antibiotic residues of norfloxacin on the quality of broiler muscles/meat by measuring the oxidant/ antioxidant parameters. Five weeks old broiler birds were experimentally administered with norfloxacin (10 mg/kg b.wt/day) for 5 consecutive days. Six birds were used for each time interval for the detection of antibiotic residue by HPLC with fluorescent detection as well as oxidant and antioxidant status of serum and muscles was measured by photometric method. Drug residues were maximum in broiler serum and muscles on day 1 of norfloxacin treatment. Norfloxacin did decrease the antioxidant parameters in serum and muscles of broiler chicken post medication that may lead to deterioration of broiler meat. However, after 4 days of wash out period for drug, the antioxidants status was improved without any significance. The reactive oxygen species (ROS) production (oxidative capacity) increased in serum and muscles at day 1 of norfloxacin treatment in broiler birds. In conclusion our results did show that residues of norfloxacin have deteriorative effects on meat quality of chicken.

**Keywords:** Norfloxacin, Broiler, Antibiotic residues, Oxidant status

*[M3-11]: Meat \_Extra session (ID: 100008)**[Egypt]*

## **Effect of medical feed additives on growth performance, metabolic functions and economic efficiency of growing female ducks**

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Ninety one day old, growing female Muskovy ducks were performed to evaluate the effect of adding 0.5% of each source from some medical feed additives (MFA) i.e. Thymus (Thymus Vulgaris), Marjoram, (Marjorana hortensia), Ginger (Zingiben officinale) and mixture of these previous three herbs to growing Muskovy ducks diet on growth performance, some metabolic functions and the economic efficiency. Birds were divided equally into 5 groups containing 18 birds each. Each group contained 3 replicates, of 6 males. Each treatment of the tested diets contained one source of MFA at level of 0.5% except the 5th treatment contains mixture of these previous three herbs. The control diet had no additions. The experiment was terminated when birds were 60 days old. Body weight, weight gain and feed intake were recorded. Feed conversion and economic efficiency were calculated. At the end of the experiment carcass characteristics were measured. Blood samples were taken at 4 and 8 weeks of age to determine some blood plasma constituents. The data revealed that, birds fed dietary mixture of MFA recorded greatest ( $P<0.05$ ) body weight, body gain and feed conversion efficiency. Adding different MFA to the control diet slightly ( $P>0.05$ ) reduced the feed intake. No significant differences ( $P>0.05$ ) were detected in dressing percentage as effect of adding all MAF additives to the control diet, however the greatest ( $P<0.05$ ) edible % was calculated for birds fed dietary Ginger (G). Blood samples indicated that birds fed dietary G recorded the greatest ( $P<0.05$ ) values of Total Leukocytes (WBC's), Erythrocytes (RBC's), T3, Glutamic–Pyruvic Transminase (GPT), and Glutamic –Oxaloacetic transminase (GOT), while, birds fed dietary Marjoram (M) recorded the best ( $P<0.05$ ) value of Packed cell volume (PCV)%. Moreover, birds fed dietary mixture presented the highest values of Hemoglobine (HB), T4, T3/T4, and glucose. Adding MFA such as T, M, G, or the mixture to ducks diet presented the lowest ( $P<0.05$ ) value of cholesterol and urea and the highest ( $P<0.05$ ) value of the economic efficiency (Net revenue and percent of net revenue/feed cost) of the diet.

**Keywords:** Medical herbal, performance, metabolic functions, male Ducks

[M3-12]: Meat \_ Extra session (ID: 100070)

[Indonesia]

## **Performance and Cholesterol Content of Broiler Fed Fermented Product by *Phanerochaete chrysosporium* and *Neurospora crassa* in the Diet**

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An experiment was conducted with 100 unsexed broilers of the Arbor Acres strain to determine the capability of fermented product by *Phanerochaete chrysosporium* and *Neurospora crassa* in the diet on performance and cholesterol content of broiler. The substrate of this fermentation was *Dhuryo zibethinus* waste. Broilers were divided into 20 cages. This study involved a completely randomized design (CRD) with five treatments and four replicates. Dietary treatments used in this experiment were RA: diet containing 0% fermented product, RB: diet containing 5% fermented product, RC: diet containing 10% fermented product, RD: diet containing 15% fermented product, and RE: diet containing 20% fermented product. Diets were iso nitrogenous (22% crude protein) and iso caloric (3000 kcal/kg diet). Measured variables were feed consumption, average daily gain, feed conversion, abdominal fat pad, carcass, blood and meat cholesterol. Feed intake and body weight were recorded weekly until slaughter at the age of 6 weeks. Data were analyzed by analysis of variance for CRD. Increasing fermented product levels in the diets had no effect ( $P>0.05$ ) on feed consumption, average daily gain, feed conversion, carcass and abdominal fat pad, but the treatments decreased ( $P<0.05$ ) blood cholesterol and meat cholesterol. It can be concluded that fermented product by *Phanerochaete chrysosporium* and *Neurospora crassa* has a positive effect to decrease cholesterol content in blood and meat of broilers and maintain performance.

Keywords: cholesterol content, fermented product, *Neurospora crassa*, *Phanerochaete chrysosporium*, performance

[M3-13]: Meat \_ Extra session (ID: 100097)

[Indonesia]

## **Effect of probiotic *Lactococcus plantarum* on intestinal microflora and performance of broiler chickens, depending on age of administration**

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A study was designed to know the effects of *Lactococcus plantarum* (LP) isolates from Virgin Coconut Oil processing waste on the number of lactic acid bacteria (LAB) in the intestine and on performances of broilers, depending on the age of administration. The research used 160 day-old Cobb broilers divided into 4 treatment groups : TO (without LP), T1 (LP administrated at 1 week age), T2 (2 weeks age) and T3 (3 weeks age). The basal diet consisted of corn, rice bran, fish meal, soy bean meal, bone meal, vegetable fat and premix (crude protein 21.1% and Energy Metabolism 3038kcal/kg). Chickens were given LP only one time and were slaughtered every week until 5 weeks old. Variables measured were number of LAB, E. Coli and Salmonella in intestine, thickness and length of the intestine, carcass weight, fat and cholesterol content of carcass, body weight, feed intake and feed efficiency. The data were analysed in a completely randomized design using SPSS version 19.0. The results showed that LP administration affected the balance of microflora in the gut, thickness and length of the intestine. LP treatment significantly increased the number of LAB in the intestine ( $P < 0.01$ ) up to two weeks after administration, whereas it decreased E. coli and Salmonella. When given at 2 and 3 weeks, the effect of LP increased intestinal length and performance of broiler was highly significant ( $P < 0.01$ ). Probiotic treatment (LP) did not affect carcass percentage and abdominal fat but affected both fat and cholesterol of broiler meat. Optimal body weight, feed conversion ratio (1,78) and cholesterol content were observed when LP was given at 2 weeks of age.

Keywords: probiotic, age, microflora, intestine, performance

[M3-14]: Meat \_Extra session (ID: 100111)

[Indonesia]

## **The effect of the addition of Fish Oil Microcapsules for carcass quality and Meat Cholesterol levels from local Broiler Duck of West Sumatra - Indonesia**

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This study aims to determine the effect of the use of fish oil (FO), fish oil microcapsules (FOM), turmeric extract encapsulation (ETE) in the diet and the addition of turmeric extract ( *Curcuma domestica* Val ) orally on carcass quality of broiler ducks and meat cholesterol levels and fatty acid omega-3. The materials used in this study were as many as 60 local broiler ducks from West Sumatra Province of Indonesia (itik bayang) aged 6 weeks and an average weight of 420 grams. This study was designed using a completely randomized design (CRD) with five treatments. Each treatment with 4 replications and each replication consisted of three ducks. The treatments used were A: Control diet, B: ration containing 0.8 % FO, C: ration containing 4 % FOM (~ 0.8 % FO ), D : ration containing 0.4 % FO, and 2 % FOM and E : D ration plus 0.2 % ETE ( ~ 1.4 ml of extract of turmeric ). Turmeric extract as much as 2 % (1.4 ml / animal) administered orally on each duck for treatment B, C and D. The results of this study showed that performance values (feed intake, weight gain, feed conversion), carcass quality, meat cholesterol levels and fatty acids omega-3 significantly affected ( $P < 0.01$ ) by treatments. It was concluded that the use of fish oil in combination with microcapsules of fish oil and turmeric extract encapsulation could to improve fatty acids omega-3 and was decreased cholesterol and fat abdominal levels better than the other treatments. Meat cholesterol decreased from 105.44 mg/kg (treatment A) to 64.07 mg/kg (treatment E).

Keywords: fish oil, fish oil microcapsules, turmeric extract, cholesterol, local ducks

[M3-15]: Meat \_Extra session (ID: 100162)

[Iran (Islamic Republic of)]

## **Effect of medicinal herbs powder (Thymus vulgaris, Echinaceae purpurea, garlic) and antibiotics on performance, blood biochemistry and immune response of broiler chickens**

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Day-old Arian chicks (1080) were randomly distributed (under completely randomized design) into six experimental diets with four replicates (45 chicks per replicate) and raised until 42 days of age. The experimental diets were as follows: 1-Control diet, 2- Diets + thyme powder at 1%, 3- Diets + echinaceae purpurea powder at 1%, 4- Diets + garlic powder at 1%, 5- Diets + mixed three powder as mentioned above at 1% and 6- Diets + antibiotics at 0.02%. The results revealed that neither feed additives alone significantly altered the performances. However, simultaneous addition of the three herbs powders in the diets increased body weight, as compared to control groups. It also improved Feed Efficiency (FE) as compared to antibiotics and other additives. Non-significant feed intake was observed while, the higher and the lower feed intake were referred to diets + antibiotics and thyme powder respectively. Whereas, Thymus vulgaris powder decreased feed intake as compared to antibiotics. Feed efficiency also was not observed significantly throughout the experimental period. The better FE was observed in diets+Thymus powder. Production index was increased by inclusions of mixed powder in the diets as comparing to control and other experimental groups. Mixed powder in the diets increased carcass percentages as compared to other experimental groups except control groups ( $p < 0.05$ ). Abdominal fat percentages along with other immune responses were not significantly altered. Blood parameters were not affected by inclusions of medicinal herbs. Antibiotics in the diets increased immune responses according to controlling harm bacteria in small intestine. While, medicinal herbs as thymus vulgaris increased Influenza and Newcastle antibody titers and Sheep red blood cells (SRBC), IgG, IgM, except antibiotics.

Keywords: Echinaceae, garlic, thyme, performance, immune responses

[M3-16]: Meat \_Extra session (ID: 100176)

[Turkey]

## **Effect of wild cocoyam (*Caladium bicolor*) on the performance and carcass yield of cockerel birds.**

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A twelve (12) week feeding trial was conducted using 63 day-old spotted cockerels to determine the effect on the performance and carcass yield of 0%, 5% and 10% inclusion levels of wild cocoyam (*Caladium bicolor*) meal (WCM) fed at starter (Energy value = 3000kcalME/Kg and crude protein (CP)=23% ) and finisher (Energy value = 2,800 kcalME/Kg and CP =20%) phases. Three diets were formulated at each phase such that diets 1(Starter phase) and 4 (finisher phase) had no inclusion of wild cocoyam meals while diets 2 (Starter phase) and 5 (finisher phase) had 5% inclusion of wild cocoyam meals and diets 3 and 6 had 10% inclusion of wild cocoyam meals. The birds were randomly distributed to the experimental diets using completely randomized design. Each experimental diet had 21 birds divided into 3 replicates of 7 birds per replicate. The results of the experiment showed that the average body weight (ABW), average body weight gain (ABWG) and efficiency of feed utilization (EFU) for birds on diet 2 were higher than others but were not significant at the starter phase. At the finisher phase, ABW of birds on diet 5 was significantly ( $p<0.05$ ) increased and different from others. In the carcass analysis the weights of breast, drum stick, eviscerated, neck, thigh, plucked varied among the treatments and were significantly ( $p<0.05$ ) different with highest weights recorded in birds on diet 5 but not in intestine and back weights. Therefore, birds on 5% level of inclusion of WCM performed better than others in many of the parameters measured and the diet enhanced growth more at starter and finisher phases at a very competitive cost.

**Keywords:** cockerels, wild cocoyam and performance.

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[M3-17]: Meat \_Extra session (ID: 100098)

[Indonesia]

## **The compensatory growth of local duck by restricted feeding at initial period of growth**

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The study was conducted to determine the effects of restricted feeding on local ducks performance. A total of one-hundred day old duck were used which was arranged in Randomized Block Design with five replications. Four types of treatment were applied, which was divided into ad libitum, restricted feeding up 15%, 30%, and 45%. The treatments were started since two weeks to five weeks old. The ducks were fed ad libitum until eight weeks old (refeeding). The results showed that feed consumption, body weight gain, feed conversion, carcass weight and carcass percentage were highly significant ( $P < 0.01$ ) decreased by restricted feeding. There was no significant effect ( $P > 0.05$ ) in all treatment after refeeding for all variables. The compensatory growth of duck was showed after refeeding.

**Keywords:** compensatory, growth, duck, restricted, refeeding

[M4-01]: Poultry meat microbiology and hygiene (ID: 100031)

[France]

## **Deciphering bacterial diversity and ecological interactions on poultry meat to improve food quality and safety.**

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The variability of microbial communities contaminating meat products depends on seasonal changes and production processes. In order to understand the microbial interactions in food products it is necessary to investigate the diversity of food microbial consortia. However, microbial communities are yet poorly described. The aim of this study was to describe the microbial community of chicken legs packaged under modified atmosphere. Bacterial diversity was determined by cultural methods on 23 different meat samples and by 16S rDNA pyrosequencing on a sub-set of 10 samples. An important variability of bacterial population between samples was observed: total viable counts varied from 103 to 108 CFU per gram of meat. The use of various specific or selective media showed that lactic acid bacteria (LAB), *Brochothrix thermosphacta*, and *Pseudomonas* spp. were the main bacterial flora and represented at least 10% of total viable counts. The characterization of the bacterial diversity by 16S rDNA pyrosequencing confirmed the presence of *B. thermosphacta*, and revealed that *Pseudomonas* was mainly represented by *P. extremaustralis* and *P. cedrina*. As well the main LAB species were *Carnobacterium* species and *Shewanella* species. The predominance of *Pseudomonas* was correlated to meat packaging with high oxygen concentration, except when *B. thermosphacta* was dominant, suggesting a competition of these 2 species. No clear cut correlation could be observed between farming or meat processing and bacterial communities. However, the results suggested that poultry leg microbial communities were similar in meat products issued from the same slaughterhouses.

**Keywords:** Food safety, Poultry meat, Microbial communities, Pyrosequencing, Bacterial interactions

[M4-02]: Poultry meat microbiology and hygiene (ID: 100040)

[France]

## **Objective evaluation of feed additive as alternative to antibiotics: example of activated copper exchanged on specific clay**

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The use of antibiotics in broiler production can lead to antibiotics residues in meat and then can participate at the human antibiotic resistance development. Lots of feed additives claiming a partial or a total substitution of antibiotics are available on the market. Feed additives trials results are mainly presented one by one and one after one. Consequently, to conclude about the global efficiency by this way is not totally acceptable. One impartial and reliable way to assess the efficiency of one product is to submit all individual results to Rosen evaluation (Rosen G.D. 2004.). This holo-analysis contains 7 criteria to determinate if a growth promoting product can be considered effective or not. These criteria evaluate the reliability of the results, the performance improvement level and the modelization of the effects. In this study, Rosen evaluation is applied to a patented feed additive: activated copper exchanged on specific clay (B-SAFE® – NEOVIA® / INVIVO NSA®). Results of 36 trials in broiler were compiled and analyzed. Trials were conducted from 1 to 35 days old, with a contemporary negative control group in the same building. Some of the trials included also an antibiotic growth promoter treatment as positive control group. These trials were conducted in diversified farming conditions, going from well managed experimental farm environment to downgraded field conditions. Performances were improved in 74% of the trials and coefficient of variation of response was of 6%. European efficiency factor was improved by 5% and, additive effect was stronger on growth than on feed conversion. Moreover, it was possible to modelize performance response to the product dose. The optimal dose is depending on farming conditions and has to be adapted to. All Rosen's screen targets were achieved and this feed additive is therefore considered as a reliable growth promoter solution for broilers.

**Keywords:** feed additive evaluation, intestinal microbiota modulation, broiler, antibiotic substitution, natural growth promoter

[M4-03]: Poultry meat microbiology and hygiene (ID: 100114)

[France]

## Is this a fiction to tackle *Campylobacter* in the broiler food chain?

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*Campylobacter* is the most common cause of human bacterial intestinal infections in the world. At the European level, more than 200 000 confirmed cases of campylobacteriosis were reported in 2012 by the European Food Safety Authority (EFSA). Raw poultry products and cross-contamination are the main risk factors for human infection. Risk assessment studies concluded that a reduction of *Campylobacter* loads in broiler intestines by 3 logs would reduce the public health incidence by at least 90%. Therefore, several studies have been conducted at the primary production level in order to reduce *Campylobacter* amounts in live animals. In France, our team developed different control measures throughout the broiler food chain: at the farm level through two strategies: administration of additives in feed or animal vaccination; at the slaughtering level through the optimization of chilling parameters since *Campylobacter* is sensitive to cold temperature, and at the retail and consumer level through data collection to perform a quantitative risk assessment study adapted to the French situation and to suggest performance criteria to improve the quality of the products before they reach the consumers. The results showed possible reductions at the farm level using additives in feed; significant decreases were observed at least at one of the sampling points between 14 and 42d after infection. Fatty acids and their salts and a prebiotic based product represent the products that mostly affected *Campylobacter* load in live animals. At the slaughtering level, the most relevant result indicated that *Campylobacter* load on carcasses is the most significant parameter and heavily contaminated carcasses (> 103 CFU/g) cannot be significantly decontaminated after chilling. Moreover, we contributed through prevalence data collection to estimate performance criteria at the slaughtering level which if applied will discard heavily contaminated carcasses from the retail outlets. At the retail level, products with skin are at higher risk of contamination and similarly, those packaged under a plastic wrap film are more contaminated than under modified atmosphere. These results suggested a possible method of decreasing product contamination before it reaches the consumers. A quantitative risk assessment study is currently running to estimate campylobacteriosis risk in France associated with the broiler food chain. Tackling *Campylobacter* in the broiler food chain is a collective and cooperative approach involving all the people working throughout the chain and also the consumers by applying good hygiene practices in the domestic kitchens to protect themselves from campylobacteriosis burden.

Keywords: *Campylobacter*, broiler chain, control strategies

[M4-04]: Poultry meat microbiology and hygiene (ID: 100125)

[France]

### **Optimization of a vaccination protocol against *Campylobacter* for poultry**

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*Campylobacter* is the main cause of human bacterial gastroenteritis in developed countries and constitutes a major public health risk. Human contamination occurs by contaminated poultry meat consumption and handling. Vaccination of broilers, leading to a decrease in the intestinal colonization, could be a good way to reduce human campylobacteriosis incidence. Many studies aiming to develop a vaccine have been conducted with various vaccine antigens, *Campylobacter* strains and/or administration routes, rendering difficult the comparison between studies and the identification of the parameters that are important to induce efficient protection. Therefore we are developing here a sub-unit vaccine model that should be useful to compare in the future the protective potential of new vaccine antigens. Flagellin was chosen as the model vaccine antigen because it is described as a highly immunogenic protein. Thank to this single antigen, different parameters will be optimized: the type of the vaccine, the comparison of different adjuvants, and the administration routes. This will be done in three successive trials, the first one being dedicated to DNA vaccination. Tools to evaluate the immune responses induced by the vaccine and/or *Campylobacter* challenge are being developed. This is the case in particular for an ELISA test to measure the production of IgY antibodies against *Campylobacter* in serum. Preliminary results on chickens infected or not by *Campylobacter* are confirming that (1) there is induction of antibodies upon infection and (2) there is a vertical transmission of antibodies from infected hens to the eggs.

**Keywords:** *Campylobacter*, poultry, vaccination

[M4-05]: Poultry meat microbiology and hygiene (ID: 100089)

[France]

## **Impact of chilling conditions on chicken carcasses contamination by *Campylobacter* spp.**

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*Campylobacter* is the leading cause of bacterial gastroenteritis in many industrialized countries, with handling and consumption of raw or undercooked chicken meat the main source of infection. Risk assessment studies have indicated that campylobacteriosis associated with consumption of chicken products may be reduced 30 times by a 2 log reduction of *Campylobacter* concentration on carcasses (Rosenquist et al., 2003). The objective of this work is to define chilling conditions to reduce *Campylobacter* levels on poultry carcasses. For this purpose, this study was set up to investigate three major parameters in the chilling process (temperature, duration and air velocity) individually and their interaction on the behaviour of *Campylobacter* using the Doehlert shell design. As our previous studies have shown that carcasses presenting more than 1000 CFU/g of *Campylobacter* would not be significantly cleared during the chilling process (Rivoal et al., 2014), the carcasses were artificially inoculated with 1000 CFU/g. Sixteen tests were performed using a chilling prototype: air velocity (between 1 and 3 m/s), chilling duration (between 1 and 5 hours) and temperature (between 1 and 7°C). After chilling, *Campylobacter* counts were conducted in accordance with the ISO standard 10272-2. The contamination reduction ranges from 12% to 41% of initial concentration. Temperature ( $p=0.0045$ ) had a significant effect: the reduction rate decreased when the temperature increased. Interaction between temperature and air velocity had also a significant effect ( $p=0.007$ ) on *Campylobacter* contamination. At low air velocity, the effect of temperature is very important. The reduction of the bacterial load decreases greatly when the temperature increases. At high air velocity, the effect of the increase of temperature is mitigated: bacterial reduction decreases but only slightly. The important outcome of this work is that a chilling process with low temperature can significantly reduce the bacterial load on chicken carcasses contaminated with 1000 CFU/g.

Keywords: *Campylobacter*, chilling process

[M4-06]: Poultry meat microbiology and hygiene (ID: 100151)

[Netherlands]

## **Quantification of extended-spectrum- $\beta$ -lactamase- and AmpC- $\beta$ -lactamase-producing *Escherichia coli* through processing in two broiler chicken slaughterhouses**

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While broilers are recognized as a reservoir of extended-spectrum- $\beta$ -lactamase (ESBL)- and AmpC- $\beta$ -lactamase (AmpC)- producing *E. coli*, there is currently limited knowledge on the effect of slaughtering on its concentrations on poultry. The aim of this study was to establish ESBL/AmpC producing *E. coli* concentrations on broiler chicken carcasses through processing. In addition the changes in ESBL/AmpC producing *E. coli* concentrations were compared with generic *E. coli*. In two slaughterhouses, the surface of whole carcasses was sampled after 5 processing steps: bleeding, scalding, defeathering, evisceration and chilling. In total 17 batches in two different slaughterhouses were sampled during the summers of 2012 and 2013. ESBL/AmpC producing *E. coli* were enumerated on MacConkey agar with 1 mg/L cefotaxime, and the ESBL/AmpC phenotypes and genotypes were characterised.

The ESBL/AmpC producing *E. coli* concentrations varied significantly between the incoming batches in both slaughterhouses. The concentrations on broiler chicken carcasses were significantly reduced during processing. In Slaughterhouse 1, all subsequent processing steps reduced the concentrations except evisceration which led to a slight increase that was not statistically significant. In this slaughterhouse, concentration changes between processing steps were relatively similar for all sampled batches. In contrast, the effect of processing steps in Slaughterhouse 2 varied between batches. The overall reduction through the processing was higher in Slaughterhouse 2. Changes in ESBL/AmpC producing *E. coli* along the processing were similar to changes in generic *E. coli* in both slaughterhouses. Detected genotypes of ESBL/AmpC producing *E. coli* (CTX-M-1, SHV-12, CMY-2, TEM-52c, TEM-52cvar) match normal poultry genotypes. The genotype distribution differed between batches and in some batches changed throughout processing. The concentration levels found after chilling were between  $10^2$  and  $10^5$  CFU/ carcass. Changes in ESBL/AmpC producing *E. coli* concentrations on broiler chicken carcasses during processing are influenced by batch and slaughterhouse, pointing to the role of both primary production and process control for reducing ESBL/AmpC levels in final products. *E. coli* can be used as a process indicator of ESBL/AmpC producing *E. coli*, because the processing steps had similar impact on both organisms. Cross contamination may potentially explain shifts in genotypes within some batches through the processing.

**Keywords:** Poultry, Slaughter Hygiene, Antibiotic resistance

[M4-07]: Poultry meat microbiology and hygiene (ID: 100056)

[Pakistan]

## **Simultaneous endemic avian Myelocytomatosis observed in different commercial layer flocks in Pakistan**

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In the present study, avian leukosis virus infection was observed in three commercial layer farms present at district Toba Tek Singh and Faisalabad. At these farms the mortality, hatchability and egg production was 0.1, 80-85 and 70% respectively. Various clinical signs such as emaciation with prominent keel bones, pale and anemic combs along with whitish sclera were frequently observed in affected birds. At necropsy well differentiated multiple whitish nodules discretely were observed over the serosal surfaces of intestine and uterine tube. Livers of affected birds were extensively enlarged and occupied the entire abdominal cavity. Multiple whitish focal areas of necrosis and enlarged spleen with marbling and granular cut surface were also observed in infected birds. Microscopically most tumorous cells were cytologically mature myeloid cells with marked eosinophilic granules in the cytoplasm and large, vesicular, eccentric nuclei and one or two nucleoli. The cells resembled normal granular myelocytes. Massive quantity of cells with slightly basophilic cytoplasm and almost concentric large nucleus with several nucleoli, typically of normal myeloblasts in liver, spleen and kidney tissues were observed. Neoplastic cells proliferation replacing the entire parenchyma of liver and leaving islands of few healthy hepatocytes were the striking changes in liver sections. Metastatic cells were also observed in the ovarian clutch. Well circumscribed tumorous cells with multiple acini and frequent fibrous tissue were observed in the nodular extension over the serosa, however; lamina propria, mucosal and sub mucosal lining of the intestine were heavily infiltrated with the neoplastic cells. In conclusion the finding of the present study is a serious threat to poultry industry due to the circulating strains of the oncogenic viruses within the country it is therefore need to explore the isolation and characterization of the etiological agent to secure the economic losses in the egg type chickens.

**Keywords:** Avian Myelocytomatosis, Pathology, Layers

[M5-01]: Nutrition and meat quality (ID: 100010)

[France]

## **Effect of Different Dietary Sources of n-3 Fatty Acids on the Growth Performance and Technological, Nutritional and Sensorial Quality of Chicken Meat**

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The aim of this study was to increase the content of n-3 fatty acids (FA) of meat without affecting its sensorial and/or technological properties or the growth performance of chickens reared under standard conditions. Male chickens, Ross 308 were distributed into 5 groups (n=90) corresponding to 5 different diets for the growing and finishing periods: control (T), containing extruded linseeds exhibiting high level of fibers (GLE), extruded linseeds exhibiting low level of fibers (GLDP), microalgae, or an association of 75% GLDP and 25% MA (GLDP+MA). The diet containing microalgae induced a decrease in feed consumption without affecting the growth of chickens which exhibited a lower feed conversion ratio than the other groups for the growing and finishing periods but also the whole rearing period. The use of linseeds in diets had no effect on the growth performance of chickens in comparison with the control group. The dietary enrichment with n-3 FA had few effects on the carcass composition, the ultimate pH and colour of breast meat. The microalgae increased the meat susceptibility to oxidation. The lipid content of breast meat was not affected by the diets. The breast meat of chickens fed diets containing linseeds and/or microalgae had greater n-3 FA content (X 2.4 to 3.9 in comparison with group T). The linseeds and microalgae mainly increased the contents in linolenic acid and long chain n-3 FA, respectively. The dietary enrichment with n-3 FA had no effect on the sensorial quality of fillets whereas the thighs of MA group exhibited the lowest score for the flavour “chicken” and the greater score for the flavour “abnormal” corresponding to a fish flavour.

Keywords: chicken, muscle, meat, lipid, fatty acids

[M5-02]: Nutrition and meat quality (ID: 100020)

[Poland]

## **Functional value of meat of broilers fed diets enriched in n-3 polyunsaturated fatty acids, vitamin E and selenium assayed on adult rats**

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In view of the increasing consumption of poultry meat, enhancing its functional value is an important issue. The aim of the study performed on adult rats was to evaluate the functional value of chicken meat enriched with n-3 polyunsaturated fatty acids (PUFA<sub>n-3</sub>), vitamin E (VE) and selenium (Se). During the last 3 weeks of fattening period, chickens were fed isoproteic and isocaloric diets containing either lard (Control diet) or a mixture of rapeseed and fish oils (RO diet), as sources of lipids, and supplemented with 50 mg VE and 0.3 mg Se per kg (RO diet), or RO based diets further supplemented up to 150 mg VE per kg (ROE diet), or 150 mg VE and 0.7 mg Se per kg (ROES diet). After killing the birds, carcasses were autoclaved, deboned, lyophilized, homogenized and included into four isocaloric semi-synthetic rat diets at a level 240g/kg. The content of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) was higher and n-6/n-3PUFA ratio was lower in rat diets containing meat from RO, ROE and ROES broilers compared with control. Four groups of 10-week-old male rats (10 per group) were fed the diets for 8 weeks, feed intake and body weight was measured then rats were sacrificed, the hematological and biochemical markers in blood were analyzed as well as fatty acids in liver and brain. Feeding diets containing chicken meat from RO, ROE and ROES groups effected in higher level of DHA and lower n-6/n-3PUFA ratio in liver and brain lipids of rats compared with control ( $P \leq 0.05$ ). The concentration of HDL-cholesterol in blood was higher, but concentration of immunoglobulin M was lower in rats receiving chicken meat from ROES group ( $P \leq 0.05$ ). It may be concluded that meat of chickens fed diets containing rapeseed, fish oil and high levels of VE and Se can be considered as a functional product in comparison to the meat of chickens fed diets containing lard and low VE and Se supplementation

Keywords: Functional foods, Fatty acids, vitamin E, Selenium, chicken meat

[M5-03]: Nutrition and meat quality (ID: 100068)

[Brazil]

## **TBARS in the meat of broilers fed different quality corn and two vitamin levels of supplementation**

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Vitamins levels in Brazil should be reviewed in order to counteract the effect of feed quality and environmental challenges. This experiment aimed to study meat oxidation of broilers fed good or poor quality corn, supplemented with low (commercial level) or higher vitamin levels (OVN - Optimum Vitamin Nutrition, DSM), than the NRC levels. We used 1400 day-old male Cobb 500 chicks, randomly divided into 40 pens in a 2 x 2 factorial design (poor or good quality corn; low or OVN vitamin levels), with 10 replicates/treatment of 35 birds each. The experiment was designed as a completely randomized design and Tukey test used to compare treatments. At 42 days, breast and whole leg (thigh and drumstick) samples were collected from two carcasses per replicate and stored for 0, 3, 6, and 9 hours under refrigeration (4°C) to determine TBARS levels. Quality of corn was determined as low (6.5% CP, 2.8% CF, 61% starch) and high quality (11.8% CP, 1.3% CF, 76% starch). Lower TBARS levels were found in breast (low vitamin, 1.5; 45.1; 67.3; 86.5; OVNTM, 1.2; 31.1; 50.9; 69.4; for 0, 3, 6 and 9 hours of storage, respectively) and whole leg meat (low vitamin, 1.7; 26.1; 45.6; 56.0; OVN, 1.7; 18.1; 35.9; 47.9; for 0, 3, 6 and 9 hours of storage, respectively) from broilers fed OVN diets, when compared to low vitamin level, independent of the corn quality ( $P < 0.05$ ). In breast meat after different storage times, the lowest TBARS values were obtained for OVN supplemented broilers both in the poor quality corn with commercial vitamin level (low vitamin, 0 hours 2.2; 3 hours 23.1; 9 hours 52.2; OVN 0 hours 1.9, 3 hours 18.9 and 9 hours 47.7), and in the good quality corn (low vitamin, 0 hours 1.1; 3 hours 29.1; 9 hours 59.8; OVN 0 hours 1.5; 3 hours 17.4; 9 hours 47.8). No interaction for treatments in filets TBARS at 6 hours storage was observed ( $P < 0.05$ ). For legs meat, interaction was observed in 0 hours for good (low vitamin 1.1; OVN 1.1) vs worse (low quality 1.8; OVN 1.3). Vitamin supplementation affected TBARS levels after 3 (low quality 45.1; OVN 31.1), 6 (low quality 67.3; OVN 50.9) and 9 (low quality 86.5; OVN 69.4) hours of storage. An increased level of dietary vitamins reduced the oxidation process in the meat of broilers fed poor quality diets.

**Keywords:** chicken meat quality, corn quality, peroxide, vitamin supplementation

[M5-04]: Nutrition and meat quality (ID: 100130)

[Pakistan]

## **Influence of plant origin dietary carotenoids on pigmentation of broiler chicken meat**

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Three experiments were conducted to evaluate the effects of plant origin carotenoids on the pigmentation of broiler chickens. In Trail 1, the birds were fed basal diet with or without supplementation of marigold flower extract (lutein) at various concentrations, i.e., 0, 100, 150 and 200 mg/kg of feed for 42 d. At marketing age, the yellowness ( $b^*$ ) value of the breast and thigh muscles was increased in dose dependent manner by the dietary supplementation of marigold flower extract compared to control. While, lightness ( $L^*$ ), redness ( $a^*$ ) and ratio of redness to yellowness ( $a/b$ ) values were not affected as measured by chroma meter. Moreover, Roche colour fan scores of the shank skin were also increased on dose basis. The objective of Trail 2 was to determine the effect of two carotenoids (curcumin and lutein) on pigmentation of lipopolysaccharide (LPS) induced broiler chicks. The birds were randomly distributed into three dietary treatment groups: a basal diet without carotenoid supplementation (control), a basal diet supplemented with 200 mg/kg curcumin (CRM), or a basal diet supplemented with 200 mg/kg lutein (LTN) for 42 d. At the ages of 16, 18, and 20 d, half of the chicks in each group were injected either LPS or an equal volume of 0.9% NaCl. The intensity of the shank color and the  $b^*$  (yellow) values of the breasts and thighs were highest in lutein-supplemented broilers, followed by curcumin-supplemented and control broilers, whereas the  $a^*$  (red) value of the thigh muscle was highest in curcumin-supplemented LPS-induced birds. Based on the above-mentioned study, we concluded that carotenoids have positive effects on pigmentation of broiler chickens. Subsequently, another Trail (3) was designed and the broilers were challenged with *Eimeria* parasites because it is well known fact that coccidiosis decreases immunity and pigmentation of broiler chickens. In this trial, we used 300 mg/kg of curcumin, 300 mg/kg lutein and a combination of 150+150 mg/kg curcumin+lutein in chickens challenged with sporulated oocysts of *E. maxima*. At two weeks post infection the highest intensity of the shank skin color was observed in the broilers supplemented with a combination of both carotenoids C+L, followed by LTN, CRM and control groups. While, the skin color was significantly higher in LTN, followed by CRM, L+C and Control. The results obtained by HPLC revealed that the highest lutein levels were detected in the liver and muscle of lutein supplemented broilers and in the plasma and faeces of combined group. While, curcumin was not detected in any tissue. Based on the results obtained by a series of experiments, it was concluded that: dietary supplementation with marigold flower extract (Lutein) at the rate of 200 mg/kg of feed enhanced carcass and shank colour under normal management conditions. Both carotenoids improve colour stability in coccidiosis infected birds, however Lutein was better pigment than curcumin.

Keywords: Curcumin, Lutein, Pigmentation, Chicken, Carotenoids

[M5-05]: Nutrition and meat quality (ID: 100067)

[Indonesia]

## **The Effect of Dragon Fruit (*Hylocereus polyrhizus*) Peel on Broiler Thigh Meat Quality and Organ development**

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Dragon fruit (*Hylocereus polyrhizus*) consumption produces fruit peels which are without economic value and normally discarded as waste.  $\beta$ -Carotene, Anthocyanin, Betacyanin, and Betalain which are also available in dragon fruit peel have been reported as inhibitors in cholesterol synthetic pathway and could therefore be valuable to reduce cholesterol in poultry meat. Besides, high tannin content in dragon fruit peel may affect the development of broilers organs. It was previously shown that dragon fruit peel could be incorporated into broiler diet up to 15 % without affecting performances (feed consumption, daily weight gain, feed conversion, body weight, carcass percentage and fat pad percentage). The inclusion of 5 % dragon fruit peel in diet was also shown to lower Cholesterol, LDL, Triglyceride, and maintained HDL effectively in broiler blood. The present experiment was designed in completely randomized design with 4 different levels of dragon fruit peel (0, 5, 10, and 15 % of red dragon fruit peel mash) incorporated in a commercial broiler diet. All diets were iso-proteic (22 %) and iso-energetic (3000 kcal/kg). Protein, fat and cholesterol of broiler thigh meat were measured, as well as organ development (gizzard, liver, pancreas, heart, proventriculus, duodenum, colon, lymph, and cecum). The results showed that the inclusion of dragon fruit peel in broiler diet lowering fat and cholesterol of broiler thigh meat significantly ( $P < 0.05$ ), while it did not affect protein in thigh meat and organ development ( $P > 0.05$ ). In conclusion, the inclusion of 15 % of dragon fruit peel in broiler diet lowered cholesterol and fat content of thigh meat, while protein content and organ development were maintained.

Keywords: dragon fruit peel, broiler, thigh meat, cholesterol

[M5-06]: Nutrition and meat quality (ID: 100155)

[France]

## **Seleno-hydroxy-methionine: an efficient source of organic selenium for chickens' meat enrichment**

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Selenium (Se) is an essential trace element involved in many biological activities through specific selenoproteins like glutathione peroxydases and thioredoxine reductases: playing a major role in Redox cellular regulation. Dietary selenium is supplied as inorganic or organic forms and the present work aimed to compare the selenium tissue deposition of those sources with seleno-hydroxy-methionine (HMSeBA), a new organic selenium source. Dietary sodium selenite (SS), seleno-yeast (SY) and HMSeBA were added to a basal diet (0.04 mg Se/kg) at different concentrations (mg Se/kg feed; SS – 0.3; SY – 0.1 and 0.3; HMSeBA – 0.1 and 0.3 and a Negative Control, NC- 0). Male Ross PM3 broilers (six replicates of 25 birds per treatment) were fed those diets from 0 to 42 days of age. Those treatments did not influence growth performance parameters measured at 21 and 42 days. Selenium concentration, measured by ICP-MS, in plasma, liver and breast muscle indicated Se enrichment from all Se sources at both D21 and D42 compared to the NC group. For all treatments, the muscle Se content tended to be reduced between D21 and D42, probably due to fast development of the breast muscle during this period. Nevertheless, muscle Se concentrations were significantly improved with organic Se sources at 0.1 mg Se/kg compared to SS-0.3 ( $p < 0.05$ ). A significant dose effect on muscle Se content was observed for organic Se sources ( $p < 0.05$ ). In addition, for all level of inclusion, HMSeBA was more efficient for muscle Se deposition ( $p < 0.05$ ). The relative muscle Se enrichment comparison, using a linear regression slope ratio, indicated an average of 1.48 fold higher selenium deposition in muscle for HMSeBA compared to seleno-yeast. Other results indicated higher selenocysteine concentration using HMSeBA compared to SY, an indication of Se incorporation into biologically active selenoproteins. Those results indicate that HMSeBA, a chemically pure organic selenium source, is more efficient to supply selenium to broilers, and allow higher selenoproteins enrichment potentially involved in meat quality improvement as suggested by recent authors.

**Keywords:** Selenium, selenomethionine, selenocysteine, seleno-hydroxy-methionine, broiler chickens

[M7-01]: *Production schemes and meat quality* (ID: 100060)

[China]

## **Effect of housing system on chicken carcass, muscle development and meat quality traits**

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This aim of the present study was to compare the effects of two housing systems on growing performance, muscle development, carcass characteristics and meat qualities of Beijing-You chickens. Day old female Beijing-You birds (n = 30) were allocated to battery cages or floor pens, respectively. The same feed was provided ad libitum. The feed intake and body weight gain were recorded. At 120 day of age, these chickens were slaughtered for measurement of carcass traits (carcass weight, eviscerated yield, abdominal fat yield, and breast and thigh muscle yield) and meat qualities (pH value, shear stress, drop loss, meat colour, inosine-5-monophosphate (IMP) content, and intramuscular fat (IMF) content). The breast muscle IMP content was measured using high performance liquid chromatography method. Succinate dehydrogenase staining was used to distinguish the white and red muscle fibres on breast muscle paraffin section. The results showed that there was no difference for live weight, carcass weight and eviscerated yield of the birds from two systems. Breast and thigh muscle yield, were higher for the birds reared on floors, while abdominal and intramuscular fat content was lower. The meat of the birds reared in floor pen was also tenderer. Muscle fibre typing was not different between housing systems, white muscle fibre density per unit area was higher i.e. more numerous for the birds reared on floors. In conclusion, the carcass characteristics, meat qualities and muscle fibre size are influenced by housing system: rearing in floor pens may improve muscle development and reduce fat deposition, as a result of increased activity of the birds, without impairing their growth.

Keywords: housing system, meat quality, carcass, muscle chicken

[M7-02]: Production schemes and meat quality (ID: 100088)

[Italy]

### **Evaluation of meat quality parameters in the Italian chicken breed Milanino**

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The aim of this study was to evaluate several physical-chemical parameters related to the meat quality of the Italian composite chicken breed Milanino. A total of 120 birds were reared in outdoor pens (5 m<sup>2</sup>/bird) from 35 days of life, and fed ad libitum a standard commercial diet (20% CP, 4.5% Fat). On 150 and 180 days of age, 20 birds (10 birds/sex) were slaughtered after 24 h feed withdrawal. Thigh and breast meat samples were collected from each subject and colour parameters (on skin and meat), pH, Water Holding Capacity (WHC; centrifugation method) were determined. Cooking loss and Warner-Bratzler Shear Force (only for breast samples) were determined on cooked meat. Analysis of variance was performed (GLM proc. of SAS) and sex, age and sex\*age interaction were considered as sources of variation. Significant higher luminosity (L\*), and yellow (b\*) indexes were observed on the skin of female carcasses, both in thigh and breast samples, with a significant increase from 150 to 180 days; higher red (a\*) index values were detected in males, without variations between ages. Considering meat colour, higher values of L and b\* indexes, and lower a\* index were observed in females; lower L\* and higher a\* values were recorded at 180 days, if compared to 150 days. No significant differences between pH values recorded in males and females were found in both thigh (6.02-6.06) and breast (5.65-5.70) meat. Considering the meat potential loss of water, WHC values ranged from 22% to 28%, without variations between sexes or ages of birds. Mean cooking losses of 12.2% and 14.8% were measured for breast and thigh meat, respectively; in general, lower values were observed in male chickens and in older birds. The hardness of breast meat was significantly higher in males compared to females (14.2 vs. 11.9 N), and significant differences were not found between ages.

Keywords: italian chicken breed, meat quality, physical parameters

[M7-03]: *Production schemes and meat quality* (ID: 100120)

[France]

## **Multicriteria assessment of different rearing systems for intermediary growing broilers**

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In France, production of poultry meat relies essentially on the production of standard fast growing broilers in intensive system. If this production is effective from an economic point of view, it also has to deal with criticisms concerning the image of its production systems. To meet the social concerns while insuring acceptable economic and environmental performances, innovative systems of production were evaluated in conditions close to field. Thus, 3 types of housing environment were compared for medium-growing chickens. Classical rearing in confinement was compared to i) rearing giving a free access to a winter garden allowing a limited and sheltered outside access and ii) rearing giving animals a free access to outdoor as it is practiced for "Label Rouge" production. Experiment was repeated twice, in spring and in autumn, and included each time two flocks of 230 animals by condition. The density in poultry house was 14 chickens/m<sup>2</sup> and outdoor access was allowed from 30 to 57 days (slaughter age). A multicriteria analysis was performed including measurements of live performances, behavior, carcass and meat quality, welfare and environment. Results indicate that rearing chickens in alternative systems barely affect their growth performances and meat yields. They even allow producing less fatty carcasses. A major advantage of the alternative systems is to favor the general activity of animals and limit the occurrence of food pad dermatitis. The multicriteria assessment of the three production systems showed that the development of alternative systems would improve the image of the products without significant adverse impact on the economic and environmental performance.

**Keywords:** Alternative rearing system, Meat quality, Multicriteria assessment

[M7-04]: *Production schemes and meat quality* (ID: 100149)

[France]

## **Replacing soybean meal by alternative protein sources: Multicriteria assessment of medium or slow-growing chicken production system**

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This study aimed to assess the feasibility of producing medium (MG) or slow (SG)-growing chickens while limiting or totally removing soybean meal from the animal diets. Three feeding strategies were compared for MG production: a control (with soybean meal), a low soybean strategy (BS) and a soy-free strategy (0%S) including alternative sources of proteins. Only the control and 0%S diets were compared for SG production. MG and SG chickens of both sexes were reared up to 56 or 84 days of age, respectively. Various measurements were carried out, including growth performances, skin lesions, carcass and meat quality and mass balances. Performances of MG chickens were not affected by the BS strategy while the 0%S strategy negatively impacted slaughter weight, feed conversion ratio and breast meat yield. The 0%S strategy had no impact on final live weight and breast meat yield. Regarding environmental aspects, mass balances showed that nitrogen and phosphorus excretion rates were affected by the two alternative feeding strategies while nitrogen volatilization was reduced in the 0%S strategy. The 0%S strategy influences mainly the appearance of carcass and meat with a more pronounced yellow color. The multicriteria assessment of the MG production system showed that live weight production costs were not affected by the BS strategy while they increased by 4% in the 0%S one. Meanwhile, greenhouse gas emissions were significantly reduced in both alternative strategies (-12 and -27% respectively for BS and 0%S). For SG chickens, the live weight and breast meat production costs were little affected by the 0%S strategy (+ 1%), while greenhouse gas emissions were significantly reduced (-41%). Replacing soybean by other protein sources would thus be helpful to better meet the expectations of poultry meat consumers (non-GM feed, use of local feedstuffs...) while minimizing the negative environmental and economic impacts.

**Keywords:** nutrition, protein sources, multicriteria assessment, chicken

[M7-05]: *Production schemes and meat quality* (ID: 100117)

[Netherlands]

## **Improving animal welfare: automated monitoring of foot pad lesions**

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Conditions in the poultry house e.g. leaking water cups, watery feces and poor ventilation may cause wet litter. Van Harn et al (2014) reported that wet litter can induce foot pad lesions, but can also affect overall animal welfare, the ability to walk, quality and yield. To get grip on this issue, the first step is to monitor foot pad lesions post mortem. Dir 2007/43/CE Annex III prescribes that possible indicators of poor animal welfare conditions, like contact dermatitis are monitored, and communicated with the farmer and the competent authority, to enforce appropriate action. Foot pad lesions are an important form of contact dermatitis and therefore a point of attention (Ask 2010). In practice, feet are collected from the slaughter line; the Swedish model prescribes the collection of 2 x 50 feet per flock, at 1/3 and 2/3 of processing of that flock. However, manual scoring of foot pad lesions is subjective, labour intensive and not constant in time. Litter conditions may vary considerably within a poultry house, so foot pad lesions may vary within a flock. This would require continuous monitoring during the entire time a flock is processed. To overcome these issues, an automated foot pad lesion monitoring system has been developed and validated, based on a score card and an imaging system to grade the sessions. During validation, results of the camera grading system proved to be consistent, and comparable to the judgment of trained judges. (de Jong et al 2011, de Jong 2013). The system has been approved by the Dutch and Norwegian authorities, and is used on a daily basis in the Netherlands (4x), Denmark (3x) and Norway (3x). This automated system allows a more thorough monitoring of foot pad lesions, thereby creating a basis for addressing the causes of foot pad lesions, thereby improving animal welfare. References. van Harn et al (2014) *Journal of Applied Poultry Research* 23: 51-58 Dir 2007/43/CE Official Journal of the E.U., L 1182/19-28 Ask, B (2010) *Poultry Science* 89:866-875. de Jong I.C. et al (2011) WUR LR report 463 de Jong I.C. (2013) WUR LR report 713

**Keywords:** Automated, monitoring, foot, pad, lesions

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[M7-06]: *Production schemes and meat quality* (ID: 100129)

[Netherlands]

## **A visual guide to monitor lesions in broiler carcasses in abattoirs**

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The incidence of carcass lesions and the economic impact of these B-quality carcasses have been evaluated since 2010 at 45 abattoirs in Europe, Egypt and South Africa. To make this evaluation systematic a visual guide to identify and describe lesions in broiler carcasses was developed. Lesions were scored using a 3-point scale with 0 (normal carcass and no economic loss), 1 (minor lesions damage and minor economic loss) and 2 (major lesions, affected part rejected and big economic losses). Seventeen parameters from four categories were scored: skin integrity (e.g. nail scratches, pododermatitis, cellulitis, skin ruptures and litter spots), vascular integrity, (e.g. hematomas and blood splashes), skeletal lesions (e.g. epiphysiolysis, fractures and dyschondroplasia) and muscle abnormalities (e.g. white striping, wooden breast, green muscle disease, deep pectoral myopathy and PSE-like meat). For each parameter a set of 100 carcasses was evaluated. A standard form for recording of these lesions has also been developed. The scoring of carcasses in abattoirs revealed the lesions varied between flocks, between abattoirs and by lesion types. On average 16 % of the carcasses were downgraded (A to B-grade) and out of these more than 30% were related to epiphysiolysis in the wing joint. The second most common reason for downgrading were wing bleedings (at least 25 %) followed by skin rupture in the tail area (8 %). Hematomas in breast fillets and in drumsticks are generally the most expensive losses for the abattoirs. Besides the direct loss in sales of meat there are often extra costs for labor due to trimming carcasses.

**Keywords:** broiler carcass lesions visual guide

[M8-01]: Poultry meat products (ID: 100190)

[Denmark]

## **MSM Mechanically Separated "Meat"**

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According to present legislation any "meat" obtained by mechanically removal of residual meat from carcasses or bones, after the primal cuts have been removed, should if used for human consumption, be included in the list of ingredients. Technical developments within the industry now allows for production of MSM, which in terms of quality, hardly, if at all, can be distinguished from regular minced meat. Consequently there are no objective reasons for maintaining the ban or downgrading of higher qualities of MSM. The legal text states, that the level of degradation of muscle tissue is the key factor for quality, although this rarely, if ever, is considered in standard quality assessments. Audit reports from EU countries on the interpretation and implementation of the regulation showed, that individual countries and even regions had developed different ways of interpreting and implementing the regulations and a scientific opinion from EFSA on the topic concluded, that microscopic examination of tissue structure was one of the most promising methods for characterizing levels of degradation and would be the best prerequisite for setting threshold values for different classes of MSM. This is the scope of the MACSYS project which is a project funded by the European Union's Seventh Framework Program ([www.macsysproject.eu](http://www.macsysproject.eu)) for further information). The presentation will include a comparison of the 3 currently available histochemical methods (a German, English and a Danish method) on reference material as well as standard material from factory production lines. We will attempt to validate these methods with the limitation of the size of the project, suggestions will be made to threshold values, by which MSM can be graded and finally we open up for a discussion on alternative quality traits that could be included in an overall assessment of quality of MSM.

Keywords: MSM, quality, grading, methods

[M8-02]: Poultry meat products (ID: 100014)

[United States]

## **Effect of marination on CIE L\* and pH values of chicken breast pectoralis major with different color lightness**

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Color lightness (CIE L\* values) and pH are widely used as quality indicators for raw poultry breast fillets (pectoralis major). The objective of this study was to evaluate the effects of vacuum-tumbling marination on L\* and pH values of raw chicken breast meat with different color lightness. Early deboned (2 h postmortem) breast fillets from electrically-stimulated broiler carcasses were selected based on their initial color lightness and marinated in a vacuum tumbler (-0.6 atm, 16 rpm, 20 min) yielding a targeted 15% uptake. Fillet color (dorsal surface) and pH (cranial end) were measured at both 4 h and 48 h postmortem. Results show that for pale fillets (average L\* = 61) there was no difference in L\* values between 4h and 48h non-marinated samples. However, for non-marinated normal (average L\* = 53) and dark (average L\* = 47) fillets, L\* values were more than 5 units higher at 48h compared to 4h postmortem (P<0.05). There were no pH differences between the two postmortem times in non-marinated fillets regardless of the initial color lightness. Marination significantly affected both L\* and pH values (P<0.05) in the chicken fillets. In pale fillets, marination reduced L\* values by more than 6 units and increased pH by more than 0.2 units (P<0.05). In normal fillets, L\* value of marinated fillets at 48h was higher (>1.5 units) than at 4 h postmortem, but was lower (>3.5 units) than non-marinated samples at 48h. The fillet pH was not influenced by marination or postmortem time. For dark fillets, L\* and pH values of marinated fillets were higher than 4h controls (P<0.05); however, there were no differences in L\* and pH values between controls and marinated fillets at 48h postmortem. Our data demonstrate that the effects of marination on CIE L\* and pH values of early-deboned broiler breast meat depend on raw material color lightness. Marination reduces color lightness in pale broiler breast fillets, prevents color lightness from increasing during postmortem aging in normal fillets, and has no effect on changes in color lightness with postmortem aging in dark fillets.

Keywords: broiler, meat, marination, color, pH

[M8-03]: Poultry meat products (ID: 100134)

[China]

## **Influence of multiple Freeze-Thaw cycles on Structure, Texture and Water contents of Broiler Meat**

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A study was conducted to evaluate the changes in the breast muscle's texture and quality of broiler meat in various freeze and thawed cycles. Chicken meat was cut into 10×7.5×2.5 cm<sup>3</sup> pieces per replicate, packed in moisture impermeable polyethylene bags, sealed and stored at -20 °C for five weeks. For each week, a set of frozen samples was thawed at 4 °C for 12 h and a weekly analysis of the samples was performed over five weeks. The frozen samples were subjected to either 0 (fresh), 1, 3 and 5 freeze–thaw cycles. Effect of freeze-thaw (FT) cycles on gel-forming ability and quality of breast muscle of broiler meat was measured by observing differential scanning calorimeter (DSC), dynamic visco-elastic behavior (DVB), water holding capacity (WHC) and drip loss. The results showed that the fresh samples had good gel-forming ability as revealed by dynamic visco-elastic behavior, reduced thermal transition temperatures (T max) and enthalpy of denaturation ( $\Delta H$ ) ( $p < 0.05$ ). Frozen storage at -18 °C for each week significantly ( $p < 0.05$ ) reduced the gel-forming ability of chicken breast meat. Reduction in protein solubility during frozen storage was also significant ( $p < 0.05$ ). Structural change of proteins during frozen storage was apparent from reduced viscosity and gel filtration profile. Higher drip loss and reduction in gel-forming ability of chicken breast meat is ascribed to denaturation of proteins after multiple freezing and thawing cycles. The freeze–thaw process therefore has a detrimental effect on the quality and gel-forming ability of chicken breast.

Keywords: Chicken meat, freeze–thaw cycles, texture, water content,

[M8-04]: Poultry meat products (ID: 100168)

[Pakistan]

## **Production of a water-cooked salted duck meat product using high pressure technology**

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The study investigated the application of high pressure processing (HPP) for production of water-cooked salted duck meat product with improved quality in shorter time. Frozen whole breast meat (Skin-on) samples of Cherry valley duck were thawed (overnight, 4°C), dry salted with 10% w/w salt mixture (20-25°C, 3 h) and pickled in 1:2 w/v brine solution (20-25°C, 2 h). The pickled samples were packed with cooking medium (1:2 w/v) and sealed. The pickled samples were subjected to various treatments, such as HPP alone (200 MPa, 20-25°C, 15 min), or HPP either before or after heating (95-99°C, 15 min). The results were compared against a cooked-control (CK) (95-99°C, 45 min). The results revealed that HPP alone significantly decreased ( $P < 0.05$ )  $L^*$  (lightness),  $b^*$  (yellowness),  $E$  (color distance) and whiteness ( $W$ ) in comparison to CK. However, HPP before or after heating significantly increased ( $P < 0.05$ )  $L^*$ ,  $b^*$ ,  $h^\circ$  (hue angle),  $E$  and  $W$  compared to those of CK. HPP alone exhibited the highest Warner-Bratzler shear-force (WBSF), followed by HPP before heating. HPP after heating exhibited significantly lower WBSF than HPP before heating, but non-significantly different ( $P > 0.05$ ) than CK. Storage modulus ( $G'$ ) of raw meat indicated three regions of protein network at 20-55, 55-65 and 66-85°C. Salting slightly increased  $G'$ , but pickling decreased  $G'$ . Heating further decreased  $G'$  in CK, but HPP alone exhibited the highest  $G'$ . HPP before heating exhibited lower  $G'$  than CK. The increase and decrease in  $G'$  values indicated the formation and disruption of protein networks in the myofibrillar matrix, respectively. HPP after heating exhibited the least  $G'$ , which indicated HPP destroyed myofibrillar protein networks formed by heating. The highest and lowest firmness values of HPP alone and HPP before heating were also in compliance with WBSF results. HPP before heating improved optical colour, texture and rheology of salted duck meat product than CK in shorter processing time.

Keywords: HPP, cooking, duck meat, meat color, hardness

[M8-05]: Poultry meat products (ID: 100021)

[Brazil]

### **Aging process as a method to improve the tenderness in chicken meat**

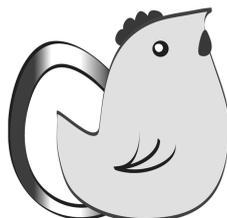
**Mello, J.L.M. (1), Souza, R.A. (2), Ferrari, F.B. (3), Gianpietro-Ganeco, A. (4), Paschoalin, G.C. (5), Viera, L.D.C. (6) and Borba, H. (7)**

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The aim of this study was to evaluate possible effects from lineage and aging process on the tenderness and the collagen content in breast meat from broilers. Were used 60 Pectoralis major muscle from deboned carcasses, purchased from a commercial slaughterhouse, being 30 from Cobb lineage (fast growth) and 30 from Label Rouge lineage (slow growth). Samples destined to aging process were individually packed in vacuum and stored in a BOD chamber ( $2^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ ) for three and seven days, and after frozen to late analysis. Were evaluated shear force, collagen content and myofibril fragmentation index. From samples previously cooked were obtained subsamples with known area ( $\text{cm}^2$ ) and submitted to cut in Texture Analyzer TA-XT2i texturometer coupled to Warner Bratzler device, which determined the shear force in kgf. The collagen content was determined by quantification of hydroxyproline amino acid. The myofibril fragmentation index was determined according CULLER et al. (1978). For statistical analysis a completely randomized design in  $2 \times 3$  factorial was used with two lineages, three aging periods, in ten replications. There was a significant interaction between aging period and lineage for shear force, collagen content and myofibril fragmentation index. Initially, meat from slow growth lineage was less tender ( $4.942 \text{ kgf/cm}^2$ ) than the meat from fast growth lineage ( $3.399 \text{ kgf/cm}^2$ ). The tenderness increased significantly with the aging process from  $3.399 \text{ kgf/cm}^2$  to  $1.531 \text{ kgf/cm}^2$ , after seven days, in samples from fast growth lineage, and from  $4.942 \text{ kgf/cm}^2$  to  $1.534 \text{ kgf/cm}^2$  in samples from slow growth lineage. As the tenderness increase, occurred a decrease of collagen content in samples from slow growth lineage (from 6.03% to 4.80%). Aging process reduced ( $p < 0.05$ ) the myofibril fragmentation index value in samples from both lineages. The lineage influences tenderness in chicken breast meat. The aging process promotes the tenderization of chicken breast meat.

Keywords: Breast, collagen, meat quality, myofibril fragmentation index, shear force



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[peG-01]: Genetic and rearing system (ID: 100012)

[Iran (Islamic Republic of)]

## **Estimation of genetic and phenotypic parameters for internal egg quality traits of Azarbaijan native chickens**

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For the first time, an experiment was conducted to estimate heritability, genetic and phenotypic correlations among internal egg quality traits of Azarbaijan native fowls. The data set that was used in this study included the records that collected in West Azerbaijan province's native chicken breeding center and agriculture central laboratory complex of university of Tabriz. Statistical models for all traits were fitted using GLM procedure of SAS software. Fixed effects including generation and incubation time were significant ( $p < 0.01$ ) for all traits except for egg meat-blood stains and yolk depth. Eight univariate animal models were compared for estimation of heritability and other genetic parameters and the most appropriate model for each trait was determined based on deviance information criterion (DIC). The genetic and phenotypic correlations between certain traits were also estimated through a multivariate animal model. Obtained results showed that direct heritability estimations of egg quality traits ranged from 0.02 for yolk depth to 0.31 for albumen percent. There were high positive genetic correlations between albumen weight and Haugh Unit (0.96) as well as between egg weight and albumen weight (0.86). Considering the importance of egg quality traits in fertility and rural egg production in Iran, these genetic and phenotypic parameters could be used to improve internal egg quality traits in Azarbaiejan native chickens.

**Keywords:** Native chickens, internal egg quality traits, heritability, genetic and phenotypic correlation

[peG-02]: Genetic and rearing system (ID: 100013)

[Iran (Islamic Republic of)]

## **Evaluation of maternal effects and detecting major genes in internal egg quality traits of Azarbaijan native chickens**

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The aim of this study was to evaluation of maternal effects and detecting major genes in internal egg quality traits in Azarbaijan native chickens. The data set that was used in this study included the records collected in West Azerbaijan province's native fowl breeding center and agriculture central laboratory complex of university of Tabriz. Statistical models for all traits were fitted using GLM procedure of SAS software. The probabilities of major genes segregation were separately studied in all investigated traits under a univariate animal model using Bayesian analysis and Major Gene Index (MGI) procedure. The major gene index calculated using outputs from univariate animal model. Segregation of major genes was confirmed for internal egg quality traits including yolk width, yolk height, albumen pH, yolk weight to albumen weight ratio, yolk index, yolk and albumen percentages and finally for yolk and albumen dry matter values in Azerbaijan native fowls. Given that major gene segregation was confirmed for internal egg quality traits, it is concluded that molecular techniques can be successfully used to map the related major genes in Azarbaijan native fowl.

**Keywords:** Major gene segregation, Major Gene index, Azerbaijan Native fowl, Molecular techniques

[peG-03]: Genetic and rearing system (ID: 100079)

[China]

### **Effect of FMO3 genotype and dietary canola meal supplementation on egg quality and yolk trimethylamine content in laying hens**

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The use of canola meal (CM) in laying hens diet is limited due to a potential adverse effect on production performance and egg quality. Further, dietary CM and the mutation of chicken flavin-containing monooxygenase 3 (FMO3) involved in the production of eggs with a fishy odor. This taint is caused by the accumulation of trimethylamine (TMA) in the yolk. This experiment was conducted to investigate the effect of FMO3 genotype and dietary CM supplementation on egg quality and TMA contents. A 3 × 4 two-factorial arrangement was employed with FMO3 genotypes (AA, AT and TT) and dietary CM supplemental levels (0%, 7%, 14% and 21%) as main effects. The trial lasted for 6 wk. An increase in CM content of the diets was accompanied by the unfavorable changes in some egg qualities, including a significant decrease in yolk color in groups fed 21% of CM and a decrease in yolk weight in hens fed 14% of CM. Egg quality was not affected by the genotype with exception of yolk weight which was higher in AA hens. The effects of genotype, diet, and their interaction on yolk TMA concentration were significant. Yolk TMA concentration was increased significantly by dietary supplement CM at 7%, 14% and 21%, and higher values were observed in 14% and 21% CM group compared with that of 0% and 7% CM group. TT hens shows a higher TMA content than that in AA and AT hens. The TMA contents in egg yolk from TT hens increased linearly ( $R^2=0.9611$ ) in response to the increase of CM supplementation. The results suggested that feeding laying hens with less than 14% of CM might have no negative effect on egg quality. But the addition level of CM might be restricted to 7% to reduce the occurrence of fishy tainting.

Keywords: Laying hens, canola meal, FMO3 genotype, egg quality, trimethylamine content

[peG-04]: Genetic and rearing system (ID: 100146)

[Russian Federation]

## **Increasing of egg yolk size by selection as a way for improvement of nutrition value of chicken eggs**

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Intensive selection of layers resulted in a shift of albumen: yolk ratio towards to the larger share of albumen and smaller share of yolk ( yolk share in average has decreased from 29,0 - 33,5 % to 23,0 – 31,0 % during the last 45 years). This determined a negative effect on nutritional values of chicken eggs for human consumption and for developing embryos. To avoid such effect it is necessary to increase a share of yolk in egg composition. According to our studies, the variability of yolk proportion in the eggs (both white and brown) of commercial layer crosses ranks 26,0 to 29,0%, with Cv 4,5 – 7,0%. Layers during their lives keep their ranks of yolk size (coefficients of rank correlation in yolk portion 0,37 ± 0,10, in egg mass 0,42± 0,10) Coefficient of heritability of relative yolk size is about 0,5. Coefficients of phenotypic correlation between yolk proportion and some parameters of nutritional values of chicken eggs were: Dry matter (%) in egg yolk: 0,20 – 0,25.; protein in dry matter (%) of egg yolk: 0,40; triglycerides in yolk( g/100 ml):- 0,16...- 0,30; hatchability (%) of layer's eggs: 0,15 – 0,35.

The most exact way to measure yolk mass is to weight it after breaking of an egg. But it's the most expensive and labor-intensive way at the same time. In our Institute there was developed a method of evaluation of yolk size (cm<sup>3</sup>) without of eggshell breaking with using of ultrasound scanning (M.A.Lapa, O.I.Stanishevskaya, 2013). Also can be used an express method - measurement of average yolk diameter (cm) on an echogramme. To evaluate a hen for yolk size there is enough 3-5 eggs, laid in a sequence. The correlation between yolk diameter and yolk mass was high ( $r = 0,90$   $P < 0,001$ , calculated on eggs of gene pool hens). Age-related rank correlation (34 and 52 weeks) of diameter/yolk mass was about 0,72 ( $P < 0,001$ ). Rank correlation coefficient of yolk diameter between «mother-hens» and the «daughter-hens» was rather high  $r = 0,57$ . We suppose that selection for increase of yolk proportion up to 31,0 % can be beneficial for improvement of nutritional values of eggs for human consumption, technical use and for improvement of conditions for embryo environment.

Keywords: layers; eggs; yolk; correlations

[peG-05]: Genetic and rearing system (ID: 100194)

[France]

## **Attempts for early gender determination of chick embryos in ovo using Magnetic Resonance Imaging**

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Our objective\* was to develop a non-invasive method based on Magnetic Resonance Imaging (MRI) for early detection of the sex of the chick embryo (*Gallus gallus domesticus*) in ovo. This research field is of high relevance due to ethical considerations regarding the elimination of eggs of one inappropriate sex in poultry production (male for egg production). Two imaging methods (morphological and parametric) were explored in this study: - (1) The development and the evaluation of "morphological" 3D MRI sequences to detect gonads in 1,5 and 4,7 Tesla magnetic fields using a fine exploration of the morphology of the embryo to detect the asymmetrical difference of the ovaries and the testis, the size of which is not exceeding a few millimeters. The urogenital systems were well identified with the 4,7 T imager but, despite the numerous attempts using MRI observations of eggs at various stages of embryonic development (up to 17 days), it failed to identify gonads. Gonads develop on kidneys and do not have a composition which allowed distinguishing both tissues. Unexpectedly this technique could not reveal gonads. It is also noteworthy that this non-invasive method would have been quite difficult to settle in hatchery because of the number of eggs and the industrial speed of sorting chicks or eggs - (2) The development and the evaluation of "parametric" 3D MRI sequences to observe and characterize the different compartments of the egg and to see if their volume or their composition allowed sex discrimination between eggs. Two types of parametric image sequence (T1 and T2 relaxation rates) were tested at both 1,5 and 4,7 Tesla fields. Besides the embryo, the MRI sequence, particularly the T1 weighed images, allowed to very clearly differentiate 4 compartments: albumen, vitelline sac and the allantoic and amniotic cavities. Numerous eggs were scanned by MRI at various stages to statistically evaluate if volumes and T1 or T2 relaxation rates of the different egg compartments differently evolved between both sexes. Unfortunately our measures did not highlight significant differences between both sexes.

\*We acknowledge the region Bretagne, Pays de Loire and Centre for financial support

**Keywords:** gender determination, chick embryos, in ovo, Magnetic Resonance Imaging, RMI, R.M.I

[peG-06]: Genetic and rearing system (ID: 100122)

[India]

## **Comparative external, internal Egg Quality characteristics and egg component yield of Pearl and White Guinea Fowl Strains at different ages**

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Pearl and White guinea fowl strains are commonly reared in India. A study was conducted to investigate the comparative external, internal egg quality characteristics and egg component yield of pearl and white guinea fowl strains at different ages. A total of 120 guinea fowl pullets of eighteen weeks old Pearl and White strains were divided into two groups with three replicates of 20 pullets each maintained under intensive system of management up to 95 weeks of age. Standard nutritional and managerial condition was followed throughout the experiment. The study period consisted of 20-95 weeks with 19 periods of collection comprising 4 weeks interval each. A total of 456 eggs comprising 12 eggs/ period/strain i.e., 228 eggs/strain were collected and subjected for external, internal egg quality characteristics and egg component yield as per the standard procedure. The yolk colour was determined by Yolk Fan score. The overall mean external egg quality characteristics namely egg weight, egg shape index and egg specific gravity did not differ significantly ( $P>0.05$ ) between pearl ( $37.68 \pm 0.17$ g,  $80.21 \pm 0.28$  and  $1.109 \pm 0.002$ ) and white ( $38.03 \pm 0.13$ g,  $79.76 \pm 0.24$  and  $1.111 \pm 0.002$ ) guinea fowls. Pearl guineafowl eggs had significantly ( $P<0.01$ ) greater egg surface area ( $51.47 \pm 0.26$  cm<sup>2</sup>) than White ( $50.82 \pm 0.25$ cm<sup>2</sup>) guineafowls. The overall mean internal egg quality characteristics namely albumen index, Haugh unit score, yolk index, yolk colour and shell thickness did not differ significantly ( $P>0.05$ ) between pearl ( $0.220 \pm 0.008$ ,  $86.48 \pm 0.15$ ,  $0.589 \pm 0.009$ ,  $7.71 \pm 0.09$ , and  $0.418 \pm 0.004$ mm) and white ( $0.224 \pm 0.008$ ,  $86.45 \pm 0.14$ ,  $0.593 \pm 0.009$ ,  $7.74 \pm 0.08$ , and  $0.416 \pm 0.004$ mm) guinea fowls. The overall mean egg component yield namely per cent albumen, yolk and shell did not differ significantly ( $P>0.05$ ) between pearl ( $53.68 \pm 0.25$ ,  $29.89 \pm 0.22$  and  $16.44 \pm 0.26$ ) and white ( $53.75 \pm 0.27$ ,  $30.10 \pm 0.24$  and  $16.15 \pm 0.23$ ) guinea fowls. It can be concluded that both the pearl and white guinea fowl strains had comparative external, internal egg quality characteristics and egg component yields at different ages, except egg surface area.

**Keywords:** Guineafowl, egg quality characteristics, component yield, strain

[peG-07]: Genetic and rearing system (ID: 100027)

[Brazil]

## **Performance and quality of eggs of quail feeding at different times under conditions of heat stress**

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Japanese quail egg production has increased considerably in the last few years, which has promoted research aimed at improving production efficiency of the birds. Regarding temperature regulation, quail birds are extremely demanding as to the limits of climate variables. Feeding time stimulates feed intake because the noise and movement generated appear to act as an habituation factor, i.e., birds get used to these stimuli, increasing their feed intake. Knowing the optimal feeding time for Japanese quail may be helpful under circumstances when feed intake is low, such as when there is heat stress, which commonly results in egg production drop and decreased eggshell quality. The present study aimed to evaluate the performance and egg quality of quails subjected to two different feeding schedules created in conditions of caloric stress. Japanese quail (*Coturnix coturnix japonica*), 192 birds at 24 weeks of age were distributed in a completely randomized design with twelve treatments and two replicates each of eight birds. The measurements of performance and egg quality were conducted over three periods of 21 days each. The experiment was conducted at the Poultry Section of the University Federal Rural of Rio de Janeiro from October to December 2012. The treatments consisted of two different schedules of feeding: 6:00 and 16:00. The variables used to evaluate the performance were: feed intake (g/bird/day), egg production (%), egg mass (g), feed conversion per egg mass (kg/kg), feed conversion per dozen eggs (kg/dz) and viability (%) for egg quality were evaluated: bark thickness (mm), percentage of albumen, yolk percentage and average egg weight (g). In the conditions of caloric stress under which this experiment was performed, it can be concluded that better performance was obtained by feeding Japanese quails at 16:00 and better egg quality was obtained by feeding Japanese quails at 06:00.

**Keywords:** Feeding management, japanese quails, egg quality

[peG-08]: Genetic and rearing system (ID: 100142)

[Brazil]

### **Age of laying hens from cage free system decreases the egg shell quality**

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This study aimed to evaluate the influence of the age of semi-weighted laying hens raised in alternative system upon the shell quality and upon the internal content of eggs intend for human consumption. It was used 45 eggs from pullets of the laying strain Isa Brown housed in cage-free alternative system (floor system with litter). Eggs were collected from pullets with three different ages: 45, 63 and 83 weeks. A completely randomized design was used with three treatments: 45, 63 and 83 weeks old, with five replicates with three eggs each. For the analysis it was used fresh and uncracked eggs. The variables evaluated were: egg weight, yolk weight, albumen weight and shell weight and thickness. The eggs were broken and its internal content was removed and separated in yolk, albumen and shell. The yolk was individually weighed with a digital scale and its respective weight was expressed in grams (g). The shell was washed and dried at room temperature for 72 hours and then it was weighed. The albumen weight was obtained by the difference between the weight of whole egg and the yolk weight and shell weight after drying. For the shell thickness evaluation it was used fragments from the apical, equatorial and basal regions of the egg shell, including the internal membrane. The measures were made with a digital micrometer, Mitutoyo, with 0,001 mm resolution, on the 3 regions of egg shell, obtaining an average expressed in millimeters (mm). Data were submitted to analysis of variance and means compared by Tukey test (5%) using the statistical program SAS. No significant effects were recorded ( $P>0,05$ ) of treatments on egg, yolk and albumen weights. However, the shell weight and thickness were statistically different between treatments, both greater for the eggs of younger pullets. These results show that egg shell quality decreases with the age of the pullet.

Keywords: Cage-free, egg components, external quality, physical analysis

[peG-09]: Genetic and rearing system (ID: 100136)

[Brazil]

## **Strength of fracture of the eggs shell from laying hens of different ages bred in cage-free system**

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The experiment took place at the Products of Animal Origin Technology Laboratory of the Department of Technology of Veterinarian and Agricultural Sciences of UNESP, Jaboticabal Campus, São Paulo, Brazil. The present study aimed to evaluate the effect of the ages of laying hens bred in cage free alternative system, upon the weight of the eggs and the resistance of the shell to fracture. To perform this study one used 54 brown shell eggs, all of them with no snaps, proceeded from semi-weighted commercial laying hens, from Isa Brown lineage, being 45,63 and 83 weeks old lodged in cage free breeding system (bred on pavement with bed). The experimental lineation was totally randomized, with three treatments (age of the birds: 45. 63 and 83 weeks old), with repetitions of three eggs each. The eggs from reach treatment were evaluated as for their weight (g) and the resistance of the shell to the snaps (kgf). The analyses were done with fresh eggs, collected the same day, in the morning period. After the separation by treatment, the eggs were weighted on digital scale of 0,01 g precision and the weights were registered. For the analysis of the shell resistance, the whole egg was put in the vertical position in a support and submitted to crash with rupture probe of 40 mm in a Texture Analyser TA.XT plus, with pre-test speed of 2,0mm/second, test speed 1,0 mm/second and post-test 10 mm/second. The shell was pressured until the snap occurred and the necessary used force was the indicator of the shell resistance. The data were submitted to variance analysis and Tukey test through SAS program, considering 5% significance. No significant effects of the treatments upon the weight of the eggs were registered ( $P>0,05$ ) and the shell rupture strength. Those data showed that the age of the birds did not influence the weight and the shell resistance to snap.

Keywords: alternative system, laying eggs birds, shell resistance

[peG-10]: Genetic and rearing system (ID: 100147)

[Brazil]

## **Physical and chemical changes and functional properties of brown eggs as a function of time and conditions of storage**

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We evaluated quality changes, chemical composition and functional properties of eggs from 30 weeks-age Hisex Brown hens according to the time and conditions of storage. We used 240 eggs weighing between 55 and 65g, 120 being stored under ambient conditions and 120 under refrigeration for 28 days. We used a completely randomized design with 10 treatments in a 2x5 factorial scheme (temperatures and storage periods), six replicates of four eggs each. The quality variables: egg, albumen, yolk and shell weight, yolk index, Haugh Unit, albumen, yolk and shell percentage and, albumen and yolk pH. For chemical composition we evaluated crude protein, total lipids, total solids, ash, and moisture for both albumen and egg yolk. Functional properties studied were formed and drained volume of the foam, volume of oil used to form the emulsion, early destabilization of the emulsion and yolk colorimetry. Eggs stored under refrigeration maintained good quality of the yolk index and UH during the 28 days of the experiment while eggs stored under ambient condition showed lower quality at seven days of storage. Regarding fresh refrigerated eggs, the yolk index increased at seven days. The storage period influenced negatively the UH values, with the worst values being observed for eggs stored under ambient conditions. Refrigerated eggs suffered less weight loss compared to eggs stored under ambient condition. The pH of the albumen and yolk of chilled eggs remained lower than those observed in eggs stored under ambient conditions. The total solids content decreased in the yolk and increased in albumen with the increase in the storage time. There was loss of moisture of the albumen during storage being higher for eggs stored under ambient condition. There was a decrease in the volume of foam formed after 21 days. Regardless of the storage period, the volume of drained liquid and the volume of oil used to form the emulsion were lower for refrigerated eggs. Cold eggs showed darker and more intense egg yolk color. Storage under refrigeration was able to preserve the quality of the eggs for a longer period of time, ensuring and also improving some functional properties.

Keywords: Egg white, egg yolk, foaming, emulsifying properties, storage, total solids

[peG-11]: Genetic and rearing system (ID: 100016)

[Spain]

## Effect of oviposition time on egg quality characteristics

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The oviposition time seems to affect several egg quality characteristics, although a significant effect has been revealed by most of investigators only for egg weight and shell strength, eggs laid in the morning being generally heavier and having worse shell strength than those laid in the afternoon. Other studies have indicated that egg weight and shell strength are not significantly affected by the oviposition time. Furthermore, data on the effect of oviposition time on other egg characteristics are very scarce. The objective of the study was to assess the effect of oviposition time on external egg quality characteristics using several Spanish chicken breeds. A total of 704 eggs were collected (cracked and dirty eggs were discarded), 362 in the morning (between 08:30 and 11:30 h) and 342 in the afternoon (between 11:30 and 14:30 h). White-, tinted-, brown-, and dark brown-shell egg layers were used (18 birds from each group). They were in separate pens in the same house, bird density being 6 birds/m<sup>2</sup>. The lighting regime was 14 h light: 10 h darkness (light from 07:00 to 21:00 h). Egg weight was measured to the nearest 0.1 g using a standard balance, shell strength was measured using specific gravity, and shell colour was measured using an egg reflectometer. Eggs were broken, and albumen height was measured (results expressed as Haugh units), yolk colour was measured using the DSM fan, and blood spots were determined by eye. Data were analyzed by analysis of variance and chi-square test (GLM and FREQ procedures of SAS). There were statistical significant differences ( $P < 0.001$ ) between oviposition times in egg weight and yolk colour, eggs laid in the morning being heavier (55 vs. 53 g) and having lighter yolks (sheet 10 vs. 11) than those laid in the afternoon. Although there was a trend ( $P < 0.1$ ), there was no significant difference in blood spots incidence (6 vs. 9 %). There were no significant differences in shell strength, shell colour, and albumen quality. The results do not show evidence of practical significant effects of oviposition time on egg quality characteristics.

Keywords: oviposition time, external egg quality, internal egg quality, Spanish breeds, chicken

[peM-01]: Egg safety and microbiology (ID: 100048)

[Italy]

## **Mycoplasma synoviae in layer hens, field and laboratory activities**

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*Mycoplasma synoviae* (MS) is recognized as an important poultry pathogen, recently a new particular alteration of the egg shell in layer sector has been related with MS. Layer industry is a very good environment for the maintenance of MS infection, in particular the presence of multiage groups allows MS to be constantly present inside the layer population, in fact when new MS-free layers group are introduced in the farm, they become positive after some weeks, due to the persistence of this pathogen in the oldest layer groups. Based on some experimental data, showing a decrease in number of laid eggs, we decided to better understand the possible impact of MS infection during the period around the production peak. Moreover basing on historic MIC (Minimum Inhibitory Concentration) data of the selected farm, we decided to apply a specific drug treatment in order to mimic a controlled infection, similar to MG controlling scheme, applied at the beginning of MG control plan. Briefly the schedule treatment included a first treatment after all newest layers are translated at the production site and a second treatment one week before the presumptive peak of production. Obviously this kind of approach should be applied only in flocks where a MIC monitoring scheme is performed during the production cycle, providing useful knowledge for a proper use of the selected drug/drugs and offering a new tool to the practitioners for the assessment of a “drug strategy” flow chart in case of clinical sign during the production cycle. The drug scheme applied in this study showed good improvement in production parameters if compared with production data analysis of past production cycles without any specific MS treatment. In conclusion, this data produce the basis on the possible impact of MS in eggs production, and deeper studies are strictly advised.

Keywords: *Mycoplasma synoviae*, Layer Hens, eggs abnormalities

[peM-02]: *Egg safety and microbiology* (ID: 100053)

[Australia]

## **Effect of infectious bronchitis virus strains (N1/88, T) on eggshell colour in unvaccinated brown egg laying hens**

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Shell colour has been linked to egg quality parameters in brown eggs and with some known antimicrobial properties against gram positive bacteria. Protoporphyrin IX (PP IX) is the main eggshell pigment in addition to biliverdin and its zinc chelates. The Australian strains of infectious bronchitis virus (IBV) have the ability to multiply in the shell forming region of oviduct of laying hens and deteriorate the brown eggshell colour. The objective of the present study was to study the effect of IBV strains (N1/88 and T) on the brown eggshell colour of unvaccinated Isa Brown laying hens. Eggshells were collected at days 1-11 post infection (p.i.) from unvaccinated Isa Brown laying hens challenged with IBV strains N1/88 or T as well as from a negative control group of unvaccinated hens. Shell reflectivity (%) and shell colour L\* were measured on shells with and without cuticle and shells were further processed for the quantification of PP IX from the same shell with and without the presence of cuticle. There was a significant effect ( $P < 0.0001$ ) of day p.i. and challenge virus strains on shell reflectivity, shell colour L\* and PP IX values for shells with and without cuticle. Shell reflectivity and shell colour L\* values for the control eggs were significantly lower compared to those from hens challenged with both strains of IBV and were also significantly lower on day 1 compared to rest of the days p.i. The PP IX was quantified by spectrophotometric analysis of digested eggshell solutions. The mean PP IX in 1g of shell with and without cuticle was significantly higher on day 1 compared with the other days. The amount of PP IX in the shell decreased with time post infection for the IBV groups. The amount of PP IX in whole eggshell was highest for the control group and lowest for the T strain group, with the N1/88 group intermediate. In conclusion, the IBV strains reduced the intensity of brown shell colour to different extents.

**Keywords:** hen shell gland; brown eggshell colour; protoporphyrin IX; infectious bronchitis virus

[peM-03]: *Egg safety and microbiology* (ID: 100095)

[Brazil]

## **Phenotypical characterization and molecular detection of *Salmonella* in samples in Starter, Grower and Egg Production phases in commercial Laying hens**

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*Salmonella* is a genus that is distributed worldwide and is an important zoonotic agent as it can cause toxic infections in humans fed contaminated food. Eggs and poultry meat are the foods most often contaminated by *Salmonella*, and the egg is considered the most prevalent when the risk of human food toxic-infection is considered. The dissemination of this pathogen in the poultry chain can occur vertically, when contaminated day-old chicks are placed on farms and horizontally, when their diet and or their housing facilities are contaminated. In this study we monitored the prevalence of *Salmonella* sp. throughout the production chain using conventional bacteriology and real time PCR techniques. The sampling protocol was as follows: The transport crate's flooring material (meconium) was swabbed when the chicks were first placed. Samples were then collected from the environment (swab of cages and nipple drinkers), the birds (cloacal swabs), the feed and insects at strategic time points (during allotment, at 5 weeks, 13 weeks and 45 weeks of age) throughout the brooding, rearing and laying periods. In total 864 samples were collected, 248 samples during the early brooding and rearing period, 392 from the growing period and 224 from the laying period. Of the 864 samples collected, 2,8% were positive using the bacteriological technique and 15,3% using real time PCR. The contamination was higher in brooding and rearing periods and declined during the laying period. Twenty four isolates of *Salmonella* were identified with the following prevalence: *Salmonella* Agona (41,7%), *Salmonella* Livingstone (33,3%), *Salmonella* Cerro (16,7%), *Salmonella* Senftenberg (4,2%) and *Salmonella* Schwarzengrund (4,2%). *Salmonella* Livingstone was identified only during the early brooding and rearing period. This finding suggests that vertical contamination of this pathogen had occurred and permitted a horizontal contamination in the environment of crate samples and insects. In other ages, no more contaminated samples were found with this serovar. At rearing and laying periods, isolated material belonged to serovars Agona, Cerro, Senftenberg and Schwarzengrund, pointing to horizontal contamination. It is possible to conclude that both vertical and horizontal contamination are important during the cycle of commercial egg production and contamination in rearing period is higher than in the laying periods.

**Keywords:** *Alphitobius diaperinus*, cage flooring, environment, laying period.

[peM-04]: Egg safety and microbiology (ID: 100022)

[Algeria]

## **Comparison of three diagnostics methods of *Mycoplasma gallisepticum* in Batna governorate (Algeria)**

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*Mycoplasma gallisepticum* is the most pathogenic avian *Mycoplasma*; however, strains may differ markedly in virulence. Because of the multiplicity of pathways of transmission of the pathogen, early detection of new infections is essential. For a long time, control programs were based on use of techniques with internationally accepted standardization : Serum plate agglutination (SPA), hemagglutination inhibition (HI) and ELISA are the most common serological techniques. Direct diagnosis requests isolation and identification of the agent in selective culture media or the demonstration of the DNA of the pathogen in the host using the polymerase chain reaction (PCR). The aim of this study is to compare the effectiveness of three methods for detection of MG by the PCR, culture and serology (SPA) for the detection and differentiation of MG infection in order to highlight the best techniques from those below. **Materials and methods:** In this study, the technical performance of culture, a commercially available polymerase chain reaction (PCR) test and rapid plate agglutination (SPA) test were compared for the detection of *Mycoplasma gallisepticum* infections from 18 birds. Results showed a high percentage of positive samples of both culture and PCR tests (72.22% and 63.63% respectively). SPA showed a less positive rate (61.11%). the utilization of SPA towards MG diagnosis is limited by its reduced specificity and the high incidence of false positives. Contradictory to other studies, bacteriology was more sensitive than PCR. Several studies support strongly the use of the PCR as a technique for the diagnosis of *Mycoplasma* infections since this technique is more sensitive than serology and culture. This study showed that it is not advisable to rely completely on one test (system) only.

**Keywords:** *Mycoplasma gallisepticum*, diagnostic, SPA, culture, PCR.

[peM-05]: Egg safety and microbiology (ID: 100107)

[Germany]

## **The first bivalent Salmonella live vaccine for chicken, turkeys and ducks**

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The consumption of poultry meat and eggs, which represent a major source of affordable high energy protein for much of the global population, is believed to be the main cause for Salmonella infections in humans. Food-borne infections with the Salmonella (S.) serovars S. Enteritidis and S. Typhimurium are a serious public health concern. In a joint effort, the poultry meat and egg industry and the authorities have made significant progress in reducing the contamination rate of poultry flocks and products over the past years in Europe. Vaccination plays an important role in the overall biosecurity system on chicken farms to prevent Salmonella infections. Live attenuated vaccines derived from S. Enteritidis and S. Typhimurium are widely used and their efficacy, ease of use and excellent safety under field conditions has been proven. Recently, a new bivalent live vaccine consisting of live attenuated S. Enteritidis and S. Typhimurium strains obtained marketing authorization in Europe, which contains the two vaccine strains already successfully used in monovalent Salmonella Enteritidis and Salmonella Typhimurium live vaccines. The bivalent vaccine is produced in an innovative co-fermentation process which allows the simultaneous fermentation of both Salmonella vaccine strains in one fermenter. Extensive studies demonstrated the safety of the bivalent live vaccine in the target species. Efficacy was investigated after oral challenge infections with either S. Enteritidis or S. Typhimurium field strains. Now for the first time a bivalent Salmonella live vaccine for use in chicken, ducks and turkeys which provides homologous protection against S. Enteritidis and S. Typhimurium and protection against the monophasic S. Typhimurium variant is registered. In chicken, the active immunization with this vaccine effectively reduces fecal shedding and the colonization of internal organs with S. Enteritidis and S. Typhimurium field strains and the S. Enteritidis contamination of eggs.

Keywords: Salmonella Enteritidis Typhimurium Live Vaccine

[peM-06]: Egg safety and microbiology (ID: 100158)

[Pakistan]

## **Prevalence of Salmonella enteritidis in hatcheries and broiler retail outlets in Rawalpindi, Pakistan**

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Poultry eggs and meat are nutritious food items as they consist of protein, phosphorous and important vitamins and minerals. Salmonellosis is a food born zoonotic disease, caused by salmonella. To study the prevalence of Salmonella enteritidis in hatcheries and broiler retail outlets, a total of 1257 samples were collected, including 345 egg shell samples, 174 egg contents, 354 egg storing trays and 384 broiler meat samples. A sterile cotton swab was used for swabbing of samples from egg shell surface and egg storing trays while 25 gram meat and egg content samples were collected randomly from hatcheries and broiler retail outlets of Rawalpindi. Tetrathionate broth and Hektoen enteric agar were used for culturing of Salmonella. Salmonella enteritidis was confirmed by specific primers by multiplex PCR. Overall prevalence of Salmonella enteritidis was eggshells 128 (37.10 %), egg contents 38 (21.83%) egg storing trays 123 (34.74 %) and broiler meat 97 (25.26%).So, it can be concluded that poultry meat and eggs are potential source of salmonella into kitchen of Pakistan people. This study at farm and retail level can provide more definitive evidence for food born human infections due to presence of salmonella; and also allows accurate measurement to reduce salmonella population in poultry meat and eggs.

Keywords: Salmonella enteritidis, food born zoonosis, eggs, hatcheries, meat

[peN-01]: *Hen nutrition and additives* (ID: 100004)

[Iran (Islamic Republic of)]

## **Impacts of various levels of hull less barley and Enzyme on Intestinal bacterial count and egg quality**

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In compare with common barley, Hull less barley contains more amounts of none -starch polysaccharides. High levels of soluble none-starch polysaccharides in poultry feed cause anti-nutrient effects and microbial count in digestion system plays considerable role on anti-nourishing characteristics of these compounds. The current research is conducted to Study changes in bacterial number exist within small intestine in layer hens fed various levels hull-less barley and enzyme. 216 layer pullets in their 24th week from W36 species, grouped in cages to 18 groups, each group contains 12 pullets (6 occurrences, 2 pullets in each occurrence). Trials including diets with 0, 20, and 30,40,50,60 percent hull less barley and three levels of biform enzyme contains  $\beta$ -Glocanase and Xilanase with 550 and 800 unit per gram (0,0.5 and 1 gram per Tone) respectively exploited during 18 weeks. Results showed that total count number of aerobic and anaerobic bacteria influenced by adding hull less barley ( $P<0.05$ ), however exploiting enzymes along with hull less barley has not shown significant impact. The results also showed that  $\beta$ -glucanase and xylanase had negative effects on egg shell quality as reduced egg shell weight (4.6%) and egg shell thickness (5.32%). The addition of  $\beta$ -glucanase and xylanase had also no effects on yolk color and Hugh units of eggs either.

Keywords: egg quality, hull less barley

[peN-02]: *Hen nutrition and additives* (ID: 100011)

[Pakistan]

## **Hemp seeds (*Cannabis sativa* L.): influence on cholesterol and fatty acids composition in egg yolk**

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The present study was designed to find the effect of the addition of hemp seed (HS) into the diet of laying hens on egg yolk cholesterol and fatty acids changes. Sixty hens (Rhode Island Red x Fyoumi) at the peak production (34 weeks) were randomly divided into four groups. Each group was replicated twice with five birds per replicate. HS was acquired from the local market and included in the ration at the level of 0.0 (HS-0), 15 (HS-15), 20 (HS-20) and 25% (HS-25). HS was fed to the birds for consecutively three weeks. During the third weeks, three eggs per replicate were collected and subjected to analysis of fatty acid and cholesterol profile. The results revealed that egg yolk total cholesterol, myristic (C14:0), palmitic (C16:0) and stearic (C18:0) decreased significantly in HS-25. Total and individual monounsaturated fatty acids decreased significantly and total and individual polyunsaturated fatty acids increased significantly in the HS-25. Similarly, total omega-3 and omega-6 increased significantly in the HS-25 group. We concluded from these results that feeding HS at the rate of 25% to the laying hens improved the cholesterol and fatty acids profile in egg yolk.

Keywords: Layer, egg, cholesterol, fatty acids, hemp seed

[peN-03]: *Hen nutrition and additives* (ID: 100109)

[Indonesia]

## **Effect of Substitution of Leaf and Seed Rubber (*Hevea brasiliensis*) Fermentation with Soybean meal for Production and Quality Egg Laying Chicken**

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This study aims to determine the level of use of rubber leaf and seed fermentation (DBKF) instead of 100% soybean meal in livestock rations Chicken Laying so as not to interfere with Chicken Laying livestock production. The study consisted of a series of field experiments. Experiments in the field / cage biological test for variables measured were feed intake, feed conversion, and income over feed cost (gross profit). As well as variables related to egg production (Hen day and egg weight) and the variables that affect the quality of the eggs (thick eggshell and yolk color index), the Chicken Laying aged twenty weeks were two hundred and forty day old. The draft completely randomized design with six treatment is replacement of 0, 20, 40, 60, 80 and 100% of soybean meal protein with leaves and rubber seed fermentation and four replications. Data were analyzed statistically using ANOVA, and if it shows a marked influence continued with Test Duncans / DMRT. The parameters measured were feed intake, feed conversion, income over feed cost (IOFC), Hen day, egg weight, egg shell thickness and yolk color index in chicken Laying. The results showed that the production performance of laying chicken mainly on feed intake, feed conversion and egg production is not influenced by the use of rubber leaf and seed fermentation (DBKF) in livestock rations. Soybean meal protein replacement rate with leaves and rubber seed fermentation in the ration can be up to 100% in the diet of laying chicken.

**Keywords:** Leaves and seeds rubber (*Hevea brasiliensis*), fermentation, substitution, production, chicken laying

[peN-04]: *Hen nutrition and additives* (ID: 100059)

[Romania]

### **Study on the efficiency of grape seeds cakes used as antioxidant, compared to vitamin E, in layer diets enriched in polyunsaturated fatty acids**

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The study was conducted for 4 weeks on 180 Lohmann Brown layers (52 weeks) assigned to three groups (C, E1, E2). The diet formulation for group C (corn, soybean meal and corn gluten as basic ingredients) had 19% crude protein and 15 MJ/kg metabolisable energy. Unlike the diet for group C, the diet formulations for groups E1 and E2 included 5% flax meal and different antioxidants. The level of  $\alpha$  linolenic acid was almost 10 times higher in the fat from E1 and E2 diets compared to group C. The E1 diet was treated with 100 mg vitamin E/kg feed, on a DM basis. The E2 diet included 2% grape seeds cakes (polyphenols 630.89  $\mu$ g EAG/g; flavonoids 5.0651 mg/ml; antioxidant capacity 28.4678 mM Trolox equivalent/g sample). The antioxidant capacity of E2 diet was higher than that of C, but lower than that of E1. The data on Haugh unit determined in the eggs (18 eggs per group) harvested during the final experimental week, were not significantly different between groups. The  $\Omega$ 6/ $\Omega$ 3 polyunsaturated fatty acids ratio in yolk egg fat was  $4.46 \pm 0.11$  in E1 and  $4.52 \pm 0.21$  in E2, three times lower ( $P \leq 0.05$ ) than in the control group ( $14.70 \pm 0.43$ ). In group E1, particularly, but in group E2 too, the concentration of total polyphenols in the egg yolk was higher ( $P \leq 0.05$ ) than in group C.

Keywords: eggs, polyunsaturated fatty acids, antioxidants, grapes seeds cakes, quality

[peN-05]: *Hen nutrition and additives* (ID: 100042)

[Australia]

## **Effect of dietary supplementation with calcium pidolate with or without vitamin D metabolite on egg quality of laying hens**

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Lohmann Brown laying hens (147) were housed individually in cages from 21 to 50 weeks of age. Birds were divided into 7 groups, a control and groups receiving layer mash formulated to commercial standards supplemented with either a single or double dose of supplemental calcium pidolate, with or without supplemental Hy.D at either a single or double dose. Egg quality was measured as shell quality, internal quality, shell colour and cuticle coverage. There was a significant main effect of hen age and treatment group on all variables measured. Albumen quality decreased with increasing hen age. As hens grew older, shell colour decreased but cuticle cover either stayed relatively constant or increased slightly. With increasing hen age, egg weight and shell weight increased and then remained relatively constant although shell weight tended to decrease at later ages in some treatment groups. However, the increase in shell weight and thickness did not match that of egg weight so that percentage shell decreased with increasing hen age. Shell translucency score was low and remained relatively constant across the experiment. Shell breaking strength and deformation fluctuated but were generally lower towards the end of the experiment. Albumen quality was higher when the diet was supplemented with calcium pidolate and Hy.D. Shell colour was darker for some treatment groups. Shell cuticle cover was best for the control group being lower for the other groups with the exception of the group receiving a single dose of calcium pidolate along with a single dose of Hy.D. Shell quality was generally not improved by the addition of calcium pidolate with or without Hy.D to a complete layer diet and some of the treatments resulted in small but significant reductions in shell quality. In summary, the addition of calcium pidolate with or without supplemental Hy.D, to a fully-formulated diet, resulted in relatively small effects on egg quality. These findings suggest that the cost of using these supplemental products may not be cost effective for commercial layer producers.

Keywords: calcium pidolate, vitamin D metabolite, egg quality

[peN-06]: *Hen nutrition and additives* (ID: 100152)

[France]

## **Influence of the incorporation into the feed of Calcium Carbonate (Oyster Shell) on the quantitative and qualitative parameters of the egg production**

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The degradation of egg shell quality from birds over 50 weeks of age leads to loss of collected eggs and an increase in downgraded eggs. This phenomenon is generally attributed to the reduced capacity for absorption and mobilization of body calcium in the aged birds. A second limiting factor is involved: the advanced age of the animals causes a reduction in the capacity to synthesize components of the egg's internal membrane. This experimental study, realized during a thesis, compares the influence of a source of calcium carbonate (oyster shell at 3 grams/layer/day) with Calcium Pidolate (incorporated at 300 ppm). The treatments are repeated four times on 12 Lohmann hens (55 weeks old): egg production, egg shell quality and feed conversion ratio (FCR) are studied over 8 weeks of production. Calcium Pidolate group significantly increased egg production by 5% ( $p < 0.05$ ) and reduced the number of downgraded eggs due to shell quality problems by 25% ( $p < 0.05$ ). The egg weight was also improved. The combination of these improvements leads to a decrease in FCR of 10%. The incorporation of Calcium Pidolate, which is involved in calcium metabolism and synthesis of components of the egg shell internal membrane, allows maintenance of egg shell quality and higher production parameters when compared with the addition of oyster shell- a  $\text{CaCO}_3$  source considered to be more bioavailable than limestone.

**Keywords:** Egg shell, Pidolate, Calcium, Oyster shell, Egg production

[peN-07]: *Hen nutrition and additives* (ID: 100039)

[Brazil]

## **Calcium levels in the maintenance of internal egg quality of Japanese quails after storage**

**Souza, D.S. (1), Calixto, L.F.L. (2), Lemos, M.J. (3), Heluy, G.M. (4), Pinho, T.P. (5) and Oliveira, S.M. (6)**

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The exploitation of coturnicultura posture has been maximizing in Brazil. The shell quality plays an important role in the maintenance of internal egg quality because thicker shell eggs lost less CO<sub>2</sub> and water, has a smaller reduction of the internal components such as albumen and yolk, having smaller reduction in weight during storage. Older hens produce larger and heavier eggs, however, the amount of deposited shell does not accompany the increase in size of the egg, resulting in more prone to breakages and cracks fragile shell. The increasing levels of calcium in the diet of laying provides enhanced thickness of shell eggs because the inclusion of 1% more calcium can increase up to 0,013mm in thickness. This study was designed to evaluate the influence of increasing levels of dietary calcium in the improvement of the quality of the shell to keep the internal quality of quail eggs in the final production and stored for 14 days. The experiment was conducted at the Poultry Section of the UFRRJ March to May of 2013. 400 Japanese quails aged 46-58 weeks distributed in a completely randomized design with five treatments and ten replicates. The treatments consisted of five levels of calcium (2.95; 3.25; 3.55; 3.85 and 4.15% Ca). Twenty eggs from each treatment were collected during three consecutive days, totaling 300 units evaluated at each interval of 21 days. Fresh eggs were stored in the laboratory at room temperature the UFRRJ in carton open for a period of 14 days. The egg weight, weight loss (%), shell thickness (mm) and percentage of constituents were analyzed. The results were subjected to analysis of variance for the linear and quadratic a 5% significance level regression. Increasing levels of calcium promoted better shell thickness, yolk percentage, increase in egg weight and less weight loss during storage at ambient temperature for 14 days, being efficient in maintaining the internal egg quality of Japanese quails after storage .

**Keywords:** Egg weight, *Cortunix cortunix japonica*, yolk percentage

[peN-08]: Hen nutrition and additives (ID: 100154)

[France]

## **Seleno-hydroxy-methionine as a dietary selenium supplement to improve selenium concentration of table eggs**

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Selenium (Se) is a trace element active in many biological pathways through the amino acid selenocysteine present in a particular class of proteins named selenoproteins. A new organic Se source, seleno-hydroxy-methionine (SO) was tested in laying hens in comparison to standard Se sources for its effect on eggs in three different studies. In the first study, SO and seleno-yeasts (SY) were supplemented at 0.1 or 0.2 ppm Se, in comparison to a negative control not supplemented in Se and a positive control supplemented in sodium selenite (SS) at 0.2 ppm. After 56 days, Se transfer into eggs was assessed. In a second study SS and SO (at 0.3, 0.6 and 0.9 ppm), and a negative control, were fed to hens for 28 days and Se transfer in egg albumen and yolk was measured as total Se. A third study, conducted with broiler breeders, compared a SS source (0.3 ppm) with SO and SY (0.2 ppm) supplied during 24 weeks. Transfer of Se into eggs was determined as total Se and SeMet/SeCys speciation present in albumen and egg yolk. In the first two studies, egg Se concentration using organic Se sources was significantly improved compared to SS source ( $P < 0.01$ ). Within the two organic sources, the first study indicated an additional Se transfer with SO compared to SY (+29 %,  $P < 0.01$ ). The second study, showed a significant improvement of Se, predominantly into egg albumen with SO resulting in three to fourteen times more Se compared to SS ( $P < 0.01$ ). The third study confirmed the Se transfer efficiency hierarchy such as  $SS \ll SY < SO$  ( $P < 0.01$ ). Moreover, SeMet and SeCys speciation analyses indicated that Se improvement induced by organic Se sources was mainly in the form of SeMet in egg albumen compared to SS. Interestingly, the additional Se induced by SO compared to SY was characterised by higher SeCys levels into egg albumen. Thus, SO enabled a high Se transfer rate into eggs mainly oriented in the albumen as selenocysteine compared to SY. These different aspects could be involved in embryo and early chick development as well as a source of functional food.

**Keywords:** Egg, laying hens, selenomethionine, selenocysteine, seleno-hydroxy-methionine

[peN-09]: *Hen nutrition and additives* (ID: 100071)

[Brazil]

## **Eggshell Quality of Commercial Laying Hens Fed Diets Containing Inorganic Or Chelated Microminerals From 60 To 80 Weeks Of Age**

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In this experiment we aimed to evaluate the effects of supplementation of trace minerals in chelated or inorganic form on eggshell quality of laying hens. A total of 288 60 weeks of age Bovans White laying hens were and separated into two categories according to the specific gravity of the eggs produced. The groups were selected to contain specific gravity average of 1.075 and 1.095. Diets were isonutritive and isoenergetic and calculated according to Brazilian Tables recommendations. The experimental design was a completely randomized in a factorial arrangement 2 x 3, the first factor being the egg specific gravity at the beginning of the assay and the second factor the source of minerals used, 100% inorganic, 100% chelated and 50% chelated minerals, six treatments and eight replicates of six birds each. The supplements contained (per Kg of supplement) - Mineral: Manganese 120.000 mg, Zinc 120.000 mg, Iron 60.000 mg, Copper 18.000 mg, Iodine 2.000 mg. Organic: Manganese: 50g, Zinc: 40g, Iron: 30g, Copper: 6g, Iodine: 400mg, Selenium: 180mg. We analyzed eggshell characteristics (weight, percentage, thickness and specific gravity) every 4 weeks. Hens selected for reduced shell quality remained with lower values when compared to the initial shell quality which was evidenced by lower weight and shell percentage and specific gravity in all ages evaluated. Hens selected in the beginning for higher specific gravity maintained higher values for specific gravity (1.085 x 1.087), shell percentage (9,14 x 9,55) and shell thickness (0,40 x 0,41mm) at 80 weeks of age compared to the low quality ones.

Keywords: eggshell quality, micro-minerals, organic minerals, specific gravity

[peN-10]: *Hen nutrition and additives* (ID: 100101)

[Nigeria]

## **Effect of supplemental copper on growth, Haematological Indices and Reproductive performance of Japanese Quails**

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The study was carried out to evaluate the effect of supplemental copper (0, 200, 300, 400mg/kg) on growth, haematological indices, laying performance and egg quality of Japanese quails. A total of 360 birds randomly allocated to four dietary treatments with 30 birds per replicate in a completely randomized design were used for the growth trial for a period of four weeks. The laying phase comprised of 132 six weeks old Japanese quails randomly allocated to four treatments with three replicates of 11 birds each in a completely randomized design for four weeks. The result of the growth phase showed no significant ( $P>0.05$ ) difference in feed consumed, final weight, weight gain and feed conversion ratio, weight of first egg, age at peak lay, number of eggs and mortality. Significant ( $P<0.05$ ) difference was observed in age at first egg, age at 10% lay and age at 50% lay. There was also no significant ( $P>0.05$ ) difference in packed cell volume (PCV), haemoglobin (Hb), total protein (Tp), red blood cells (RBC), white blood cell (WBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC). The result of the laying phase showed no significant ( $P>0.05$ ) difference in final weight, weight gain, daily feed intake, feed conversion ratio, egg number, average egg weight, egg mass, hen-housed production and hen-day production. However, yolk diameter significantly ( $P<0.05$ ) increased with the inclusion of dietary copper. Supplemental copper (0, 200, 300, 400mg/kg) did not improve growth, haematological indices, laying performance and egg quality of Japanese quails.

**Keywords:** quails, copper, growth, haematology, egg

[peN-11]: Hen nutrition and additives (ID: 100054)

[Romania]

### **Influence of botanic mixes high in carotenoids (lutein and zeaxanthin) used in layer diets on the quality parameters of the eggs**

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For this study it was used 2 botanic mixes obtained through selection of plants rich in carotenoids: BA 1 (alfalfa meal, dry pumpkin pulp, dry marigold flowers) and BA 2 (dry buckthorn leaves, dry pumpkin pulp, dry red maize grains and dry marigold flowers). The experiment run for 6 weeks on 120 Lohmann Brown layers (aged 42 weeks). The layers were assigned to three groups (C, E1, E2) and were housed in special cages (2 layers per cage) stacked on three tiers. Group C was fed the standard diet formulation (corn, wheat, soybean meal, rapeseed meal, rice bran) with 16.45% CP and 2538.15 kcal/kg ME. Compared to diet C, the diet formulations for groups E1 and E2 included 2% BA 1 (E1) and 2% BA 2 (E2). Throughout the experiment it was sampled randomly 18 eggs per group in week 2 and in the final experimental group. The eggs and egg components were weighed; it was also determined the colour intensity, the Haugh unit, egg freshness, eggshell thickness and eggshell breaking strength. In the end of the experiment, yolk colour intensity in E1 ( $5.87 \pm 0.89$ ) and E2 ( $6.04 \pm 0.73$ ) was significantly ( $P \leq 0.05$ ) stronger compared to C ( $3.27 \pm 0.91$ ). Throughout the experiment period, the Haugh unit was constantly higher in the experimental groups than in group C but statistically uninsured. The Haugh unit determinations in the eggs harvested in the end of the experiment and stored for 14 days was significant ( $P \leq 0.05$ ) higher in E2 group then in C group.

**Keywords:** eggs, feed additives, carotenoids, parameters

[peN-12]: Hen nutrition and additives (ID: 100055)

[Romania]

## **Evolution of lutein and zeaxanthin concentration in the yolk of layers fed lutein-enriched diets**

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The experiment was conducted for 5 weeks on 120 Lohmann Brown layers (27 weeks) assigned to 3 groups (C, E1, E2). The layers were housed in three-tier cages (2 layers per cage), with free access to the feed and water. The diet formulation for group C comprised corn, wheat, soybean meal and sunflower meal, and had 2751.8 kcal/kg ME and 17.06% protein. The diets for groups E1 and E2 included 5% alfalfa and 5% gluten, 0.05% lutein powder (E1) and 0.1% lutein powder (E2). The lutein and zeaxanthin concentrations of the three diets were 4.3 mg/kg (C), 27.939 mg/kg (E1) and 40.774 mg/kg (E2). The eggs harvested (18 eggs/group) in the second and last week of the experiment were measured for yolk colour intensity and yolk content of lutein and zeaxanthin. Yolk colour intensity was significantly ( $P \leq 0.05$ ) higher in groups E1 and E2 compared to C after the first two weeks. Between groups E1 and E2, yolk colour intensity was higher in E2 (0.1% powder lutein), but it decreased slightly between the second and last week. The lutein and zeaxanthin concentrations in E1 and E2 was than in C, for both series of determinations. There have been higher ( $P \leq 0.05$ ) concentration in E2 than in E1. The highest concentrations of lutein and zeaxanthin were noticed in the eggs harvested at 14 days from the start of the experiment. The lutein and zeaxanthin determinations in the egg yolk samples from the eggs harvested in the end of the experiment and stored for 14 days have shown a significant ( $P \leq 0.05$ ) decrease of the lutein and zeaxanthin concentrations in groups E1 (3.5%) and E2 (17.7%)

**Keywords:** eggs, lutein, zeaxanthin, stability, yolk colour

[peN-13]: *Hen nutrition and additives* (ID: 100164)

[Pakistan]

### **Effect of dietary supplementation of different lutein sources on yolk enrichment and other egg characteristics in Hy-line commercial layers with three body sizes**

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The aim of study was to evaluate the effect of various lutein sources (free, esterified and combination of both (free + esterified) at 500mg/Kg inclusion) on egg quality of Hy-line W36 commercial layers. For this, four hundred thirty two, 31 week old commercial layers were divided into 3 body weight categories i.e., heavy, medium and light, with 4 groups each. These groups were further divided into 6 replicates comprising 6 layers / replicate. All groups were fed diets supplemented with all lutein sources, separately. Statistically analyzed data revealed improve yolk color with the supplementation of free, free + esterified and esterified lutein sources whereas body weight categories had positive correlation with egg weight. In conclusion, egg yolk can be enriched with lutein supplementation (free, esterified and combination of both) without exerting any harmful effect on egg geometry and quality.

**Keywords:** layer, lutein sources, body weight, egg quality

[peN-14]: *Hen nutrition and additives* (ID: 100199)

[Lithuania]

## **Effects of supplementation of prebiotic and NSP enzymes on production performance and egg quality in laying hens**

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The trial was conducted to investigate the effects of prebiotic and prebiotic with NSP enzymes mixture supplementation on the laying hens' performance and quality of eggs. Thirty 38 wk of age Lohman Brown laying hens were assigned to 3 dietary treatments for 8 wk. The dietary treatments were 1) control, 2) basal compound feed supplemented with prebiotic (mannanooligosaccharides (MOS) 2.0 kg/t of feed), 3) basal compound feed supplemented with prebiotic (MOS 2.0 kg/t of feed) and NSP enzymes (enzymes activity: endo-1,4- $\beta$ -xylanase 1100000 VU/t and endo-1,3(4)- $\beta$ -glucanase 1500000 VU/t) mixture. All laying hens were kept under the same conditions. Egg quality was determined using automatic egg quality analyzer „Egg MultiTester EMT-5200“; hardness of eggshell - the device „Egg Shell Force Gauge MODEL-II“, and thickness of eggshell was evaluated with electronic micrometer „MITUTOYO“. Draper and Hadley (1990) method (HPLC system) was used to determine content of MDA. During the test period (38-46 weeks) eggs quality parameters, i.e. eggs weight and eggshell thickness were not increased by the dietary inclusion of the prebiotic and prebiotic with NSP enzymes mixture compared with the eggs of control layers. The weight of albumen was tended to be greater in the group supplemented with prebiotic and Haugh unit – with the prebiotic and NSP enzymes mixture ( $P < 0.05$ ) supplemented group compared with the control group. After storage for 28 days, MDA concentration in the eggs yolk of prebiotic supplemented group decreased by 0.036  $\mu\text{mol/kg}$  compared to control group ( $P < 0.05$ ). The results of the present study suggest that 2.0 kg/t supplementation of prebiotic don't affect eggs productivity and FCR of hens, but tend to affect MDA concentration and albumen weight.

Keywords: laying hens, prebiotic, enzymes, egg production, egg quality

[peN-15]: Hen nutrition and additives (ID: 100161)

[Egypt]

## **Effect of Probiotic and Black Seed on the Production and Egg Quality of Japanese Quail**

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The present study aimed to investigate the impact of probiotic and black seed as natural growth promoters in practical Japanese quail laying hens diets on productive performance and egg quality. A total number of 120 laying Japanese quail hens were randomly assigned to four treatment groups, each of 30 birds in three replicates, in a completely randomized design. Four diets were formulated with diet 1 containing no supplement. Diet 2 contained 0.1 % probiotic (*Saccharomyces cerevisiae*). Diets 3 and 4 contained black seed (*Nigella sativa* L.) at 0.5 and 1.0 %, respectively. The inclusion level of either 0.1% probiotic or 0.5 and 1.0 % black seed significantly gave higher egg production percentage and egg mass/hen / day than those of control group. Feed conversion ratio and egg shell thickness significantly ( $P \leq 0.05$ ) improved for all experimental groups as compared to the control. Probiotic significantly ( $P \leq 0.05$ ) decreased yolk total cholesterol; however, black seed inclusion had significant effects ( $P \leq 0.05$ ) in decreasing yolk total cholesterol, total lipids and low density lipoprotein compared with the control group. Significant ( $P \leq 0.05$ ) reduction in blood cholesterol, triglycerides, total lipids and low density lipoprotein were recorded for quail fed supplemented diets.

Keywords: Quail, Black seed and probiotic, Production, Egg quality, Lipid profile

[peN-16]: *Hen nutrition and additives* (ID: 100112)

[Algeria]

## **Efficacy of enzyme supplementation on egg production parameters in laying hens fed local diets**

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We investigated the impact of dietary supplementation of a commercial enzyme complex (containing xynalase, protease,  $\alpha$ -amylase and cellulase), on productive parameters and egg quality of laying hens reared in Algerian breeding conditions. One hundred eighty 34-wk-ISA Brown laying hens were divided into 3 groups (5 replicates of 12 hens per treatment) and fed with a same basal diet containing either 0, 250 or 300 g of the enzyme complex /ton feed from 35 to 38 wk of age. Whatever the rate of incorporation, dietary enzyme addition significantly ( $p<0.05$ ) enhanced both of the laying rate (+17%) and the total number of eggs (+5%) but had no significant effect on egg constituents. In our conditions, enzyme supplementation improved feed efficiency (by about 16%,  $p<0.05$ ) and body weight at 38 wk of age (+5% on average,  $p<0.05$ ). Thus, the inclusion of exogenous enzymes in feed of laying hen is beneficial in terms of improving the laying rate and body weight.

**Keywords:** laying hens, enzymes supplementation, egg quality, egg production.

[peN-17]: *Hen nutrition and additives* (ID: 100028)

[Brazil]

### **Egg quality of Japanese quail fed with zootechnical additives**

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Nowadays, in Brazil, quail production has been increasingly developed and adjusted to production technologies, taking the country to occupy second position as the biggest world - wide quail egg producer. Along with this development, works involving the usage of zootechnical additives in nutrition of broilers and laying hens have been spreading in the country. Among them, prebiotics, probiotics, and the association of the two, known as symbiotic; however, data regarding the usage of these substances in quail is scarce in national literature. In this context, it was aimed to develop a study to assess the internal quality and shell of eggs produced by japanese quail fed with diet incorporated with different kinds of zootechnical additives. The experiment was conducted in the poultry sector of the Federal University Rural of Rio de Janeiro (UFRRJ) from June to September, 2014. 288 japanese quails (*Cortunix cortunix japonica*) were used, during five cycles of 21 days, distributed in a completely randomized design with four treatments, eight repetitions of nine birds each. The treatments were as follows: control (reference diet without zootechnical additives), prebiotic (reference diet + 1,5 kg/t of prebiotic), probiotic (reference diet + 20 ppm of probiotic) and symbiotic (reference diet + prebiotic + probiotic). The variables analyzed were: egg weight (g), Haugh unit, constituents percentage (albumen, yolk and shell), yolk pigmentation and shell thickness (mm). The inclusion of additives regardless of the type promoted ( $P < 0,05$ ) increase in average weight of eggs and eggshells, resulting in increased egg weight and improved shell thickness compared to the reference control (without additives). In the condition which the experiment was conducted, can be concluded that the inclusion of zootechnical additives regardless of the type, into the japanese quail diet, internal quality was kept, egg weight increased and quality of the shell assessed by thickness improved.

Keywords: Haugh unit, prebiotic, probiotic, shell quality, symbiotic

[peT-01]: Egg technology, biological activity and nutritional value (ID: 100006)

[Turkey]

## Evaluation of Color Changes in Various Edible Coated Eggs during Storage

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Eggs, versatile food, are high quality complete proteins that contain essential amino acids including vitamins and minerals essential for human health. Eggs are widely used in the food industry due to their multifunctional properties. However, interior quality of eggs change during storage based on increasing air-cell size, weight loss, albumen pH increase, and decrease in albumen viscosity. Development of novel practices is necessary for extending shelf life of egg, such as edible coating that seals its pores while reduce cracked egg numbers as well. Various edible coating materials suitable for use, protein (corn zein, whey protein isolate-WPI and whey protein concentrate-WPC) and lipids (shellac) used as a barrier and mechanical coating films in this study. The research was preformed to investigate the effectiveness of WPC, WPI, corn zein and shellac coatings on the quality attributes such as color changes and stability in egg yolk and albumen of fresh eggs during storage at 24°C for 4 weeks. For the study clean, white shell and freshly laid unwashed eggs supplied from local producer and treatments consisted of eggs coated with WPI, WPC, zein and shellac as well as uncoated eggs as control. Whey protein films were prepared at 10% (w/w protein) using WPI and also WPC in 100 ml of water. Shellac and Zein were mixed with ethyl alcohol (10:90 v/v). Glycerol was then added to give protein: plasticizer ratios of 2.5:1 w/w in solution while the solution was stirred continuously on a magnetic stirrer at 80 °C for 30 min. After immerse washing with water at 24°C, clean eggs were immersed individually by hand in the coating solutions for 1 min, then immersed again for 1 min and then dried at ambient. The eggs were subsequently placed in open moulded plastic egg trays in storage at 24°C until testing. The color values of shell egg, albumen and yolk samples were measured with Konica Minolta Chroma Meter CR-400 and results were recorded as L\*, a\*, b\* where L\* describes lightness, a\* redness and b\* yellowness.

Lightness of egg albumens significantly ( $p < 0.05$ ) increased from  $78.73 \pm 2.40$  in week 0 to  $83.25 \pm 3.17$  at the end of storage (week 4), while b\* values (yellowness), decreased from  $13.40 \pm 0.94$  to  $9.63 \pm 2.04$  (control),  $11.12 \pm 1.26$  (WPI),  $11.97 \pm 1.02$  (WPC),  $10.92 \pm 0.58$  (zein) and  $9.34 \pm 1.07$  for shellac coated samples in time. For color component b\* there were no significant interaction among protein based coatings after storage.

Lightness of egg yolk decreased significantly from  $64.56 \pm 2.05$  to  $58.58 \pm 1.88$  that shows destruction of carotenoids in the egg yolk and formation of brown lipid amine-aldehyde products with protein discoloration were observed in eggs during storage. Redness of shellac coated eggs decreased significantly from  $-3.49 \pm 0.25$  to  $-1.86 \pm 0.52$ , while other samples ranged between  $-2.58 \pm 0.23$  and  $-2.98 \pm 0.37$ , shellac coated egg albumens "a\*" values significantly increased during storage.

We can conclude from the present study that WPI, WPC and zein coatings is effective in preserving the color stability of fresh eggs without affecting color component during storage for 4 weeks at ambient temperature.

Keywords: Egg freshness, edible coating, whey protein isolate, whey protein concentrate, shellac, zein, color, and storage.

[peT-02]: Egg technology, biological activity and nutritional value (ID: 100063)

[Turkey]

## Investigating FT-NIR Spectral and Color Properties of Lysozyme-Chitosan Coated Egg Freshness during Storage

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Eggs are globally an important source among the most nutritious foods consumed worldwide. However, they are highly perishable and can lose interior quality in short time depending on storage condition. Egg coating is alternatively an effective method to preserve interior quality of eggs during storage at 24°C. Various studies have been conducted on eggs such as hydrocolloids, lipid, proteins etc. Chitosan, a deacetylated form of chitin obtained from shellfish waste, provides excellent oxygen barrier film properties. Lysozyme is a peptidoglycan N-acetyl-muramoylhydrolase bacteriolytic enzyme. This study aimed to evaluate the effects of chitosan based coatings combined with lysozyme at 0, 10, 20 and 60% (w/w) with storage time of 6 weeks at 24°C on the quality characteristics of shell eggs. Spectral measurements were taken on the eggs yolk and albumen in reflectance and transmittance modes using an FT-NIR spectrometer of Bruker multi-purpose analyser that equipped with InGaAs detectors and a 20 W high-intensity tungsten-halogen NIR light source. Reflectance measurements obtained with a fibre optic probe covered the wavelengths of 780–2500 nm. The color values of shell egg, albumen and yolk samples were measured with Minolta Chroma Meter CR-400. Results were recorded as L\*, a\*, b\* where L\* describes lightness, a\* redness and b\* yellowness.

This study investigated the effectiveness of lysozyme-chitosan coatings to maintain the quality attributes such as albumen and yolk color and spectral properties of fresh eggs during storage at 24°C for 6 weeks. Lightness and redness of egg albumens significantly increased during storage for all egg groups during storage, while b\* values decreased in time. Lightness of egg yolk decreased from  $65.32 \pm 0.59$  to  $57.27 \pm 0.84$ , while redness of egg albumens significantly increased during storage. FT-NIR spectroscopy system acquired diffuse reflectance spectra in the range of 833 to 2500 nm. By NIR spectroscopy, C-H, N-H and O-H bonds are induced to vibrate. NIR scanning for 800 to 2800 nm spectra was applied to analyse the effect of lysozyme-chitosan (L-C) coatings on fresh egg. The absorbance spectrum stays relatively flat around 1200-1300 nm. The 20% and 60% L-C coatings were more effective than chitosan alone and 10% L-C coating for maintaining the internal quality of fresh eggs during storage. The control egg albumen and yolk spectra were used as a base for comparison to determine changes in secondary structure of control and end of storage, instead of to show correlation between color values and NIR measurements. Studies results showed the correlation between Haugh until and NIR spectral values. Albumen becomes thinner over time, which leads to a change in the transmitted spectra while water band changes depending on the water content were clearly observed.

In particular this study showed that L-C coatings could be an alternative to other coatings for maintaining the internal qualities of fresh eggs during long-term storage while FT-NIR spectroscopy could be used as a new tool for the assessment of freshness and has a potential as a rapid and non-destructive analysing technique to determine quality changes in fresh eggs during storage period.

Keywords: Lysozyme, chitosan, coating, shell egg, color, near-infrared spectroscopy.

[peT-03]: *Egg technology, biological activity and nutritional value* (ID: 100038)

[Japan]

## **Non-destructive determination of egg cholesterol contents by NIR spectroscopy**

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Hen's egg has been known as a valuable source of nutrition, but the egg yolk contains high cholesterol. Each egg yolk cholesterol content was reported to vary from each other. We studied non-destructive determination of hen's egg-cholesterol by near infrared (NIR) spectroscopy to estimate each egg cholesterol content before cooking. Transmittable spectra of samples were scanned in the range of wavelength region between 400 and 1100 nm by NIRS model 6500 (Foss NIR Systems, Laurel, USA). The first derivative spectra were used to develop calibration equations by partial least square (PLS) regression. The prediction accuracy was evaluated in terms of square of correlation coefficients (RSQ), standard error of cross validation (SECV) and ratio of standard deviation of reference data in predicted sample set to SECV; SD/SECV (RPD) values. We obtained the first derivation data by NIR spectroscopy with enzymatic destructive egg yolk cholesterol data. Both data were performed using by partial least square (PLS) regression analysis and predicted values were estimated by cross validation method. The total cholesterol concentration of egg yolk (mg/100g egg yolk) and total cholesterol contents (mg/egg) showed high correlation coefficient with the enzymatic analysis value. Their coefficients of determination ( $R^2$ ) were 0.885 and 0.893, respectively.

**Keywords:** cholesterol, egg, near infrared, non-destructive

[peT-04]: *Egg technology, biological activity and nutritional value* (ID: 100139)  
[Hungary]

### **Eggshell quality: comparing two measuring methods**

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The role of eggs in human nutrition is having an increasing importance considering the increase in the human population. Large scale egg producing systems and genetic for selecting high producing hens are the basis of producing good quality and enough quantity of eggs. However, there's an unquestionable economic loss due to unfavourable eggshell quality due to hen aging. The main question is, which are the factors affecting the strength of the eggshell, and how all the interrelated causes of these problems could be overcome. Prevention and the method of egg processing could minimize the losses for most of the negative factors (except management technology). Feeding – as a very important component in the laying hen sector – affects the most the quality and quantity of eggs. What remains as a question, is the control of insults having a negative impact on the eggs on their way from the farm to the customer. Therefore we've analyzed two methods for testing eggshell strength, in order to characterize the influence of the constraints applied to the egg. Tetra SL laying hybrids and 4800 eggs (2400/method) were involved in our study. We compared two methods of eggshell strength testing (compression plate and needle probe) so we could reproduce the various mechanical forces affecting the eggs during the commercial chain. Based on our results, there is a significant difference between the two measurement methods because of the different surface of the instruments. Although there is difference between the two measurements every month in the analysis, but the results of needle probe have changed less over the time, while the results of compression plate method showed relatively large variability. The methods of needle probe show stability so this technique is good for investigate stock ones. However, the methods of compression plate explore changes in the egg production period. If we want to characterize the forces in the course of commercial chain, we have to use both methods of eggshell strength testing.

**Keywords:** eggshell strength, laying hybrids

[peT-05]: *Egg technology, biological activity and nutritional value* (ID: 100061)

[India]

## **Evaluation of nutritive value of eggs of pearl and white Guinea Fowls reared under intensive system in India**

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Guinea fowl (*Numida meleagris*) farming is gaining popularity as a diversified poultry species in India. A total of 120 grower guinea pullets comprising 60 pearl and white strains each were randomly divided into two treatment groups with three replicates of 20 pullets each under intensive system and reared from 18-95 weeks of age to study the nutritive value of eggs of guinea fowl reared under deep litter and cage systems. Experimental birds were fed with ad libitum isocaloric and isonitrogenous guinea fowl layer mash and drinking water. A total of 60 eggs comprising 30 pearl and white guinea fowls each were subjected for evaluation of nutritive value. The overall mean per cent moisture, crude protein, ether extract, total ash, gross energy and calcium content of Guinea fowl eggs were  $56.90 \pm 1.44\%$ ,  $18.86 \pm 0.45\%$ ,  $17.86 \pm 0.55\%$ ,  $1.55 \pm 0.08\%$ ,  $2917.38 \pm 67.97$  kcal/kg and  $26.74 \pm 0.22\%$  respectively. Strain did not have significant ( $p > 0.05$ ) influence on proximate composition of Guinea fowl eggs. Both pearl and white guinea fowl eggs had similar per cent moisture content ( $58.06 \pm 1.25\%$ ). Though the pearl guinea fowl eggs had numerically higher mean per cent crude protein and total ash content ( $18.78 \pm 0.62\%$  and  $1.64 \pm 0.09\%$ ) than white guinea fowl eggs ( $18.68 \pm 1.19\%$  and  $1.46 \pm 0.12\%$ ) it was not statistically different. White guinea fowl eggs had numerically higher mean per cent ether extract, gross energy and calcium contents ( $18.27 \pm 0.79\%$ ,  $2962.55 \pm 98.94$  kcal/kg and  $26.99 \pm 0.34\%$ ) than Pearl ( $17.44 \pm 0.77\%$ ,  $2872.20 \pm 94.66$  kcal/kg and  $26.50 \pm 0.27\%$ ) and it was not statistically different. It can be concluded that the eggs laid by both the pearl and white guinea fowls reared under intensive system had comparable nutrient contents.

**Keywords:** Guinea fowl egg, Nutritive value, strains

[peT-06]: Egg technology, biological activity and nutritional value (ID: 100175)

[Poland]

## **Biological activity of peptides derived from de-fatted egg yolk granules hydrolysed with serine protease from *Y. lipolytica* yeast**

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In the present study, antioxidant and angiotensin I-converting enzyme (ACE) inhibitory peptides were isolated from an egg-yolk protein (YP) preparation hydrolysate, and then characterized. Enzymatic hydrolysis was conducted using a non-conventional protease from *Yarrowia lipolytica* yeast (dose: 40 U/mg of hydrolyzed YP; 4h) to obtain the protein hydrolysates. It was shown that this hydrolysate (DH= 34.8%) exhibited antioxidant activities, including ferric ion reducing (FRAP) (88.25 µg Fe<sup>2+</sup>/mg), ferric ion chelating (420.0 µg Fe<sup>2+</sup>/mg) and DPPH free radical scavenging (2.75 µmol troloxeq/mg) activity. The compiled isolation procedure (ultrafiltration, size-exclusion chromatography (GF-250 column, HPLC) and RP-HPLC) of the bioactive peptides from the YP hydrolysate resulted in peptide fractions with very strong DPPH free radical scavenging activity ranging from 0.52 to 4.94 µmol Troloxeq/mg. Most of the isolated peptide fractions also exerted significant ACE inhibitory activity. One of the most active peptide fractions, characterized by a strong DPPH free radical scavenging activity (4.94 µmolTroloxeq/mg) and ACE inhibitory activity of IC<sub>50</sub>=0.26 µg/mL, was identified by mass spectrometry (MaldiToF) analysis, indicating a peptide fraction that was homogenous and consisting of 10 amino acid residues with the following sequence: QSLVSVPGMS. Project “Innovative technologies in the production of bio-preparations based on new generation eggs,” Innovative Economy Operational Programme Priority 1.3.1, thematic area “Bio”, co-financed by the European Union through the European Regional Development Fund within the Innovative Economy Operational Programme, 2007–2013. This project was supported by the Wrocław Centre of Biotechnology programme, The Leading National Research Centre (KNOW), 2014-2018.

Keywords: biopeptide egg proteins, antioxidant, antihypertensive

[peT-07]: *Egg technology, biological activity and nutritional value* (ID: 100174)  
[Poland]

## **Incorporation of fatty acids into hen egg yolk phospholipid fractions through fodder enrichment with PUFA sources**

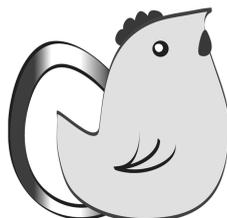
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The aim this study was to assess the degree of incorporation of omega 3 fatty acids into the structure of phospholipids from feeding hens with fodder enriched with up to 1.5% algae oil, up to 6% oil from linseed, rapeseed and fish and up to 2% humic preparations. Thirty Lohmann Brown laying hens were kept in a floor system and fed ad libitum. Control eggs were collected from 30 week old hens and started to feed them enriched fodder which was administered for 3 weeks, and the eggs were collected at 1-week intervals and analyzed in triplicate (one sample this 10 homogenized egg yolks). An ASE technique with an isopropyl alcohol was used to isolate lipids from the lyophilized egg yolks. Following evaporation of the solvent, the crude extract was dissolved in hexane (1:1 m/v). To the solution 3 volumes of cold acetone were added and the suspension was centrifuged. Then obtained precipitate (PL's) was dried under a stream of nitrogen. Following methylation, the fatty acid content was determined by GC/MS technique. After three weeks of experimental feeding with enriched fodder, the content of omega 3 fatty acids in the phospholipids fraction had risen from 8.43% to 16.08%. Over the same period of time reported a decline the content of omega 6 fatty acids in PL's to 11% and the n-6/n-3 ratio had decreased from 2 to 0.7. The levels of omega 3 fatty acids content had significantly increased after 3 weeks of supplementation with enriched fodder. The total content of  $\alpha$ -linolenic acid in the PL's fraction amounted to 1.49% and was almost 4 times less than in the triacylglycerol fraction. Whereas eicosapentaenoic acid and docosahexaenoic acid almost completely were incorporated into the structure of PL's respectively 1.83% and 12.76%, the content of these acids in the structure of TAG was less than 0.5%. This project was supported by the Wrocław Centre of Biotechnology programme, The Leading National Research Centre (KNOW) for years 2014-2018.

**Keywords:** Eggs yolk, feed supplementation, phospholipids, PUFA



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[pmB-01]: *Biological Basis* (ID: 100073)

[China]

### **The association of AKT3, FIGF, PRKAG3 and TGF- $\beta$ genes polymorphisms with myofiber characteristics in chickens**

Chen, S.R. (1), An, J.Y. (2), Qu, L.J. (3), Zheng, J.X. (4), Xu, G.Y. (5) and Yang, N. (6)

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Muscle characteristics such as myofiber diameter, density, and total number are important traits in broiler breeding and production. In the present study, nineteen SNPs of thirteen major genes which are located in the vicinity of quantitative trait loci affecting breast muscle weight, including INS, IGF2, PIK3C2A, AKT3, PRKAB2, PRKAG3, VEGFA, RPS6KA2/3, FIGF, and TGF- $\beta$ 1/2/3, were chosen to be genotyped by the high-throughput matrix-assisted laser desorption/ionization time-of-flight mass spectrometry in a broiler population. One hundred and twenty birds were slaughtered at 6 weeks of age. Body weight, breast muscle weight, myofiber diameter, density and total number were determined for each bird. Six single nucleotide polymorphisms (SNPs) with a very low minor allele frequency (MAF<1%) were excluded for further analysis. The remaining thirteen SNPs were used for association study with muscle characteristics. The results showed that SNPs in TGF- $\beta$ 1/2/3 had significant effects on myofiber diameter. A SNP in PRKAG3 had a significant effect on myofiber density ( $P < 0.05$ ). A C>G mutation in FIGF was strongly associated with total fiber number ( $P < 0.05$ ). Additionally, birds with the GG genotype of the C>G mutation in AKT3 had significantly larger myofiber numbers ( $P < 0.05$ ) than birds with the CC or GC genotype. The SNPs identified in the present study might be used as potential markers in broiler breeding.

Keywords: AKT3, FIGF, PRKAG3, TGF- $\beta$ , myofiber characteristics

[pmB-02]: *Biological Basis* (ID: 100150)

[France]

### **Effect of dietary vitamin D source (25OHD3/D3) on breast muscle properties of chicks from flock supplemented or not with 25OHD3**

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Little information is available regarding the effects of vitamin D status on muscle development. Recent studies suggest, however, that improvement of vitamin D status with 25OHD3 positively impacts skeletal muscle development in Chicken and Pig. In a first experiment, we demonstrated that replacing dietary vitamin D3 by 25OHD3 maintained cell proliferation in the chicken Pectoralis major (PM) muscle until 7-days of age, and delayed differentiation. The objective of the present study was to evaluate the effect of dietary vitamin D source (25OHD3 vs. D3) on muscle properties of chicks issued from parent flock supplemented or not with 25OHD3. Chicks were issued from 2 parent stocks (PS) that receive no supplement, i.e., vitamin D was supplied as vitamin D3 (PS#D3) or that were supplemented during 2 months with 25OHD3/vitamin D3 (PS#25OHD3). Twelve male chicks by PS origin were sacrificed on the day of hatch and their PM muscles were dissected, weighed, and frozen for further molecular or histological measurements. Remaining male chicks of each PS origin were assigned to one of the two post-hatch dietary treatments, i.e., a control feed (D3) containing only vitamin D3 or an experimental feed (25OHD3) containing 25OHD3 and vitamin D3 as source of vitamin D. At day 6, 12 chicks per treatment were sacrificed and processed as above. Day-old chicks of PS origin #D3 were heavier ( $P < 0.001$ ) than those of PS origin #25OHD3. At day 6, the body and PM muscle weights were higher in groups fed with 25OHD3 than in groups fed with D3. No interaction between diet and PS origin was observed. Quantification of the expression of several genes involved in myogenesis or vitamin D metabolism, and of satellite cell activity measured by immunohistochemistry is underway to provide new insights on the role of vitamin D on early muscle development in chicken.

**Keywords:** nutrition, 25OHD3, muscle growth, chicks

[pMB-03]: *Biological Basis* (ID: 100173)

[France]

## **Molecular regulation underlying the control of body weight and breast meat yield in broiler**

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Our study aimed to determine the molecular regulation underlying the control of muscle growth related to protein intake of the diet. Our study focused on a population of 18 chickens aged 36 days fed with two different levels of dietary proteins and that showed variable growth performance and breast meat yield. Beside body weight, we measured several parameters in the breast Pectoralis major muscle including yield, protein content, ribosomal capacity (RNA/protein), total amount and level of phosphorylation of p70S6 kinase and S6 protein (involved in protein synthesis) and mRNA levels of several genes involved in the control of proteolysis (Atrogin-1 and MuRF-1), growth (IGF-I, IGF-II, IGF-BP5) or more specifically myogenesis (Myostatin, Myf-5). Principal component analysis showed that the inherent capacity of protein synthesis, estimated by the ratio RNA/protein, was positively related to growth capacity (especially body weight) of animals. Similarly, there is a positive relationship between body weight and muscle expression of the growth factor IGF-1. However, increasing body weight and breast meat yield was inversely related to muscle protein content. In addition, the breast muscle yield is negatively correlated with the activation of p70S6 kinase (estimated by its level of phosphorylation) and instead positively with the genes related to proteolysis MuRF-1 and Atrogin-1. This suggests that in animals that had the highest growth and breast meat yield, stimulation of protein synthesis is impaired and on the contrary proteolysis is increased in the muscle, which may partly explain its lower protein contents. Altogether our observations can be related to the fact that over a certain limit, increased growth rate and live weight can lead to the occurrence of severe breast muscle abnormalities, such as white striping or wooden breast, in which muscle deposition tends to shift from protein to fat and fibrous tissue.

**Keywords:** Muscle yield, growth, proteosynthesis, chicken

[pMB-04]: *Biological Basis* (ID: 100201)

[Italy]

## **Meat quality in white striped and wooden breasts of broiler chickens of different genotypes and sex and submitted to different feeding regimes**

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The present study aimed at evaluating how the presence of white striping (WS) and wooden breast (WB) could affect meat quality in broiler chickens differing for genotype (standard vs. high breast yield), sex, and feeding regime (ad libitum vs. restricted rate, 80% from 13 to 21 d of age). To this aim, 768 day-old chicks were housed in 32 pens and slaughtered at 46 d of age. At the gross examination, genotype and sex did not affect WS rate (74.5% on average), whereas restricted birds tended to have a higher proportion of WS breasts compared to birds fed ad libitum (79.5 vs. 69.5%;  $P < 0.10$ ). Indeed, at the histomorphometric examination, 3.13% of sampled P. major were normal; 26.56% showed mild degeneration; 45.31% exhibited a moderate degeneration; and 25.00% a severe degeneration. The WS score at the gross examination and the score at the histomorphometric examination were moderately correlated ( $r = 0.30$ ;  $P = 0.02$ ). The WS fillets had higher pHu (5.83 vs. 5.87;  $P < 0.05$ ), and lower  $a^*$  (0.59 vs. 0.81;  $P < 0.05$ ) and  $b^*$  colour indexes (14.5 vs. 13.7;  $P < 0.05$ ). The overall WB occurrence was of 12.2% and it was significantly lower in females than males (8.0 vs. 16.3%;  $P < 0.05$ ); besides, WB was associated with higher slaughter weights ( $P = 0.06$ ), carcass weights ( $P < 0.02$ ), and dressing out percentage ( $P < 0.01$ ). Cooking losses (22.1 vs. 25.6%;  $P < 0.001$ ) and shear force (2.84 vs. 4.23 kg/g;  $P < 0.001$ ) were higher in breasts with WB than in those without the myopathy.

**Keywords:** myopathies, carcass quality, meat quality.

[pmH-01]: Health & Hygiene (ID: 100030)

[France]

## **Constitution of a microbial model ecosystem of poultry meat.**

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Food products can host very variable microbial communities according to seasonal changes and production processes. These bacterial ecosystems may contain pathogenic or spoilage bacteria which must be controlled to ensure safety and quality of the products. In order to understand the microbial interactions in food products most studies focus on one bacterial species and do not consider the bacterial contaminants. Our purpose was to collect endogenous flora from chicken meat to constitute a livestock that could be characterized and used to re inoculate fresh matrices to create a model ecosystem. To collect bacterial communities naturally contaminating poultry meat, different methods were tested on chicken meat. We determined conditions to isolate bacterial communities that we could store as aliquots to be reused to reproducibly inoculate meat matrixes, and that could be characterized using both cultural and molecular methods. For that purpose, we first determined the best moment to collect bacteria in sufficient amounts during the product shelf life, then the best method to separate bacteria from meat, their viability after cold storage, their ability to regrow on meat matrixes, and the best conditions to extract DNA of these stored communities to describe them by molecular methods. Results showed that the rinsing method associated to the use of Mobio DNA extraction kit was the most reliable method to collect bacteria and to obtain DNA for subsequent PCR amplification. Aliquots were stored at -80°C without important loss of viability. These bacterial communities were successfully inoculated on sterile matrices and can therefore be used for performing reproducible challenge tests.

Keywords: Food safety, Poultry meat, Microbial communities, Meat model ecosystem

[pmH-02]: Health & Hygiene (ID: 100033)

[Brazil]

## **Evaluation of performance and cecal ultrastructure in broiler chickens challenged with *Salmonella* Enteritidis and submitted to different ways of probiotic inoculation**

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The aim of this study was to evaluate the performance, cecal ultrastructure in broiler chicken and the probiotic efficiency against *Salmonella* Enteritidis challenge. Two experiments were conducted until 35 day of age. Seven-hundred-and-twenty and forty-five 1-day-old male Cobb® chicks were used for experiment I and II, respectively. A completely randomized experimental design was applied with three treatments for both experiments, 8 replicates of 30 chicks per treatment (experiment I) or 15 chicks per treatment (experiment II), each bird served as the experimental unit in the analysis. The treatments were: T1 (control) – chicks from eggs vaccinated on the 18th day of incubation against Marek disease; T2 – chicks from eggs inoculated with probiotic on the 18th day of incubation using Marek's disease vaccine as diluent; T3 – chicks from eggs vaccinated on 18th day of incubation against Marek disease and pulverized after selection via spray with probiotic solution. The probiotic used was a commercial product with a defined flora composed of 21 strains. Birds were challenged with *Salmonella* Enteritidis via intraesophageal inoculation on 3rd day of age. It was evaluated the performance: body weight gain, feed intake, feed conversion and livability at 35 day of age. To evaluate the caecal mucosa integrity by scanning electron microscope, it was used 5 birds/treatment in each experiment. Data were submitted to analysis of variance and means compared by Tukey Test at 5% of significance using GLM procedure of SAS. No differences ( $p>0.05$ ) were detected in performance at 35 day of age between the treatments throughout the study. For cecum integrity, no differences ( $p<0.05$ ) was observed between birds challenged or unchallenged with *Salmonella* Enteritidis, however it was possible to verify that the rounded contour of the opening of the crypts of caecal mucosa was more regular, and preserved a gut integrity when birds were submitted to probiotic treatment independent of pathway, when compared to control. At 35 days the number of colonies counting (CFU/mL) was below the minimum limit of contamination by *Salmonella* spp. The use of probiotic in different pathway did not affect the variables of performance but improved the gut integrity of caecal mucosa at 35 days of age.

**Keywords:** broiler chickens, competitive exclusion, in ovo feeding, probiotics

[pmH-03]: Health & Hygiene (ID: 100037)

[France]

## Genetic diversity of *Listeria monocytogenes* in broiler production from farm to fork

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*Listeria monocytogenes* is a foodborne pathogen responsible of listeriosis, rare infectious disease but with severe consequences. The aim of this work was to study the genetic diversity of *Listeria monocytogenes* in broiler production in France, to trace and identify the contamination from “farm to fork”. A total of 321 isolates were collected: 86 from breeding broiler flocks, 74 from slaughterhouses and 161 from a monitoring plan on broiler meat products in retail outlets. These isolates were serotyped and genotyped by pulsed-field electrophoresis using the restriction enzyme *AscI*. The genetic patterns were compared with Bionumerics 6.5 software (Biorad). The Simpson’s index was calculated to estimate the genetic diversity of the isolates. Eighty-three profiles were identified among the 321 genotyped isolates. Discriminatory index at rearing (0.968) is higher than retail (0.888). The serogroup IIa is prevalent (69.8%) between all levels and presents high diversity (0.9). Four profiles are common to the three levels (farms, slaughterhouses and retail), 6 are common to rearing and slaughterhouses, and 6 to slaughterhouses and retail products. Only 2 profiles are identical to the breeding and retail. A similar profile (C74) predominates in slaughterhouses (24%) and retail products (28%) but is not present at rearing. Regarding retail, this major profile, among the 32 obtained, is present on all types of products: thighs, breasts, carcasses and in all seasons (spring, summer and autumn). Moreover, five and 7 profiles are common to these 3 types and 3 seasons, respectively. These results demonstrated a persistent contamination of the finished products. This study showed that *Listeria monocytogenes*, present at the level of primary production, is a possible source of contamination since common profiles were found between broiler flocks, slaughterhouses and retail products. However, a predominant profile found in the slaughterhouses and retail products confirmed the environmental contamination at the slaughterhouses and the possible selection of particular isolates able to persist among others contaminating the environment. It would be therefore interesting to investigate the characteristics of the profile C74 which seems to be particular to the slaughterhouse environment.

Keywords: *Listeria monocytogenes*, diversity, broiler, traceability

[pmH-04]: Health & Hygiene (ID: 100047)

[Algeria]

## **Evolution of *Listeria* spp contamination on broiler carcasses along a slaughter line**

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This study was performed to assess the evolution of the prevalence of *Listeria* spp. contamination on broiler carcasses across the slaughter line at three abattoirs. 636 carcasses were collected across the three abattoirs. Sampling was performed at the processing line and carcasses were taken from two points. The half of these carcasses were collected after evisceration, the other half at the end of the processing line after packaging and refrigeration at 4°C for 24 h. Groups of three samples were pooled together, and a total of 212 samples were screened for *Listeria* according the ISO 11290-1 method. Ninety-nine (46.7%) of the 212 tested samples were positive for *Listeria* spp. Four *Listeria* species were isolated from both sampling sites at very different values across the three abattoirs. *Listeria monocytogenes* was isolated only at the end of the slaughter process in both abattoir A and B with prevalences of 23 % and 10%, respectively. In unit C, *Listeria monocytogenes* was isolated in both the evisceration stage (2.5%) and at the end of processing (20%). The innocua species was isolated in both of the stages at each of the three abattoirs and was found in 8.8% of the samples from abattoir A and 33.7% of the samples from both abattoirs B and C. *Listeria grayi* and *Listeria welshimeri* was found in 4.7 and 0.5% of the samples respectively. The *Listeria* Contamination on broiler carcasses during processing at abattoir is considerable, however the prevalence recorded were in agreement with those reported in previous studies. These results suggest that the contamination probably occurs after evisceration stage, caused by a highly contaminated environment and increases along the processing line.

**Keywords:** *Listeria*, *Listeria monocytogenes*, prevalence, Slaughter line

[pmH-05]: Health & Hygiene (ID: 100082)

[Serbia]

## **Frequency of Salmonella enterica serovar Infantis findings on broiler carcasses at slaughterline and its significance for food safety in Serbia**

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In order to determine the frequency of *Salmonella* spp. presence on broiler carcasses, 200 samples of broiler neck skin, formed by 600 carcasses, from three slaughterhouses of different capacities, were examined. A total of 17 positive samples were obtained. All positive isolates, from broiler neck skin samples, were identified with serological typing as serovar *Salmonella* Infantis (6,7: r: 1,5). Then, in order to determine the significance of this finding on food safety in Serbia, the comparison of genetic similarity between isolates originating from broiler neck skin and isolates of the same serotype, isolated from the diseased people, were performed. Genotypic identification were performed with molecular-biological method (Pulsed Field Gel Electrophoresis - PFGE). Phylogenetic comparison of isolates from poultry carcasses with strains isolated from the diseased humans, is carried out by the genome analysis, gel migration (CHEF-DR III Bio-Rad, California) and then dendrogram construction (obtained with the enzyme XbaI – broken down genome of DNA isolates of *S. Infantis*, derived from FPQuest program that shows similarity coefficients - Dice coefficient, UPGMA). Based on the results of PFGE, strains were classified into seven genotypes or genetic profiles. The similarity between the genetic profiles were 92%. Isolates within the same genetic profile showed the degree of genetic similarity of 100%. The most common profile SINFXB0001 was found in 11 strains of which 8 originated from the broiler neck skin and 3 from the diseased humans. The results indicate that the presence of *Salmonella infantis* on broiler carcass can be dangerous to human health. Several studies on risk assessment of *Salmonella* in broiler carcasses show that despite all the measures applied in the production chain of poultry meat, *Salmonella* are still present. Efforts to completely eliminate *Salmonella* from the food chain did not give a full success. Therefore, constant implementation of risk control measures in food chain are the basis for achieving the lowest level of *Salmonella* presence in food of animal origin.

Keywords: food safety, *Salmonella* prevalence, *Salmonella* Infantis, genotipization, PFGE,

[pmH-06]: Health & Hygiene (ID: 100102)

[Algeria]

## **Linseed (*Linum usitatissimum*) dietary supplementation reduces gut lesions scores in broilers infected with coccidian parasites**

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Since it can greatly affect growth at its most critical stage for frame size development, Coccidiosis is considered as the most economical important parasitic condition affecting poultry production worldwide. The objective of this study was to investigate the suppressive effects of 5% Linseed supplemented diet on coccidian parasites development by the reduction of small intestine and ceca lesions scores. The experiment consisted of 200 chicks (ISA Hubbard 15), at the end of the starter phase were divided onto two groups: The control was fed commercial diet While treatment group was fed ground linseed supplemented diet (5%) to which, its composition and nutritive metabolizable energy were assessed and balanced (Huthail et al.,2011). After sacrifice, lesions development of duodenum (D), jejunum (J) and caeca (C) of 15 subjects of each group were examined at 30(t1), 45(t2) and 54(3) days of age. The location in the host, appearance of lesions, and the size of oocysts are used in determining the species present. Coccidial infections were confirmed by demonstration of oocysts in feces or intestinal scrapings. Data were subjected to the multifactorial ANOVA using GLM and all data are presented as mean± standard deviations. Level of <0,001 was taken as statistically significant. Obtained results in % of lesions showed a significant reduced parasites invasions and developments in subjects of the treated group compared to the controls. However, at t1 coccidian lesions of D, J and C of subjects fed linseed supplemented diet were 6.46, 4.17 and 00.0 vs 13.5, 7.95 and 0.80 compared to control group respectively. At t2 lesions scores of D, J and C in treated animals were 8.12, 4.7 and 00.0, while in control animals were 20.5, 9.6 and 1.1 respectively. At 54 days of age (t3) the suppressive effects of the supplemented diet on the parasites development were highly significant (7.1, 4.3 and 00.0 in treated animals vs 19, 8.4 and 0.91 in controls respectively). Ground linseed supplemented diet with its bioactive molecules such as omega 3 and omega 6 unsaturated fatty acids, lignans and essential oils have reduced the invasion and the development of coccidian parasites. Therefore, the infiltrated tissues by these molecules become more susceptible to the oxidative attack of phagocytic cells of the immune system. *Emeria tenella* was the most sensitive towards the lethal effect of linseed compounds confirmed by the absence of lesions in the ceca segment of the linseed supplemented diet group. We conclude that linseed supplementation could be considered as a practical method for reducing coccidian intestinal lesions.

Keywords: Flaxseed, broilers, coccidiosis, lesions scores

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[pmH-07]: Health & Hygiene (ID: 100104)

[Belgium]

## **Comparison of the effects of coccidiosis vaccination and anticoccidial administration on intestinal integrity parameters**

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Coccidiosis from protozoa *Eimeria* spp. is still a major disease with a high prevalence and presence everywhere the world. Among *Eimeria* species with importance in the broiler industry, the following three species have a major importance in terms of production and economical losses: *Eimeria acervulina*, *Eimeria maxima* and *Eimeria tenella*. The average costs of coccidiosis in the US chicken industry is about \$127 million annually (Chapman, 2009) The purpose of this field experience is to compare health and intestinal parameters between prophylactic anticoccidial programs and live vaccinations in European standard broiler production conditions in two different time periods. The method used was the Elanco Health Tracking (HTS®) system and Elanco Intestinal Integrity Index (I2) The Elanco Intestinal Integrity was 5,27 points superior in the non-vaccinated group when compared to the vaccinated group, totalling a 5,93% overall improvement ( $p < 0,01$ ). A varied range of parameters of importance in an inflammatory process in the intestines were also scored and showed similar results. As a result, we conclude that anticoccidials offer a safer application and a better protection against *Eimeria* spp., maintaining at the same time a good intestinal integrity with an extra support against *C. perfringens*. An acceptable protection of the intestinal integrity was not achieved with the commercial live vaccines tested.

**Keywords:** eimeria anticoccidial vaccination intestinal integrity

[pmH-08]: Health & Hygiene (ID: 100121)

[India]

## **Molecular characterization of Marek's disease Virus from chicken from Southern Peninsular India**

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Marek's disease (MD) is one of the major viral epizootics of chicken with worldwide distribution causing heavy economic losses to the poultry industry. Emergence of very virulent and very virulent plus strains of Marek's Disease virus (MDV) lead to vaccine failures warranting the need for the development of rapid and accurate diagnostic tools. The objective of the study was to detect and characterize MDV by PCR and sequencing from chicken with MD. The materials included were 123 clinical samples comprising of 64 feather tips, 27 spleen, 23 liver, seven blood samples and one each of lung and kidney collected from 68 chickens suspected of MD from the flocks aged between 2 and 42 weeks. Both breeding and commercial broiler chicken farms from southern peninsular India, either vaccinated with Herpes Virus of Turkey (HVT) strain or unvaccinated were included. Of 123 samples, 104 were subjected to PCR by targeting three genes specific for MDV-1. The results revealed that 52 samples were positive for 132 bp repeat region of BamHI-H and BamHI-D fragments, a gene involved in Lymphomagenesis; 47 samples positive for antigen A gene as well as MeQ gene, which play an important role in infectivity, oncogenicity; and transformation respectively. Sequence analysis of PCR products revealed a significant sequence homology of about 95 to 98 per cent among BamHI fragments, 97 to 98 per cent for antigen A gene and 94 to 100 per cent for MeQ gene with other published sequences available in the GenBank. Phylogeny revealed two clusters in each of the BamHI fragment and MeQ genes. Two PCR positive samples were subjected for the isolation of MDV-1 in Duck Embryo Fibroblasts, which showed a characteristic cytopathic effect between 5 to 9 dpi consisting of round refractile cells termed as plaques. It is concluded that the field virus is frequently circulating among the flocks including the ones vaccinated with HVT, suggesting a possible vaccination failure.

**Keywords:** Marek's Disease, PCR, MeQ gene.

[pmH-09]: Health & Hygiene (ID: 100123)

[Algeria]

## **Distribution and identification of resistance patterns of *Salmonella* spp. isolated from raw poultry meat and poultry products in Algiers (Algeria)**

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The aim of our study was to determine the prevalence of *Salmonella* spp. strains in raw poultry meat and poultry products collected from retail trade in the region of Algiers, to identify serovars and examine the antimicrobial susceptibility of these strains. Twenty one out of 128 (16.41%) samples were tested positive for *Salmonella* spp. from which 23 strains (17.97%) were isolated. Among the 12 different identified serovars, *S. Enteritidis* and *S. Heidelberg* were the most prevalent with 21.74% and 13.04%, respectively. The study of susceptibility of 32 selected antimicrobial agents performed according to the CLSI recommendations revealed 95.24% (n=20) of isolates resistant to at least one antimicrobial and 38.10% (n=8) MDR. All isolates were susceptible to ciprofloxacin and cephalosporins, while resistance was recorded for pefloxacin (9.52%, n=2). Resistance to sulfonamides (85.71%, n = 18), nalidixic acid (33.33%, n = 7), tetracycline (19.05%, n = 4) and streptomycin (9.52%, n = 2) were the most frequent. Eight resistance patterns were identified. *S. Typhimurium* has acquired a resistance to 9 antimicrobials and its pattern includes an “ASCTS<sub>u</sub>” pentaresistance type. These results could be the consequence of uncontrolled and inappropriate use of several antimicrobial agents in poultry farms in Algeria. Further studies have to be conducted to determine different gene resistance.

Keywords: *Salmonella*, poultry meat, serotyping, antimicrobial resistance pattern.

*[pmH-10]: Health & Hygiene (ID: 100127)*

[France]

**Combinations of broilers' feed additives against *Campylobacter***

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*Campylobacter* is the most commonly reported gastrointestinal bacterial pathogen in the European Union and 50% to 80% of human campylobacteriosis may be attributed to the chicken reservoir. Implementation of *Campylobacter* control measures at the primary production level is needed to reduce human exposure. Inclusion of feed additives able to reduce *Campylobacter* amounts is one of the intervention strategies to consider. This work is part of the 7th framework program "CAMPYBRO". The aim of this work was to study combinations of products selected for their effect on *Campylobacter* in vivo, tested in the first part of the project. Synergistic combinations will be selected for future in vivo trials aimed at improving the effect on *Campylobacter* colonization in broilers. Nine commercial feed additives belonging to the following family of products: organic acids, fatty acids, monoglycerides, plant extracts, and prebiotics were evaluated according to a Doehlert experimental design. This approach allowed the testing of 48 combinations of the nine products. The products were prepared in brucella broth at several concentrations defined by the experimental design. A bacterial suspension of *C. jejuni* at 10<sup>7</sup> – 10<sup>8</sup> CFU/ml was added and, after 24 h of exposure, enumeration was carried out by serial dilution and plating on mCCDA plates. ANOVA analysis was performed to estimate the significance of factors individually and in interaction. Results explained the individual effect of each parameter and their interactions. The results did not reveal significant synergistic effects between the products. However, potential antagonistic effects were observed between several products, mainly between a mixture of monoglycerides and a plant-extract based product, and between a prebiotic product and a short-chain fatty acid. The nine products were selected because they were able to significantly reduce caecal colonization for at least one sampling date during previous in vivo trials. However, only three of these nine products demonstrated a significant effect on *Campylobacter* reduction in vitro. These trials highlighted antagonistic effects between the products tested and confirmed that results of in vitro and in vivo trials could not be correlated.

Keywords: *Campylobacter*, Control Measures, Feed Additive, Experimental design

[pmH-11]: Health & Hygiene (ID: 100128)

[France]

## **Quantitative risk assessment of human campylobacteriosis related to the consumption of chicken meat in France: focus on the consumer phase.**

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Campylobacter is reported as the major cause of bacterial food-borne illness in the European Union with over 220,000 human cases of campylobacteriosis reported in 2011 and 50 to 80% of these cases are attributed to the chicken reservoir. In order to determine the impact of different control measures on reduction in public health risk, a “farm to fork” QRMA model that details changes in prevalence and number of campylobacter on chickens throughout the production line from primary production to consumption was constructed. The quantitative risk assessment model (QRAM) is divided into 3 different modules: primary production, slaughter and consumer. We adapted existing models for primary production and slaughterhouse modules to current French practices and data. In order to construct the model for the consumer phase, a survey of practices during the preparation of a chicken meal was conducted on 659 consumers. The objective of this survey was to investigate the habits of handling of chicken meat during the preparation of the meal, and also to determine the proportion of risky behaviors that could lead to either direct or indirect cross-contamination between the raw meat and food ready to eat via hands or utensils. The QMRA model was finally used to benchmark different management scenarios on the final risk.

Keywords: Campylobacter, risk assessment, consumer, cross contamination

**Ofloxacin Residues and Health Biomarkers in Meat of Broiler****Rahman, Z. (1) and Asad, F. (2)**

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Quinolones are frequently used as antibiotics at poultry farms but their residual effects causing oxidative damage in chicken muscle have not been addressed. We aimed to investigate the effect of ofloxacin on total antioxidants and oxidants status in meat. Five weeks old male broiler birds (n= 24) were treated with ofloxacin @ 10 mg/kg b.wt/day for 5 consecutive days through drinking water and kept for a further 4 days of wash-out (day 6 to 10) . Control male birds (n=24) were offered fresh water during these days. Six birds were killed from each group/day (from 6 to 10 days) for the detection of antibiotic residues in serum, muscles and liver by using fluorescentHPLC. Paraoxonase, arylesterase and catalase were analyzed from serum, muscle and liver by using standard spectrophotometric methods. Analysis of variance and Duncan Multiple Range (DMR) was applied to obtain the significance difference ( $p<0.05$ ) between days after treatment. Ofloxacin in muscles and liver did show a high residual effect ( $p<0.05$ ) on day 6 after treatment and was significantly lower on day 10 of experimental period. Oxidant status in serum, muscle and liver wash high ( $p<0.05$ ) on day 6 after ofloxacin therapy and remained high throughout the experimental period. Ofloxacin treatment decreased ( $p< 0.05$ ) arylesterase in muscle but not in serum on day 10. Muscle catalase and serum paraoxonase were significantly decreased by ofloxacin on day 6 of the experimental period. On day 10 the antioxidant capacity was improved significantly. In conclusion our results did show that presence of residues of ofloxacin increases the oxidative level of muscles and has a deteriorative effects on the quality of broiler meat.

**Keywords:** Ofloxacin, Meat, Broiler, Antibiotic residues, Health biomarkers

[pmH-13]: Health & Hygiene (ID: 100193)

[Belgium]

**Oral administration of the Salmonella Typhimurium vaccine strain Nal2/Rif9/Rtt to chicks at day of hatch reduces shedding and caecal colonization after challenge with a monophasic variant of Salmonella Typhimurium.**

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A monophasic variant of Salmonella Typhimurium, Salmonella enterica serotype 1,4,[5],12:i:- is rapidly emerging worldwide. This serotype is now considered to be among the ten most common serovars isolated from humans in many countries. The public health risk posed by these emerging monophasic Salmonella Typhimurium strains is considered comparable to that of classical Salmonella Typhimurium strains. The serotype 1,4,[5],12:i:- is frequently isolated from pigs but also poultry is carrying strains from this serotype. In the current study, we evaluated the efficacy of the Salmonella Typhimurium strain Nal2/Rif9/Rtt strain (contained in the commercially available live vaccines AviPro® Salmonella Duo and AviPro® Salmonella VacT), to protect against infection with the emerging monophasic variant in poultry. Three independent trials were conducted. In all trials, laying type chicks were orally vaccinated with the Salmonella Typhimurium strain Nal2/Rif9/Rtt at day of hatch, while the birds were challenged the next day with a different infection dose in each trial (low, high and intermediate). For the intermediate dose study, a seeder bird model was used in which 1 out of 3 animals was challenged. All individual birds were infected in the other trials. Data obtained from each independent trial show that oral administration of the Salmonella Typhimurium strain Nal2/Rif9/Rtt at day of hatch reduced shedding, caecal and internal organ colonization of Salmonella Typhimurium 1,4,[5],12:i:-, administered at day 2 of life, suggesting protection through a colonization-inhibition phenomenon. This indicates that Salmonella Typhimurium strain Nal2/Rif9/Rtt can help to control Salmonella 1,4,[5],12:i:- infections in poultry.

Keywords: chick, monophasic, vaccine, salmonella

[pmN-01]: Nutrition (ID: 100007)

[Iran (Islamic Republic of)]

## **Antioxidant Status and Thigh Meat Quality of Broilers Chickens Supplemented with $\alpha$ -Tocopherol Acetate, Pomegranate Peel and Peel Extract in Diet**

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The effect of dietary  $\alpha$ -tocopherol ( $\alpha$ -Toc), pomegranate peel extract (PPE) and pomegranate peel (PP) on antioxidant status, oxidation susceptibility and quality of the thigh meat during refrigeration were investigated in chicken. Three hundred and eighty four 1-d-old male broiler chicks (Ross 308) were obtained from a commercial hatchery. Broilers were randomly allotted to 8 groups with 4 replicates of 12 birds each and standard condition of temperature, humidity, ventilation and 23 h of constant overhead fluorescent lighting reared for 42 days. Broiler chicks were fed 8 dietary treatments including: control diet,  $\alpha$ -tocopherol diet (200 mg/kg), PPE diets (100, 200 and 300 mg/kg), and PP diets (1, 2 and 3 g/kg) during 0-42 d. There were no significant differences in the concentration of saturated fatty acid (SFAs) in the thigh meat among the treatments ( $P > 0.05$ ). Long chain PUFA n-3 insert levels were higher in the thigh of broilers fed  $\alpha$ -Toc or high levels PPE diets than in those fed control or PP diets ( $P < 0.05$ ). Total phenolic content, thiobarbituric acid reactive substances (TBARS) and estimated 1, 1-Diphenyl-2-picrylhydrazyl (DPPH) radical-scavenging activity in the thigh meat were significantly improved in chickens fed diets containing  $\alpha$ -Toc or PPE ( $P < 0.05$ ). Supplementation of diets did not influence superoxide dismutase (SOD) and glutathione peroxidase (GPx) activities, but serum malondialdehyde (MDA) was reduced in chicks fed PPE or  $\alpha$ -Toc diets. In conclusion, dietary supplementation with 200 and 300 mg/kg PPE may improve the antioxidative potential, and nutritional and functional qualities of broiler thigh meat. The antioxidant potential of PPE was equal to that of  $\alpha$ -tocopherol in refrigerated meat.

**Keywords:** Pomegranate Peel, Antioxidant Status, Phenolic Content, Long chain PUFA, Broiler

[pmN-02]: Nutrition (ID: 100015)

[Iran (Islamic Republic of)]

## **The Effects of Supplementation with Probiotic, Synbiotic and Phytobiotic compounds on Growth Performance and Immune System of Broilers under Heat Stress**

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This experiment was conducted to evaluate the effects of dietary supplementation with probiotic, synbiotic and phytobiotic compounds on growth performance and immune system of broilers under heat stress. Two hundred fifty-six male day-old Hybrid Ross 308 were divided in a completely randomized design with 4\*2 factorial arrangement consisting of: eight treatments and four replicates. Dietary treatments were fed: 1) Control (without feed additives); 2) Control with probiotic (Primalac) (300mg/kg); 3) Control with synbiotic (Biomin IMBO) (1000 mg/kg) and 4) Control with phytobiotic (essential oils) (100 mg/kg) and heat treatments including: 1) normal temperature and 2) 39°C temperature were used from 35 to 42-d. The traits including feed intake, weight gain and feed conversion ratio were measured every week. Antibody titer against with Gumboro disease was determined by ELISA Kit after 10 days after Gumboro vaccination. At 42 days of age, eight birds from each treatment were selected and then blood taken from wing vein to measure IgM and IgG by ELISA Kits. The results showed that average daily gain was significantly different between synbiotic supplementation diet and control during grower period (22-42 d); So that, synbiotic supplementation diet had higher weight gain than the other treatments. Overall, the 42-d period was numerically different between with synbiotic and phytobiotic supplementation diets. But, body weight gain was not affected by environmental temperature and interactions between dietary treatments and temperature. Also, antibody titer, IgM and IgG for the birds fed the experimental treatments were higher than the birds fed to control ( $P < 0.001$ ). But, there was no significant effect of house temperature or interactions between dietary treatments and temperature on immunity system were not significant. The results showed that supplementation with growth promoters in broilers diet could be improved growth performance and immunity system status.

Keywords: Broilers, growth, growth promoters, heat stress, immunoglobulins

*[pmN-03]: Nutrition (ID: 100029)**[Nigeria]***Studies on carcass and meat quality attributes of broiler chicken fed graded levels of detoxified *Leucocephala* basal diet.****Apata, E.S. (1), Koleoso, I.M. (2), Ogungbesan, A.M. (3) and Ishola, O.J. (4)**

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Effect of feeding graded levels of detoxified *Leucaena leucocephala* meal (LLM) basal diet on carcass and meat quality attributes of broiler chickens was investigated. Seven isonitrogenous and isocaloric diets were formulated both for starter and finisher phases, designated T1, T2, T3, T4, T5, T6 and T7 respectively. The control diet no *Leucaena* meal (T1) was maize-soybean based diet, while 5% soaked LLM (T2), 10% soaked LLM (T3), 5% boiled LLM (T4), 10% boiled LLM (T5), 5% raw LLM (T6) and 10% raw LLM (T7) were incorporated into the diets and were supplemented with 0.3% methionine. 140 day old broiler chicks (Marshall Strain) purchased from Obasanjo Farm (Ota in Nigeria) were used for this study. Completely randomized design (CRD) with statistical model  $Y_{ij} = \mu + T_i + \text{random error}$  was employed. At the end of 8 weeks of feeding trial, 56 birds (8 birds from each group) were randomly selected, slaughtered and processed. Carcass cut – up parts were weighed and their percentages calculated, meat quality was measured through physical variables and sensory evaluation using a taste panel and the scores were analysed with a 9-point hedonic scale where 1 = dislike extremely and 9 = like extremely. The results showed that T5 had higher ( $p < 0.05$ ) live, eviscerated, thigh and back weights as well as carcass, thigh, back and wing dressing percentages. Meat cooking loss and thermal shortening were higher ( $p < 0.05$ ) in birds from T6, while meat from T1, T3, T6 and T7 had higher ( $p < 0.05$ ) shear force values. Meat from birds in T4 had higher ( $P < 0.05$ ) colour, flavour and overall acceptability scores, while T4 and T5 had higher ( $P < 0.05$ ) tenderness, juiciness and texture scores. It was recommended that boiled LLM be used in feeding broilers since it gave higher carcass and meat attributes of broiler chickens in this study.

**Keywords:** Carcass Meat, Quality, Broiler chickens, Detoxified *leucaena*.

[pmN-04]: Nutrition (ID: 100032)

[Brazil]

## **Dietary supplementation with organic minerals and vitamin E on the incidence of carcass lesion, skin and meat quality of broiler chickens**

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Trace mineral nutrition is critical for the development and functionality of the muscular, vascular, as well as connective tissues. In the same way, vitamin E is important for health because of its effect on the integrity and optimal function of various organ systems. This study aimed at evaluating the effect of dietary supplementation with organic zinc, organic selenium or vitamin E on skin lesion (bruises, dermatosis, cellulitis, and scratches), skin quality (resistance, collagen layer and epidermis thickness) and meat quality in broilers. The diets were formulated based on soybean-corn, to meet Rostagno et al. (2011) requirements. The feeding program consisted of crumbled pre-starter, starter, grower and finisher diets. A completely randomized experimental design in a 3x2 factorial arrangement of three dietary Vit E levels (100, 150, 200UI/kg feed), two sources of minerals inorganic (0.40 mg Se inorganic/kg and 72 mg/kg inorganic Zn) or organic (0.3 mg Se organic/kg and 45mg/kg organic zinc) plus a positive-control diet (commercial premix). In total, 1260 broilers were distributed between the seven treatments with six replicate pens of 30 birds each. At 42 days of age, 420 birds were sacrificed (60 per treatment, 10 per pen). Immediately after scalding, carcasses were examined for the incidence of skin lesions, and then approximately 2cm of the skin between the thighs and back were cut and measured using a pachymeter before and after feather-plucking, the same area of skin were collected for histological examination. After 24 hours at -4°C, meat quality parameters color, drip and cooking loss were analysed. Data were analysed by ANOVA using Statistic Software Minitab 16 (Minitab, 2010) and means were compared by Tukeys Test ( $P < 0.05$ ). Broiler fed with organic zinc and selenium showed thicker collagen layer and epidermis. Birds fed with inorganic Zn and Se and 150UI of vitamin E had the highest incidence of dermatosis. Diets did not influence skin strength and meat quality. The results showed that organic minerals and vitamin E supplementation did not influence meat quality, skin lesion and resistance, but that minerals in organic form stimulated skin development with thicker collagen layer and epidermis.

**Keywords:** Broiler chickens, meat quality, organic mineral, vitamin E

*[pMN-05]: Nutrition (ID: 100034)*

[Egypt]

## **Broiler Response to Dietary Supplementation of Barley and Corn Wet Milled Feed Products: Sensory Evaluation, Breast Meat Shear Force and Cooking Loss during Growing and Finishing Periods**

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Broiler meat and meat colour qualities are considered the most important factors for consumer and poultry meat industry. Therefore, the aim of this study was to investigate the effect of phase feeding on the meat quality and colour scores of broiler breast. During the growing and finishing period, broilers were fed different levels of Corn Wet Milled Feed Products (CWMFP) and barley based diets. A total number of 480 unsexed Ross broiler chicks (3 days old) were randomly distributed into 8 treatments and were kept under similar conditions. Each treatment comprised of 4 replicates of 15 chicks. During the starting period, chicks were fed starter basal diet (corn and soybean meal), while, during the growing and finishing periods, the first and fifth treatments were fed the grower and finisher basal diet and used as control. Second, third and fourth experimental treatments were fed the grower and finisher basal diet with incorporation of barley (Bar) with 10 % during growing period and 20% during finishing period, respectively. The sixth, seventh and eight experimental treatments were fed the grower and finisher basal diet with incorporation of Bar by 20 % during growing period and 30% during finishing period, respectively. Moreover, at each level of barley, Corn Gluten Meal (CGM) or CWMFP (corn gluten meal, corn gluten feed and corn germ) were incorporated in the experimental diets as a source of protein. Results showed that leg and muscle colours for the groups fed both levels of Bar plus CGM or CWMFP were significantly higher when compared with control groups. While there were no significant differences among all treatments in skin colour score. Highest level of Bar in grower and finisher broiler diet significantly increased yellowness of muscle compared with those fed low Bar level. Redness and lightness muscles colours scores were not affected for birds receiving both levels of Bar, regardless of CWMFP. Sensory evaluation of breast meat (flavour, juiciness, tenderness and appearance) was not affected by dietary treatments in grower and finisher broiler diets. Broiler received highest Bar level had the highest shear force compared with the other experimental groups, while the highest significant cooking loss was recorded for those received CWMFP plus the highest level of Bar.

**Keywords:** broiler- barley- CWMFP- Shear force- meat quality

[pmN-06]: Nutrition (ID: 100035)

[Saudi Arabia]

## **Colour value, sensory evaluation and meat quality characteristics of broiler supplied with barley and corn milled feed products in their finisher diet**

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The quality of broiler meat and meat colour are the most important factor for the product quality and poultry meat industry. Therefore, the aim of this study was to investigate the effect of phase feeding on the meat quality characteristics and colour scores of broiler breast meat at 42 days of age. The chicks were fed on corn wet milled feed products (CWMFP) and barley based diets during finishing period. All experimental diets were formulated to be iso-caloric and iso-nitrogenous. A total number of 420 unsexed Ross broiler chicks, three days old, were randomly distributed into 7 treatments. 4 replicates of 15 chicks each were used. Chicks were kept under similar environmental conditions. Chicks were fed starter and grower basal diet without any supplement during the starting and growing periods. During the finishing period the first treatment was fed the finisher basal diet without any supplement and used as control. Second, third and fourth experimental treatments were fed the finisher basal diet along with the supplement and 20% barley during the finishing period. Fifth, Sixth, and seventh experimental treatments were fed the finisher basal diet along with the supplement and 30 % with barley by during the finishing period, respectively. The supplements used in this study were CWMFP: corn gluten meal (CGM), corn gluten feed (CGF) and corn germ (CG). Meat quality, meat colour, cooking loss, colour of legs and skin were determined in accordance to scientifically know procedures. The results indicated significant differences between treatments in leg colour, muscle colour scores, sheer force and cooking loss. The highest leg colour value (4.75) was recorded for both broilers receiving the basal + low barley (20%) + CGM and basal + high barley (30%) + CGM in the finisher diet as compared with other treatments, while the highest scores for muscle colour (yellowness) was recorded for those fed with basal + (CWMFP) + high barley (11.72). Broiler that received the high level of barley in their finisher basal diet recorded the highest significant sheer force (2.72) compared to the other experimental groups. Broiler fed finisher Basal + CWMFP + high barley recorded the highest significant cooking loss (27.3%).

Keywords: corn wet milled feed products, barley, meat quality, colour scores

[pmN-07]: Nutrition (ID: 100064)

[China]

## **Effects of Different Oil Sources on Growth Performance, Carcass Composition and Meat Quality in Broiler Chickens**

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This study was conducted to examine effects of different commercially available oils sources in Chinese poultry industry on growth performance, carcass composition and meat quality in broiler chickens. A total of 360 day-old male Arbor Acres broiler chicks were allotted into one of the four treatments fed with chicken oil, duck oil, linseed oil or fish oil. Adding level of oil was 3% during starter phase (0-21 d) and 3.5% during grower phase (21-42 d). All the diets were isoenergetics. Results showed that poultry (chicken or duck) oil had better feed efficiency during starter phase, and ~10 g higher ADG during grower phase as well as ~5 g higher ADG during whole experimental period (0-42 d) than fish oil. No changes in carcass composition of d 21 existed. Chicken oil elevated breast muscle percentage compared to fish oil at 42 d. The pH and colour of breast muscle varied a lot among treatments. Fish oil led to lower initial pH (45min post-mortem) of breast muscle than poultry oils (6.53 vs 6.74). Chicken or duck oil generated higher L\* values (53-57 vs 43-53) and lower a\* values (4.3-5.6 vs 6.6-8.4) in breast muscle than linseed oil or fish oil, and chicken oil addressed higher b\* values (18.2-18.4 vs 14.4-15.3) of breast muscle than fish oil at 45 min or 24 h post-mortem. Although the crude fat contents in breast muscle did not differ among treatments, poultry oils group had higher cholesterol and lower triglyceride content than linseed oil or fish oil group. Fatty acid (FA) profile in breast muscle revealed that poultry oil groups had increased amount of saturated FA and linseed oil or fish oil group had higher amount of polyunsaturated FA. Taken together, our data suggest that poultry oils may improve growth and carcass composition, while linseed or fish oil may decrease growth.

Keywords: Oil sources, growth performance, carcass composition, meat quality, broiler chicken

[pmN-08]: Nutrition (ID: 100065)

[Greece]

### **Effect of dietary spirulina on broiler performance and meat lipid oxidation**

**Bonos, E. (1), Kasapidou, E. (2), Kargopoulos, A. (3), Karampampas, A. (4), Christaki, E. (5), Florou-Paneri, P. (6) and Nikolakakis, I. (7)**

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Spirulina (*Arthrospira platensis*) is a blue-green microalga, with many bioactive compounds such as proteins and essential amino acids, polyunsaturated fatty acids, vitamins, minerals and antioxidants. Aim of this study was to examine the possible effects of dietary spirulina on broiler chicken performance parameters and meat resistance to oxidation under refrigerated storage. One hundred twenty 1-day-old broiler chickens were randomly assigned to three treatment groups with four replications of ten birds. The birds were housed in floor pens with litter and were fed appropriate commercial diets with the addition of 0 g/kg (Controls), 5 g/kg (Spir-5) or 10 g/kg (Spir-10) dried spirulina powder until day 42. According to the performance results average body weight did not differ ( $P>0.05$ ) between the three treatment groups at days 21 and 42 of age. Also, oxidative stability was determined as thiobarbituric acid reacting substances (TBARS) on air packed skinless breast (m. pectoralis superficialis) and thigh (m. biceps femoris) samples stored at 4°C for 5 days, but no significant differences ( $P>0.05$ ) were noticed between the three groups. Therefore, dietary spirulina had no adverse effects on the performance and the meat lipid oxidation under refrigerated storage. Still, it could be a promising natural functional ingredient due to its potential beneficial properties, although further investigation is needed.

**Keywords:** Spirulina; broilers; performance; meat oxidative stability

[pmN-09]: Nutrition (ID: 100066)

[Greece]

## **Effect of dietary *Ascophyllum nodosum* on broiler performance and meat lipid oxidation**

**Kasapidou, E. (1), Bonos, E. (2), Kargopoulos, A. (3), Tsirantonakis, A. (4), Christaki, E. (5), Florou-Paneri, P. (6) and Nikolakakis, I. (7)**

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*Ascophyllum nodosum*, is well known brown macroalgae, containing many nutritional components, such as polysaccharides, fatty acids and antioxidants. This study was performed in order to examine the effects of dietary *A. nodosum* on broiler chicken performance parameters and meat resistance to oxidation under refrigerated storage. For this reason, one hundred sixty 1-day-old broiler chickens were randomly assigned to four treatment groups with four replications of ten birds. All birds were housed in floor pens with litter and were offered appropriate commercial diets with the addition of 0 g/kg (Controls), 5 g/kg (Asc-5), 10 g/kg (Asc-10) or 20 g/kg (Asc-20) dried *A. nodosum* powder until day 42. The results of the trials showed that the average body weight of the birds did not differ ( $P>0.05$ ) between the four treatment groups at days 21 and 42 of age. In addition, feed consumption and feed conversion ratio did not differ ( $P>0.05$ ) between the four groups. Furthermore, oxidative stability was determined as thiobarbituric acid reacting substances (TBARS) on air packed skinless breast (m. pectoralis superficialis) and thigh (m. biceps femoris) samples stored at 4°C for 5 days, but no significant differences ( $P>0.05$ ) were noticed between the four groups. Dietary *A. nodosum* could be utilized in broiler chicken diets up to 2%, without any adverse effects on performance and meat lipid oxidation under refrigerated storage. Nevertheless, further investigation is needed in order to evaluate its possible functional benefits on poultry nutrition and meat quality.

**Keywords:** *Ascophyllum nodosum*, algae, broilers, performance, meat oxidative stability

*[pmN-11]: Nutrition (ID: 100072)*

[Poland]

**Omega-6 to omega-3 fatty acids ratio in muscles of quails fed linseed diet in different growth periods.****Poławska, E. (1), Lipińska, P. (2), Tolik, D. (3) and Horbanczuk, J. (4)**

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The aim of the study was to determine optimal growth period of quails in which linseed supplementation should be applied to obtain optimal omega-6 to omega-3 fatty acids ratio in muscles. The study was carried out on 32 quails kept until 6 weeks of life. For the first 2 weeks of life all animals were fed on standard diet, and then assigned to 4 dietary treatments as follows: C- fed on standard diet until 6 weeks, L - fed on linseed supplemented diet until 6 weeks, CL – fed on standard diet in period 2-4 week and fed on linseed diet in period 4-6 week, and LC - fed on linseed diet in period 2-4 week and fed on standard diet in period 4-6 week. The control diet contained: soya bean meal, maize, wheat, triticale, rapeseed meal, rapeseeds, soy oil and potato protein. Experimental diet was made on the basis of a control diet, a part of which (rapeseed) was replaced with 4% of linseed. Protein and gross energy contents (265 g.kg-1 crude protein and 2950 kcal.kg-1 gross energy) were kept constant across the diets. The fatty acids analyses were prepared in breast and leg muscles and analysed using gas chromatography. The ratio of omega-6 to omega-3 was in breast muscles as follows: 32, 31, 7.5 and 4.89 in C, LC, CL and L group respectively. In leg muscle the ratio was 21.8, 23.4, 7.6 and 5.3 in C, LC, CL and L group respectively. The results of the study indicated that to obtain optimal ratio of omega-6/omega-3, which is close to value recommended by WHO in human nutrition, the quails should be fed on linseed diet from second to sixth week of life ( $P < 0.05$ ). Shorter linseed supplementation has more beneficial effect ( $P < 0.05$ ) on omega-6/omega-3 ratio when is applied in two last weeks of quails life than it is applied in the former growth period. Conceptualized and realized within the project 2011/01/D/NZ9/00676 financed by National Science Centre.

Keywords: omega-6/omega-3 ratio, quails, breast and leg muscle

*[pmN-12]: Nutrition (ID: 100074)***[Poland]****Retinol,  $\alpha$ -tocopherol and  $\gamma$ -tocopherol content in breast muscles of quails.****Lipińska, P. (1), Bujalska, M. (2), Józwiak, A. (3), Horbańczuk, J. (4) and Poławska, E. (5)**

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The aim of the study was to determine the content of retinol,  $\alpha$ -tocopherol and  $\gamma$ -tocopherol in breast muscles of quails fed standard and linseed supplemented diet. The study was carried out on 32 quails, 16 per each dietary (C-standard diet, L-4% linseed supplementation) treatment. The control diet contained: soya bean meal, maize, wheat, triticale, rapeseed meal, rapeseeds, soy oil and potato protein. Experimental diet was made on the basis of a control diet, a part of which (rapeseed) was replaced with 4% of linseed. Protein and gross energy contents (265 g.kg<sup>-1</sup> crude protein and 2950 kcal.kg<sup>-1</sup> gross energy) were kept constant across the diets, whereas the fat content differ across the diets (C diet -60 g.kg<sup>-1</sup> and L diet 74 g.kg<sup>-1</sup>). The content of retinol,  $\alpha$ -tocopherol and  $\gamma$ -tocopherol was determined by HPLC method in breast samples. The statistical analysis was computed using STATISTICA (ver. 9, StatSoft Inc., USA). Tukey-tests were calculated at a 5% significance level to compare treatment means for significant effects. The retinol content in muscles of quails from C group was higher (58 $\mu$ g/100g) than in L muscles (43  $\mu$ g/100g) ( $P < 0.05$ ). Contrary,  $\alpha$ -tocopherol and  $\gamma$ -tocopherol was higher in L muscles (42  $\mu$ g/100g and 1.01mg/100g, respectively) than in C muscles (34  $\mu$ g/100g and 0.97mg/100g, respectively,  $P < 0.05$ ).

The conclusion of this study is that linseed supplementation to quail diet has positive effect on tocopherols content, but not on retinol content in muscle. Conceptualized and realized within the project 2011/01/D/NZ9/00676 financed by National Science Centre.

**Keywords:** retinol,  $\alpha$ -tocopherol,  $\gamma$ -tocopherol, quails

[pM-N-13]: Nutrition (ID: 100081)

[Netherlands]

## The Effect of Dietary Zinc Source and Level on Carcass Defects in Broilers

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Hematomas, skin ruptures, and epiphysiolysis (bone protrusion) are costly defects observed in European poultry abattoirs. Zinc deficiency has been shown to disrupt endothelial barrier, decrease skin strength and deteriorate skeletal integrity. The aim of this study was to determine the effect of Zn source in reducing these defects. A total of 1296 day-old Ross 308 male broilers were allocated to one of four dietary treatments: 40 ppm Zn supplemented as ZnSO<sub>4</sub> [40ZS], 40 ppm Zn as zinc amino acid complex (Avalia®Zn, Zinpro Corporation, Eden Prairie, USA) [40AZ], 80 ppm Zn as ZnSO<sub>4</sub> [80ZS], or 40 ppm Zn as ZnSO<sub>4</sub> + 40 ppm Zn as zinc amino acid complex [40/40]. The experimental design was a randomized complete-block, with each treatment having 12 replicate pens of 27 birds. Birds were processed at 35 d of age, when determination of carcass characteristics and scoring of pododermatitis, hock lesions, and carcass defects were conducted. Weights and yields of carcass and breast, incidence of pododermatitis, and hock lesions were not affected ( $P > 0.05$ ) by dietary treatment. Bone protrusion was affected by Zn source, with less severe bone protrusion observed in carcasses of birds fed 40/40 compared to 40ZS, while 40AZ and 80ZS treatments were intermediate (1.8, 9.2, 3.3, 4.2 %, respectively;  $P < 0.05$ ). Proportion of carcasses with mild bone protrusion was higher in treatments with zinc amino acid complex (40AZ, 20.6%; 40/40, 23.9%), compared to inorganic Zn source (40ZS, 10.1%; 80ZS, 10.0 %),  $P < 0.05$ . Proportion of carcasses without skin rupture was greater ( $P < 0.05$ ) when 80 ppm supplemental Zn was provided, compared to 40 ppm Zn as ZnSO<sub>4</sub> (40/40, 64.4 %; 80ZS, 55.8 %; 40ZS, 37.8 %), while sole source zinc amino acid complex (40ZS) was intermediate (45.6 %). Proportion of carcasses without hematomas was greater ( $P < 0.05$ ) with increasing level of zinc sulphate (40ZS, 39.4 %; 80ZS, 50.0 %). Extent of carcasses lacking hematomas was even higher ( $P < 0.05$ ) with the inclusion of zinc amino acid complex (40AZ, 67.5 %; 40/40, 64.8 %). These data show that supplementation of zinc amino acid complex decreased broiler carcass defects.

Keywords: Zinc, Organic-Zn, carcass quality, hematomas, bone protrusion

*[pmN-14]: Nutrition (ID: 100103)*

[Algeria]

**Effects of linseed (*Linum usitatissimum*) dietary supplementation on body weight, mortality, blood pH and body temperature of broilers raised in high ambient temperature****Bengharbi, Z. (1), Dahmouni, S. (2), Mouats, A. (3) and Halbouche, M. (4)**

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Hot climate is probably the most obvious constraint to the future development of the poultry meat industry in general but in hot countries in particular. High ambient temperature, especially when coupled with high humidity, imposes severe stress on birds and leads to increased mortality and reduced performance. This study was conducted to investigate the effects of ground linseed (*Linum usitatissimum*) dietary supplementation on broilers resistance to high ambient temperature at finish. Composition and nutritive metabolizable energy of the experimental diet were assessed and balanced (Huthail et al., 2011). The experiment consisted of 200 chicks (ISA Hubbard 15), at the end of the starter phase, were divided onto two groups (n = 100): The control (C) was fed commercial diet and the treatment group (LS) was fed ground linseed supplemented diet (5%) Animals, at local marketing age (54 days), were exposed to a heat stress of  $36\pm 1^{\circ}\text{C}$  for 6 hours. Prior to sacrifice, body weight, blood pH and body temperature of 15 birds from each group were measured and recorded. Data were subjected to the multifactorial ANOVA using GLM; all data are presented as mean $\pm$  standard deviations. Level of  $<0,001$  was taken as statistically significant. Results showed that the treated group birds, compared to controls, were more resistant to the heat stress at finish period revealed by increased body weight ( $2262.80\pm 37\text{g}$  vs  $2057\pm 25\text{g}$ ) and decreased mortality (8% vs 20%). These findings were confirmed by a slight increase in blood pH ( $7.39\pm 0.1$  vs  $6.96\pm 0.09$ ) and significant decrease in body temperature ( $41.2^{\circ}\text{C}$  vs  $42^{\circ}\text{C}$ ) of C and LS groups respectively. Ground linseed supplemented diet with its bioactive molecules such as omega 3 and omega 6 unsaturated fatty acids, lignans and essential oils helped in reducing the detrimental effect of heat stress in broilers raised at  $36\pm 1^{\circ}\text{C}$  and, consequently, contribute to dissipate metabolic heat. This resistance may be due to the rich linseed antioxidant compounds which may decrease the oxidative stress. These results indicated that the supplementation of flaxseed improved the performance and reduced the mortality of broilers reared under heat stress and tend to improve animal's heat stress resistance.

Keywords: blood pH, body weight, flaxseed, heat stress, mortality,

[pmN-15]: Nutrition (ID: 100135)

[France]

## **Influence of beta-mannanase on the performance of standard chickens fed diets containing different sources of beta-mannan**

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Beta-mannans are components of the wall of some seeds such as legumes (soybeans), rapeseed and sunflower. They can stimulate the innate immune system of birds because of the analogy between their molecular structure and those of germs walls (bacteria, viruses, fungi). The inappropriate immune response induced by beta-mannans (=FIIR, Feed Induce Immune Response) leads to a waste of energy of up to 3% of metabolizable energy (90 kcal). This wasted energy impacts the growth performance and leads to economic losses. The use of certain enzymes called beta-mannanases avoids this waste. The objective of this study was to evaluate the effects of a beta-mannanase (Hemicell®) in commercial conditions in various food formulations (with base of wheat and corn), containing different sources of beta-mannans and in the presence of other enzymes (xylanase, phytase and glucanase). Two types of formulas were used: a formula with a source of beta-mannans provided by soybean meal (first trial) and a formula with diversified beta-mannans sources, soybean meal, rapeseed and sunflower (second trial). Each formula was tested via three different diets: positive control (free diet Hemicell®), negative control (diet - 90 kcal) and test control (diet - 90 kcal + Hemicell® at 110 ml/T). 8 repetitions of 92 chickens (Ross PM3 fattening during 36 days) were performed for the three different diets in both formulation trials. The criteria of mortality, weight at slaughter, average daily gain, feed intake, and feed conversion adjusted at 1, 8 kg and uniformity of each group were followed. The results show that Hemicell® is also effective in different feed using unique or diversified sources of beta-mannans (same performance or better vs positive control,  $P < 0,01$ ). It allows a sparing of 50 Kcal / kg feed, on average, and a significant improvement in the uniformity of the flock ( $P < 0,05$ ).

**Keywords:** Broilers, Soya, enzyme, beta-mannans, beta-mannanase

*[pmN-16]: Nutrition (ID: 100137)***[Algeria]****Effect of heat stress on soybean meal protein digestibility in rooster****Dorbane, Z. (1) and Boudouma, D. (2)**

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Summer temperatures in the Mediterranean countries, including Algeria, impose severe stress on the broiler and lead to reduced performance. Poor growth performance is often correlated with low nutrient digestibility and metabolic utilization. The objective of this study was to measure the effect of high temperature on the apparent and true digestibility of soybean meal protein. The assay was conducted on two years old roosters of the local population, kept in individual metabolic cages. In our study, two assay were conducted; in the first one 11 roosters were housed at  $22.69 \pm 0.39^{\circ}\text{C}$  and in the second one 9 birds were raised under an ambient temperature of  $30.71 \pm 0.27^{\circ}\text{C}$ . After an adaptation period of 3 days, birds were starved during 24 hours and then fed for 3 days with soybean meal in crumb form (88.27% DM, 42% CP). After that, they were starved for 1 day, a second day of starvation was observed to collect the endogenous excreta. Total excreta were collected from all birds, and water and the soybean meal were offered ad libitum throughout the adaptation and assay periods. Ambient temperature affected significantly ( $P < 0.05$ ) the apparent digestibility value of soybean protein: 92.20% (at  $22.69^{\circ}\text{C}$ ) vs 90.66% (at  $30.71^{\circ}\text{C}$ ) as well as of the true digestibility values: 92.67% (at  $22.69^{\circ}\text{C}$ ) vs 91.08 (at  $30.71^{\circ}\text{C}$ ). However, the difference between the values of soybean meal protein digestibility in rooster kept under optimum and high temperature was low, that can be a consequence of better tolerance of animals from local population to the heat stress. The data obtained show that under high ambient temperature, digestive utilization of soybean meal protein was reduced dictating a fine-tuning in poultry ration formulation. Adjusting ration formulation based on environmental temperature would also reduce the cost of feed and minimize excess nitrogen effluent in poultry manure during summer season.

**Keywords:** Digestibility, protein, rooster, soybean meal, temperature

[pmN-17]: Nutrition (ID: 100140)

[Hungary]

### **The effect of thyme and rosemary supplement on roast goose meat quality**

Szabó, R. T. (1), Erdélyi, M. (2), Drobnýák, Á. (3), Körözi, V. (4), Balogh, K.M. (5), Mézes, M. (6) and Weber, M. (7)

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There are numerous data showing that natural feed additives, such as herbs, spices and medicinal herb extracts have positive effect on the growth and health status of farm animals, including goose. For instance rosemary contains 6-8% of tannin, its dried leaves contains 1-2%, and the fresh shoots contain 0.5-1.5% essential oil. Thyme contains 1-2 % essential oil, tannin, bitter substances, saponin and rosin. The purpose of present study was to investigate the effect of rosemary and thyme in roast goose rearing in comparison with synthetic antioxidant (AO). Babat grey landes geese were divided in two groups (mixed sex ratio): complete (n=600) fed with complete feed containing synthetic AO (25018.36 mg/kg dry matter content) and experimental (n=1600) fed with the same basal diet supplemented with rosemary and thyme (both 60000 mg/kg dry matter content), but without additional synthetic AO. The animals were fed with the above mentioned diets in the period of the entire rearing from day 1 up to 9 weeks. Meat quality parameters - pH, colour (CIELab parameters with reflectance spectrometry), kitchen technical losses (cooling and cooking loss) and friability - were analysed in the thigh and breast of the geese. The pH and colour values ( $L^*a^*b^*$ ) of thigh and breast showed no significant difference between the complete and the experimental group, although the difference of visual perception ( $\Delta E^*$ ) for thigh was 'well visible' (5,68), while for breast it was 'perceptible' (1,66). The average cooling loss was the same in breast samples of goose from both groups, but cooking loss was significantly higher in the complete group as compared to the experimental one (fed with herbal supplement). It means that rosemary and thyme supplementation has positive effect of cooking loss of breast and thigh meat. No significant difference was found in the body weight but the feed to gain ratio was more favourable in the experimental (2,76 kg feed/kg body weight gain) as compared to the control (2,83 kg feed/kg body weight gain). Based on the results of present study rosemary and thyme can be used as natural feed additives in goose rearing.

Keywords: rosemary, thyme, feed supplement

*[pmN-18]: Nutrition (ID: 100144)***[Hungary]****The effect of oregano supplement on turkey meat quality, lipid peroxidation and antioxidant status****Drobnýák, Á. (1), Erdélyi, M. (2), Mézes, M. (3), Szabó, R. T. (4), Szöllősiné Bende, R. (5), Horvainé Szabó, M. (6) and Weber, M. (7)**

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The main purpose of present study was to investigate the potential antioxidant effect of oregano with the investigation of some meat quality and lipid peroxidation parameters. Total of 2134 hybrid turkeys (Converter, Hendrix Genetics) were investigated in the period of rearing (from 6 to 16 weeks of age). Two experimental groups (n= 1067 in each) were composed, a control (complete feed without oregano supplementation) and experimental (complete feed supplemented with oregano). Blood samples (n=20 from each group) were collected from aa. carotis ext. and int., v. jugularis at bleeding . Blood was separated by centrifugation and blood plasma and red blood cell 1:9 haemolysate was used for analyses. Liver samples (n=20 from each group) were taken post-mortem during dissection and stored at -18oC until analysis. Liver 1:9 homogenate was prepared (+ 4oC, 0.65 % w/v NaCl) immediately before analysis. Breast and leg meat samples (n=20 from each group) were taken from the left medallion and left leg. The animals were caught the infusion in water during the rearing (150 ml/1000l). We ensured the infusion 3 days per a week permanently, then we applied 4 days break. Among meat quality parameters the pH at 45 minute after slaughtering (pH1) and after cooling (pH2) and colour (CIELab L\*a\*b\* parameters with reflectance spectrometry) 24 hours after slaughtering were measured. Lipid peroxidation was measured with the determination of malondialdehyde (MDA), and antioxidant parameters with the amount of reduced glutathione (GSH) and activity of glutathione peroxidase (GPx) in blood plasma, red blood cell haemolysates and liver homogenate. Oregano supplementation did not cause significant changes in meat quality of leg, but breast became darker and reddish (L\*=51.98, a\*= 18.29 vs. L\*=49.52, a\*= 19.31) which is appertain to „noticeable” ( $\Delta E^*=2.9$ ) category in terms of visual perception. The pH of breast and leg was within the normal range of turkey meat in both groups. Favourable and significant changes were found in GSH content and GPx activity in blood plasma (GSH P=0.013), red blood cell haemolysate (GPx P=0.033) and liver homogenate (GPx P=0.00006) as effect of oregano supplementation. However, MDA content was the same in both groups and samples.

**Keywords:** turkey, oregano, meat quality,

*[pmN-19]: Nutrition (ID: 100153)**[France]***Influence of the incorporation into the feed of calcium Pidolate on the quantitative and qualitative parameters of the broiler production.****Rouleau, X. (1) and Alleno, C. (2)**

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The frequency of musculoskeletal disorders in commercial broiler has become a real economical and welfare issue. From multifactorial origins (genetic, density, litter quality, nutrition...), those disorders are expressed by musculoskeletal deformations and inflammations. Associated pain can affect the ability to access to resources (feeders, drinkers) for the animals more seriously hurt. Calcium Pidolate is described in the literature for its strong ionization power in comparison with other calcium sources and for its specific role in the synthesis of the bone collagen tissues. Currently widely used in the pullet's preparation with a bone development strategy, this work studies its impact on bone quality on broilers. Each group is composed of 8 repetitions of 40 broilers Ross® (M99xPM3) (22.5/ m<sup>2</sup>). First group (control) is fed under the recommendations of the genetic strain company. Second group received Calcium Pidolate incorporated, from 0 to 21 days, at 300 ppm in substitution of 300 ppm of calcium carbonate in the control diet. Quantitative parameters (weight, feed intake, FCR) and qualitative (bone stiffness, yields) are studied at 35 days. Variables are subjected to analysis of variance (Kolmogorov-Smimov and Bartlett test). Calcium Pidolate incorporation during the first days of life, improves the quality of bone deposition (bone stiffness: +14%). Feed intake was significantly improved (+3.4%) exclusively during the last 15 days of life. FCR reduction (-1.22%) and bodyweight gain (+4%) are both significant at 35 days. Bone metabolism improvement (collagen, calcium, phosphorus) during initial stage participates in a better welfare and mobility at the end of fattening. By facilitating the access to resources, the animals, especially the heavier ones, maintain high growth until the last day. The improvement of the "skeletal" welfare becomes a lever for performance and for maximal expression of the genetic potential.

**Keywords:** Leg quality, Bones, Mobility, Pidolate, Calcium

[pmN-20]: Nutrition (ID: 100160)

[Egypt]

## **Effect of Essential Oil of Garlic and probiotic on Performance, Carcass and Lipid Metabolism of Growing Japanese Quail**

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The objective of this study was to compare the response of growing Japanese quail to dietary supplementation with probiotic (*Aspergillus niger*) and garlic oil and evaluate the growth performance, carcass and lipid profile using 120 seven-day Japanese quail of both sexes from one week to six weeks of age. The quail were randomly assigned to four treatment groups in a completely randomized design and each treatment replicated three times. Four diets were formulated with diet 1 containing no supplement. Diet 2 contained 0.05 % probiotic (*Aspergillus niger*). Diets 3 and 4 contained garlic oil at 0.025 and 0.050 %, respectively. At six weeks of age six birds from each treatment were randomly chosen and slaughtered and blood samples were collected. Results showed that body weight gain and feed conversion ratio improved by different supplementations as compared to the control group. Percentage of spleen, bursa and thymus gland increased, while liver decreased in quail fed different feed additives as compared to the control group. Significant reduction in serum blood cholesterol, triglycerides, total lipids and low density lipoprotein were recorded for quail fed supplemented diets. Probiotic supplementation lowered lipid peroxidation (MDA) and elevated plasma total antioxidant capacity, followed by 0.05 % garlic oil supplementation as compared to the control group. The study indicated that garlic oil and *Aspergillus niger* as probiotic could effectively be added to quail ration to improve the performance of the birds and to optimize lipid profile.

Keywords: Japanese quail, Garlic oil, Probiotic, Performance, Lipid profile

[pM-21]: Nutrition (ID: 100163)

[Egypt]

## **Effect of dietary Sugar Beet Pulp Ethanolic extract on productive Performance, Immunization, and Meat Quality of Broiler Chicks**

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A total number of one hundred and twenty, four days old broiler chicks, were divided into 4 treatments (30 birds /each), each treatment contained three replicates of ten birds each to evaluate the effect of sugar beet pulp ethanolic extract (EE-SBP) (as a natural antioxidant) compared with butylated hydroxyl toluene (BHT) (as a synthetic antioxidant) on growth performance, carcass characteristics, blood plasma parameters, immunization, sensory evaluation of cooked meat, quality of stored meat as lipid oxidation which determined by measuring the Thiobarbituric Acid Reactive Substances (TBARS) and European efficiency factor (EEF). The treatments were: 1-The control diet; 2-The control diet +BHT;3-The control diet +0.5 % EE-SBP; 4- The control diet + 1% EE-SBP. Results obtained were: group fed diet with BHT supplementation (T2) had significantly ( $p<0.05$ ) higher feed intake and lower Performance Index (PI%), while, birds fed diets with EE-SBP (T3 and T4) showed significantly ( $p<0.05$ ) reduced feed intake, improved feed conversion and recorded higher Performance Index (PI%), compared with control group. Birds group receiving 1 % EE-SBP (T4) achieved significantly ( $p<0.05$ ) higher values of albumin, albumin / globulin (A/G ratio) and less globulin (immune cost) than control group. These results means that supplemented EE- SBP at level 1% achieved the best immunity and that is may be due to the effect on both negative- gram and positive- gram bacteria and consequently the immune cost will be decreased. Sensory evaluation of meat quality was significantly better for EE-SBP (0,5 % or 1%) compared to control and BHT. Meanwhile, 1% SBP extract significantly ( $p<0.05$ ) recorded the best effect on sensory evaluation and the lowest TBARS number.

Keywords: Antioxidant, broilers, performance, immunization, meat quality

[pmN-22]: Nutrition (ID: 100169)

[Iran (Islamic Republic of)]

### **The Effect of Supplementary L-Carnitin on Blood parameters Associated with Fat of Broiler Chickens until 3 days of age.**

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This study was conducted to evaluate the effect of dietary L-carnitine inclusions levels on blood parameters associated with lipid metabolism. Two hundred and forty day-old Ross 308 broiler chickens were reared under optimum growth condition until 10 days of age. They were randomly distributed into 12 floor pens in a randomized block design (4pen/treat, 20birds/pen). Different levels of L-Carnitine were used in this study including control, 100, 200 and 300 ppm. 72 chicks were used for blood sampling at first and third day of life. Blood parameter data measured on the first day of treatment showed no difference for all levels of L-Carnitine. On the third day, LDL level was significantly different in chicks treated with 200 and 300 mg L-Carnitine compared to the 100 and the control ( $P<0.05$ ). Cholesterol level was significantly decreased with 200 and 300 mg L-Carnitine treatment compared to the 100 mg and control ( $P<0.05$ ). We found significant difference in HDL level in 300 L-Carnitine compared to the control. In addition, triglyceride level in those treated with L-Carnitine was reduced compared to the control, but the numbers did not show any significant differences. It is concluded that L-Carnitine supplementation in the chickens' food has influence on blood parameters associated with fat. Our results are in agreement with findings from previous studies.

**Keywords:** L-Carnitine, Blood parameter, broiler chickens

[pmN-23]: Nutrition (ID: 100195)

[Poland]

## **Effects of selenium enriched diet on the concentration of hydrophobic and hydrophilic antioxidants in chicken meat**

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The objective of the study was to enhance the quality and pro-health properties of chicken breast and leg muscles by increasing the concentration of antioxidative components naturally present in meat by application of selenium to birds diet. 128 one-day old Flex (Hubbard) chicks were allocated to seven experimental groups: control (C) and fed diets enriched with organic (Se-yeast *Yarrowia lipolytica*) and inorganic selenium (sodium selenite) on three levels of supplementation 0.26 mg Se/kg (OSe, ISe); 0.38 mg Se/kg (OSe, ISe) and 0.5 mg Se/kg (OSe, ISe). Birds were kept up to 42 day of living. No significant changes ( $p \geq 0.05$ ) in protein, lipids, dry matter and ash content in chicken breast and leg meat were analyzed after Se addition. Feeding chicken with selenium enriched diets resulted in higher level of this microelement in breast and leg meat. Application of 0.5 mg Se/kg feed lifted selenium content in breast up to 19.8-22.9  $\mu\text{g}/100\text{ g}$  and in leg up to 18.5-23.4  $\mu\text{g}/100\text{ g}$  for inorganic and organic form of Se, respectively. Incorporation of 0.26 mgSe/kg increased iron content in breast, but decreased in leg meat Tocopherol concentration in both types of analyzed broilers meat was not affected by feeding modifications. Coenzyme Q content was dose dependent and increased significantly ( $p \leq 0.05$ ) in both breast and leg meat when 0.38 mg/kg of organic or 0.5 mg/kg of inorganic selenium was applied to the diet. All hydrophilic antioxidants, anserine, carnosine and glutathione, both in breast and leg chicken meat increased after diet supplementation with 0.5 mg/kg. Summing up, the addition of 0.5 mg/kg selenium had positive effects on antioxidative potential of chicken meat expressed by higher concentration of selected hydrophobic and hydrophilic antioxidants. Project supported by the Polish Ministry of Science and Higher Education, no: NN312253938.

**Keywords:** selenium enriched, hydrophobic, hydrophilic antioxidants

[pmN-24]: Nutrition (ID: 100196)

[Poland]

## **Antioxidative potential of chicken meat enriched with selenium and methionine during roasting**

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The objective of the study was to analyse the ability of selenium and methionine enriched meat to antioxidative actions during roasting. Breast and leg muscles were collected from F15 bearing dwarf genes and Flex (Hubbard) broiler chickens fed commercial diet (C) and also diet enriched with 0.5 mg Se/kg in form of selenium yeast *Yarrowia lipolytica* (OSe) and sodium selenite (ISe), additional group fed with 11.2 g/kg DL-methionine (Met) up to 35 days. Collected muscles (n = 32, p≤0.05) were then roasted in oven at 160°C until internal temperature of meat reached 72°C. The antioxidative potential of meat was analysed by the ability to scavenge DPPH and ABTS radicals, the ability to reduce iron (FRAP) and concentration of thiobarbituric acid reactive substances (TBARS). Application of selenium enriched diet resulted in higher level of the microelement in chicken muscles. Breast and leg chicken meat enriched with selenium expressed higher ability to scavenge DPPH radical and to reduce ironIII to ironII (FRAP) during thermal treatment. Feeding with methionine led to increase the DPPH radical scavenging but decrease FRAP of chicken breast and leg meat during thermal treatment. Selenium and methionine enriched diet resulted in higher resistance of chicken breast and leg meat to oxidative changes analysed by concentration of the secondary lipid oxidation products (TBARS) during roasting. Summing up, incorporation of selenium or methionine to broilers diet increased the antioxidative potential of breast and leg meat during thermal treatment. Project supported by the Polish Ministry of Science and Higher Education, no: NN312253938.

Keywords: Antioxidative, selenium, methionine

[pmN-25]: Nutrition (ID: 100200)

[Lithuania]

## **Effects of dietary inclusion of medium chain fatty acids and butyrate on growth performance, organ weights, and intestinal histomorphology of broiler chickens**

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The aim of this study was to investigate the effects of dietary supplementation of a mixture of medium chain fatty acids, butyrate, essential oils and *Saccharomyces cerevisiae* on broiler performance, productivity, organ weights and histomorphological measurements of duodenum and ileum. Six hundred 1-d-old Ross 308 broiler chicks were randomly assigned to 1 of 3 dietary treatments for 5 wk. The dietary treatments were 1) control diet, 2) diet supplemented with a mixture of medium chain fatty acids (propionic, sorbic, lauric), butyrate, essential oils and *Saccharomyces cerevisiae* at the level of 1.5 g/kg of feed 3) diet supplemented with the same mixture as in 2 treatment, but at a higher amount (2 g/kg of feed). The gastrointestinal tract was weighed after removal of the content. The gizzard, heart, liver, pancreas, small intestine (duodenum and ileum) and colon were excised and weighed. The samples for the histomorphological study were examined using an “Olympus BX63” microscope, “Olympus DP72” video camera and system (Olympus) of a computer program “Image Pro Plus”. The BW and feed conversion ratio were improved by the dietary inclusion of the both levels of a mixture of medium chain fatty acids, butyrate, essential oils and *Saccharomyces cerevisiae* compared with the control broilers. The weight of intestine (40.8 g) ( $P<0.05$ ), liver (15.53 g) and pancreas (1.56 g) ( $P<0.025$ ) tended to be greater for the lower level of supplement (1.5 g/kg) compared with the control group. Furthermore, the same treatment influenced the histomorphological measurements of small intestinal villi. Supplementation at 1.5 g/kg increased the height of duodenum villi by 98  $\mu\text{m}$ , the depth of crypts - 105.8  $\mu\text{m}$  ( $P<0.05$ ), the height of ileum villi - 597.2  $\mu\text{m}$  ( $P<0.010$ ), crypt depth - 70.4  $\mu\text{m}$  ( $P<0.010$ ). The higher amount of dietary supplementation (2g/kg of feed) increased duodenal crypt depth by 7.02 mm ( $P<0.05$ ) and an ileal villi height by 181.4 mm ( $P<0.025$ ). In conclusion, a mixture of medium chain fatty acids, butyrate, essential oils and *Saccharomyces cerevisiae* can increase broilers productivity and can improve gut health, with optimal effects obtained at the level 1.5 g/kg of feed.

Keywords: broiler chickens, MCFA, butyrate, productivity, histomorphology

[pmP-01]: *Product & Processing* (ID: 100024)

[Brazil]

## **The aging process reduces fat and cholesterol content in chicken meat**

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The aim of this study was to evaluate the influence of the aging process, age and gender of birds on the fat and cholesterol contents in chicken meat. Were used 120 deboned chicken breasts, being 60 from birds slaughtered at 42-day-old and 60 from birds slaughtered with approximately 70-week-old, which 30 from each gender. Samples destined to aging process were individually packed in vacuum and stored in a BOD chamber ( $2^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ ) for three and seven days. Were evaluated fat and cholesterol contents. For statistical analysis a completely randomized design in  $2 \times 2 \times 3$  factorial was used with two ages, two genders and three aging periods, with ten replications. During the aging process there was decrease in the cholesterol content from 25.53% to 21.23%. There was a significant interaction between age and gender for fat and cholesterol contents; and a significant interaction between aging period and gender and between aging period and age, both for fat content. Meat from spent hens showed lower cholesterol (19.45%) than females with 42-days-old (23.04%). Meat from males from both ages showed higher cholesterol (25.01%, on average) than meat from females (21.24%, on average). Meat from cocks showed lower fat (0.28%) than males with 42-days-old (0.73%). Meat from females showed higher fat content (0.95%, on average) than males (0.50%, on average). The fat content decreased due aging by seven days from 0.65% to 0.38%, in meat from males, and from 1.08% to 0.71% in samples from females. In general, disposal birds showed higher fat content than birds with 42-days-old. After seven days the fat content decreased from 0.87% to 0.56% in meat from disposal birds and from 0.69% to 0.53% in meat from birds with 42-days-old. The aging process decreases the fat and cholesterol contents in breast meat from chickens.

**Keywords:** Breast, chemical composition, cock, meat quality, spent hen

[pmP-02]: *Product & Processing* (ID: 100025)  
[Brazil]

## **Chemical composition of aged breast meat from broilers with different lineages**

**Borba, H. (1), Mello, J.L.M. (2), Souza, R.A. (3), Ferrari, F.B. (4), Gianpietro-Ganeco, A. (5), Paschoalin, G.C. (6) and Souza, P.A. (7)**

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The aim of this study was to evaluate the influence of lineage and the aging process on the chemical composition of the breast meat of broilers. Were used 60 Pectoralis major muscle from deboned carcasses, purchased from a commercial slaughterhouse, being 30 from Cobb lineage (fast growth) and 30 from Label Rouge lineage (slow growth), that were slaughtered at 42 and 85 day of age, respectively. The non-aged samples (control group) were frozen to late analysis. Samples destined to aging process were individually packed in vacuum and stored in a BOD chamber ( $2^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ ) for three and seven days, and after were frozen to late chemical composition analysis. Were evaluated crude protein, fat (ether extract), moisture and ash content, according proposed method by Association of Official Analytical Chemists (AOAC). Birds from fast growth lineage showed lower moisture content (71.63%) and higher ashes content (1.74%) than birds from slow growth lineage (73.24% and 1.50%, respectively). There was a significant interaction between aging period and lineage for crude protein and fat contents. It is observed that the meat from broilers of slow growth lineage showed higher crude protein content (21.82%) than the meat from broilers of fast growth lineage (19.70%). There was no difference between studied lineages related to fat content in breast meat. The fat content of samples from two studied lineage were reduced with aging process from 0.93% to 0.60% in broiler's meat from fast growth lineage and from 0.87% to 0.69% in broiler's meat from slow growth lineage. The lineage influences the moisture and crude protein and ash contents in breast meat from broilers. The aging process decreases the fat content in breast meat from broilers.

**Keywords:** Aging, chicken, fat, meat quality, crude protein

[pmP-03]: *Product & Processing* (ID: 100026)

[United Kingdom]

## **Quality assessment of chicken meat using chemical and textural methods.**

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Chicken meat quality is being investigated using Sodium Dodecyl Sulphate-Polyacrylamide Gel Electrophoresis (SDS-PAGE), protease activity and textural analysis. The aim of this research was to develop sample preparation methodology to give a clear, reliable and accurate resolution of protein bands and protease activity. Myofibril proteins were extracted from chicken meat (2g sample), once the purified protein was obtained. The stock protein was frozen at -18 °C prior to the addition of the SDS-PAGE reagent and measurement of this protein concentration by the biuret test. The protein mix was then introduced into the precast gel before electrophoresis. After electrophoresis, the gel was stained with Coomassie blue before the protein bands were viewed. This study achieved clear separation of protein bands which were compared with those of protein standards of known molecular weight and had their identity confirmed by MALDI-TOF machine. This can be applied to determine the degradation of myofibril proteins which include titin, nebulin, desmin, myosin and actin (in both chicken breast and leg meat). Protease activity was measured by incubation with casein followed by TCA precipitation and estimation of soluble peptide using E280. In addition to the SDS-PAGE and protease analysis, the texture of chicken breast and leg was also quantified using a Meullenet-Owens razor shear blades. For texture measurement, breast and leg meat were manually separated from the chicken carcass and deboned. The texture was then quantified using a TA-XTplus texture analyzer with Meullenet-Owens Razor Shear blades (MORS). The use of MORS in this research gave more accurate shear force and shear energy results, was less sample damaging and requires a shorter sample preparation time as compared to the Allo-Kramer shear and Warner-Bratzler test methods.

**Keywords:** Quality, Protein, SDS-PAGE, Texture

[pmP-04]: *Product & Processing* (ID: 100197)

[Poland]

## **Effectiveness of collagen/gelatin enzymatic extraction from chicken cartilage**

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The aim of the study was to evaluate the effectiveness of collagen type II and gelatin extraction from chicken cartilage. Materials used in the experiment consisted of raw chicken sternum cartilage combs. The raw material was characterized by the analyses of the chemical composition and the total content of hydroxyproline (AOAC). Chicken cartilage was submitted to acid-enzymatic treatment (pepsin) to obtain collagen in native form, and to thermal-enzymatic hydrolysis (papain) for collecting gelatin. Effectiveness of the hydrolysis was analyzed for the following levels of applied enzymes (pepsin with a concentration of 50, 100, 200 and 400 mg/g material; papain with 0.1, 0.25, 0.50, 1.0, and 2.0 mg/g cartilage), and for the processing time (24 h and 48 h for pepsin, 10 min - 48 h for papain). The collected results showed that the extraction of collagen type II from chicken cartilage by using only citric acid (pH 2.0) was ineffective (0.22% recovery of collagen), whereas, the acid-enzymatic treatment allowed the 12% to 78% of extraction of collagen in native form. The highest recovery of collagen i.e. 78% was observed after 24 hours of the processing with 400 mg pepsin per one g of raw material. During 48 hours of thermal treatment without added papain approximately 16.5% of gelatin was released from chicken cartilage comb. Whilst, thermal-enzymatic hydrolysis led to complete degradation of the cartilage when more than 1.0 mg/g papain was applied. The recovery of collagen in form of gelatin ranged from 79% to about 100%. It can be concluded that both of the enzymatic methods are highly effective for extraction of native collagen and gelatin from chicken cartilage. Project supported by Wrocław Centre of Biotechnology, programme The Leading National Research Centre (KNOW) for years 2014-2018.

**Keywords:** collagen, gelatin, enzymatic extraction, chicken cartilage

*[pms-01]: Systems (ID: 100050)*

[Italy]

**Carcass yields and meat quality in the Italian chicken breed Milanino****Mosca, F. (1), Kuster, C. (2), Madeddu, M. (3), Stella, S. (4), Zaniboni, L. (5), Colombo, E. (6) and Cerolini, S. (7)**

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Milanino is an Italian composite chicken breed included in a conservation programme started in 2012 (fund from Regione Lombardia, Milan, Italy). The aim of the present work was to assess the slaughter performance and the meat quality of male and female Milanino chickens reared in outdoor pens. Milanino chickens were hatched at the Poultry Unit (University of Milan, Lodi) and reared in controlled environment for 35 days. Then, 120 birds (60 birds/sex) were transferred into outdoor pens providing 5 m<sup>2</sup>/bird. Birds were fed ad libitum a standard commercial diet (20% CP, 4.5% Fat) for growing chickens. Total feed consumption was recorded weekly. On 150 and 180 days of age, 20 birds (10 birds/sex) were slaughtered after 24 h feed withdrawal and body weight was recorded before (BW1) and after (BW2) starvation. Carcass weight (CW) was recorded after removing the feathers, blood and the non-edible viscera; the ready-to-cook carcass weight (RCCW) was recorded after removing also edible viscera and fat. Dressing percentage was calculated for both CW and RCCW on BW2. Samples of breast and thigh meat were collected for chemical analyses. Moisture, ash, total protein and fat content were assessed using AOAC (1995) analytical procedures. Analysis of variance was performed (GLM proc of SAS) and sex, age and sex\*age interaction were considered as sources of variation. The mean dressing percentages for CW and RCCW were 85% and 66% respectively. Meat quality was characterised by high protein (25% and 21% in the breast and thigh respectively) and low fat (0.36% and 2.02% in the breast and thigh respectively) content. The RCCW dressing percentage was significantly higher in males (67%) compared to females (65%). Both CW and RCCW dressing percentages significantly increased with ageing. Meat quality was significantly different between males and females. In general, lower water and higher nutrient contents were found in meat samples collected in females compared to meat samples of males. Results on breast and thigh meat quality in both sexes are discussed.

**Keywords:** Italian chicken breed, carcass yield, meat quality

*[pms-02]: Systems (ID: 100062)***[India]**

## **Evaluation of proximate composition of meat of Guinea Fowl, maintained under different rearing systems in India**

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Globally, consumers prefer Guinea fowl (*Numida meleagris*) meat due to its dark coloured gamey flavoured nature. A biological experiment was conducted to evaluate the proximate composition of meat of Guinea fowls maintained under different rearing systems. A total of 320 numbers of one day old Guinea fowl keets were randomly divided into two groups and raised under two rearing systems namely deep litter and cage with four replicates of 40 chicks each. Standard nutritional and management conditions were followed throughout the experiment from day old to 16 weeks of age. A total of 24 birds comprising of four birds from each system were randomly selected at 12, 14 and 16 weeks of age slaughtered and Guinea fowl breast and thigh meat was subjected for evaluation of proximate composition of meat. Rearing systems exhibited a highly significant ( $p<0.01$ ) influence on proximate composition of Guinea fowl meat. The overall mean per cent moisture, crude protein, ether extract, total ash and gross energy content of Guinea fowl meat were  $70.67\pm 0.31\%$ ,  $27.21\pm 0.21\%$ ,  $1.09\pm 0.11\%$ ,  $0.877\pm 0.15\%$  and  $1651.21\pm 337.05$  kcal/kg respectively. Age of the bird exhibited a highly significant ( $p<0.01$ ) influence on proximate composition of Guinea fowl meat. As the age increased mean per cent moisture decreased and crude protein, ether extract and gross energy contents of Guinea fowl meat were increased. Total ash at 16th (0.881%) and 12th (0.884%) week of age was comparable and higher than 14th week (0.866%). The mean per cent moisture, crude protein, ether extract, total ash and gross energy contents of meat of birds reared under deep litter system at 12, 14 and 16 weeks of age were  $72.15\pm 0.43$ ,  $71.13\pm 0.15$  and  $69.13\pm 0.48\%$ ,  $26.21\pm 0.45$ ,  $26.87\pm 0.21$  and  $28.32\pm 0.4\%$ ,  $0.81\pm 0.13$ ,  $0.85\pm 0.06$  and  $1.33\pm 0.31\%$ ,  $1.308\pm 0.65$ ,  $1.053\pm 0.13$  and  $1.018\pm 0.51\%$  and  $1515.00\pm 757.50$ ,  $1634.25\pm 817.13$  and  $1736.00\pm 868.00$  kcal/kg respectively and the same nutrient contents of meat of cage reared birds were  $71.81\pm 0.2$ ,  $70.84\pm 0.18$   $\pm 18.73$  and  $68.64\pm 0.39\%$ ,  $26.75\pm 0.28$ ,  $26.86\pm 0.28$  and  $28.28\pm 0.42\%$ ,  $0.72\pm 0.04$ ,  $0.99\pm 0.24$  and  $1.87\pm 0.27$  %,  $0.460\pm 0.23$ ,  $0.678\pm 0.34$  and  $0.743\pm 0.37\%$  and  $1593.75\pm 796.88$ ,  $1636.25\pm 818.13$  and  $1792.00\pm 896.00$  kcal/kg respectively. The guinea fowls reared under deep litter system had significantly ( $p<0.01$ ) higher per cent moisture content than cages at 12, 14 and 16 weeks of age. The per cent crude protein, ether extract, total ash and gross energy contents did not differ significantly between different systems. It can be concluded that the meat of guinea fowls reared under both deep litter and cage system had comparable proximate nutrient contents except moisture.

**Keywords:** Guineafowl meat, proximate composition, rearing systems

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[pmS-03]: Systems (ID: 100076)

[Algeria]

## **Hazard analysis in poultry slaughterhouse implemented in Algeria**

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HACCP system became synonymic to sanitary safety of foods at international scale. The hazard analysis is the first step of its application. Our study uses methodology based on the standard ISO 22000 which allows proposing a directory for human hazards, linked to the consumption of fresh oven-ready chicken, their evaluation and the measures for their elimination or at least their reduction to an acceptable level for an industrial slaughterhouse implemented in Algeria. The obtained results from hazard analysis were formalized in the form of a synoptic table including each step of the process and the reasonably predictable hazards. The biological hazards represent the highest risks compared to other hazards. Precautionary measures of control were developed, it is more often about good hygienic practice in the medium staff, or good manufacturing practice, the scalding and the pluming are the most important phases in point of view of contamination, the evisceration and the packaging are requiring a permanent supervision of the staff. Thus the hazard analysis in our implemented approach (HACCP) shows that the main hazards are essentially a pathogenic bacteria (*Salmonella*, *Listeria monocytogenes*, *Escherichia Coli*, *Staphylococcus aureus* and *Clostridium perfringens*), physical hazards (glass breaking) and the chemical hazards (antibiotic residues, cleaning and sanitization products and heavy metals)

Keywords: Quality assurance, HACCP system, Hazard analysis, Poultry slaughterhouse

*[pms-04]: Systems (ID: 100084)*

[China]

**Effect of Lighting Regimen and Nutrient Density on Meat Quality of Yellow-feathered Broilers**

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The aim of the present study was to examine the main and interaction effects of 4 lighting regimes (16L:8D, intermittent lighting (3L:1D, cyclical pattern), decreasing-increasing, and 23L:1D) and 3 dietary nutrient densities (low-, medium, and high-density based on the energy and protein levels) on the meat quality of Beijing-You chickens, a typical yellow-feathered broiler breed. A total number of 1,440 day-old Beijing-You chickens were raised under 23 hours lighting from 0 to 7 days of age (d) to adapt to the research facility. Starting from 8 d, these birds were randomly allocated to 12 treatments (4 light regimens  $\times$  3 nutrient densities), with 120 birds (60 males and 60 females) per treatment. At 90 d of age, 16 birds from each treatment were slaughtered for detecting meat quality including pH. The results showed that there was no interactions effect of lighting regimen and nutrient densities on meat quality traits. As for females, the meat lightness ( $L^*$ ) of 16L:8D group was significantly higher than that of variable lighting groups ( $P<0.05$ ). The pH (24 hours after slaughter) of 16L: 8D group was significantly lower than that of variable lighting groups ( $P<0.05$ ). The intramuscular fat content of 16L: 8D group was significantly inferior to that of intermittent lighting group ( $P<0.05$ ). The tenderness of high nutrient level was significantly better than that of low nutrient level ( $P<0.05$ ). As for males, the redness ( $a^*$ ) of continuous lighting group is highly significantly lower than that of intermittent lighting group and 16L: 8D group ( $P<0.01$ ). The  $a^*$  of low nutrient level was significantly lower than that of high nutrient level ( $P<0.01$ ). Based on these observations, the middle nutrient level, and intermittent (3L: 1D) and variable lighting was appropriate for the meat quality of yellow-feathered broiler.

Keywords: Beijing-You, lighting regimen, nutrient density, meat quality

*[pmS-05]: Systems (ID: 100091)***[Indonesia]****Effect of early feeding time to physiological parameters and production performance of Broiler Chickens kept at normal temperature****heryandi, Y. (1), Abbas, M.H. (2), Agustini, M. (3), Esa, W.A. (4)**

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Variations in environmental temperature affect nutrient intake, physiological traits and growth of broiler chickens. Early feeding stimulates, while delayed feeding deteriorates physiological organs development and metabolic activity. The purpose of this study was to determine the effect of early feeding time at normal temperature on physiological parameters and performance of broiler chickens. A total of 200 day-old chicks of Cobb strain were assigned into 5 treatments in completely randomized design. Each treatment consisted of four replicates accommodating ten broiler chickens per replications. The experimental feeding time were 1 hour after hatching, 24 hours; 48 hours, 72 hours and 96 hours after hatching. One chick of each experimental unit was sacrificed and dissected before feeding and residual egg yolk and visceral organs were weighted. The body weight was measured per experimental units before and after the experiment every week. The data were analysed by using ANOVA. The time of feeding significantly influenced egg yolk and visceral organ weight of broiler chickens. The presence of egg yolk significantly reduced along with increased age of the first time of feeding ( $P < .01$ ) on the contrary to visceral organ weight ( $P < .01$ ). Results indicated that early time of feeding increased significantly to ration consumption, energy and protein intake, efficiency of using protein, feed conversion, body weight, percentage of fat abdomen and income over feed cost ( $P < .01$ ) although did not differ significantly to carcass percentage ( $P > .05$ )

Keywords: DOC, feeding, yolk, performance, visceral

[pms-06]: Systems (ID: 100116)

[Brazil]

### **The organic broiler lineage affects the color of the Pectoralis major meat**

**Souza, R.A. (1), Borba, H. (2), Mello, J. L. M. (3), Pizzolante, C. C. (4), Souza, P. A. (5), Ferrari, F. B. (6) and Paschoalin, G. C. (7)**

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It is estimated that the organic production in Brazil is 300 thousand tons/ year, which moves a market of US\$ 200 million/year. Most of the Brazilian organic production (80%) is in the South and Southeast. Around 85% of production is exported, mainly to Europe, USA and Japan. The rest (15%) is distributed domestically. Organic culture is beyond the concern with productive results and birds welfare; it adds value to the product whereas exists, too, the concern with the environment and people that work on it; the production seeks to produce healthy food with high nutritional value and attractive organoleptic characteristics. Bearing that in mind, the purpose of this study was to evaluate possible differences of meat colour parameters, L\* (luminosity), a\* (red intensity), b\* (yellow intensity), H\* (hue angle) and O/M (oxymyoglobin/metmyoglobin ratio) on the surface of the meat, between broilers of two different strains. The strains used were Ross AP95 and Hubbard, both submitted to a basal feeding in an indoor chicken barn. It was used the Pectoralis major muscle from the broilers deboned carcasses with 42 days of age with average weight 2.4 kg (two point four kilograms) and obtained from a commercial slaughterhouse, the both lineages. In each breast, the colour was measured with a Minolta CR-400 colorimeter (CIELAB). It was taken three repetitions from each. The hue angle (H\*) was determined by the formula  $H^* = \tan^{-1}(b^*/a^*)$  and the by O/M (oxymyoglobin/metmyoglobin) by the ratio between a\* and b\* ( $O/M = a^*/b^*$ ). In this case the Ross lineage presented higher values for red intensity (b\*;  $p=0.012$ ) and oxymyoglobin/metmyoglobin (O/M;  $p=0.0019$ ) than the Hubbard lineages. We conclude that these two lineages/strains submitted to the same conditions of breeding affects the colour of the meat.

Keywords: Hubbard, hue angle, oxymyoglobin, quality, Ross

*[pmS-07]: Systems (ID: 100118)***[Netherlands]****Improving animal welfare: CAS stunning before tilting****Veerkamp, W. (1), Bergsma, J. (2), Heemskerk, W. (3) and Hupkes, H. (4)**

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In Europe, live birds are mainly transported in drawer systems or containers. Until recently, such containers were emptied by tilting, so live birds glided onto a conveyor belt. From there, the birds were either hung, and stunned in an electrical water bath, or stunned by CAS (avoiding live hanging). In both cases, the drawback of unloading live birds remained. Pre-slaughter stress can be reduced by CAS-stunning birds in their transport containers. Dir. 2007/43/CE and by Reg (CE) 1099/2009 demand that avoidable stress must be avoided. Recently, MeynFPT developed a multi stage CO<sub>2</sub> CAS system, stunning birds in their container by recipe 1 (6 minutes) or recipe 2 (4 minutes). Unconsciousness is achieved by stepwise increase of CO<sub>2</sub> in the first stage; unconsciousness becomes irreversible by a stepwise increase of CO<sub>2</sub> in the second stage. Wageningen UR Livestock Research performed an independent scientific validation by observing behavior and recording ECG and EEG and checking CO<sub>2</sub> concentration, and found (recipe 1). Brain activity: Transitional EEG (slow wave activity) after 36 s. (av.); suppressed EEG (loss of  $\alpha$  and  $\beta$  waves) after 60 s. (av.). Heart activity: ECG showed bradycardia (40% slower bpm) after 22 s (av.), strong suppression (-75% slower bpm + rhythmic disorders) after 4:46 (av.). Bird behavior: gasping started at 18 s., LOP at 93 s. and convulsions at 170s. Based on the observations, they concluded: i) Indeed all birds become unconscious in the first phase (CO<sub>2</sub> < 40%) and become irreversibly stunned in the second phase; ii) Required CO<sub>2</sub> concentrations are reached rapidly and reliably; iii) During the first stage, birds may experience some discomfort, which is clearly less than the discomfort caused by live tilting, and by e.g. live handling. So, scientific research confirmed that avoiding live tilting reduces stress, thereby answering to public concern and to current legislation.

Keywords: CAS, before, tilting.

*[pms-08]: Systems (ID: 100141)***[Brazil]****The rearing system influences the color of the Pectoralis major broiler meat.****Borba, H. (1), Giampietro-Ganeco, A. (2), Souza, R. A. (3), Mello, J. L. M. (4), Demarchi, C. (5), Souza, P. A. (6) and Vieira, L. D. C. (7)**

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The purpose objective was to compare possible differences of meat color parameters, L\* (luminosity), a\* (red intensity), b\* (yellow intensity), H\* (hue angle) and O/M (oxymyoglobin/metmyoglobin) on the surface of Pectoralis major muscle from birds of different breeding systems. In each breast, the color was measured with a Minolta CR-400 colorimeter (CIELAB) in three repetitions. The hue angle (H\*) was determined by the formula  $H^* = \tan^{-1}(b^*/a^*)$  and the by O/M (oxymyoglobin/metmyoglobin) by the ratio between a\* and b\* ( $O/M = a^*/b^*$ ). 32 male birds, from four different rearing systems, were obtained from a commercial slaughter house: conventional (cobb strain), organic (cobb strain), colonial (Label Rouge strain, peeled neck) and antibiotic-free (strain cobb); these were reared in grazing area with slow density and with certified organic vegetables ingredients on the feeding and without chemotherapeutic products. The birds from the colonial system were slaughtered with 85 days. Antibiotic-free birds were reared in a system without use of antibiotics, anticoccidials, antibiotic performance and chemotherapy enhancers and without animal ingredients in diet. These were slaughtered with 45 days of age. Conventional ones were slaughtered with 42 days. It is observed that the L\* value was significantly lower in broilers reared in AF system compared to others; for red intensity (a\*), conventional had lower and consequently lower ratio of oxymyoglobin/metmyoglobin (O / M); however showed higher intensity of yellow (b\*) causing superior hue angle (H\*). The results obtained showed that rearing systems influence all the color parameters analyzed.

**Keywords:** Antibiotic-free, Colonial, Conventional, organic

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## **Selected bio-substances from eggs and possibilities of their use in the prophylaxis of lifestyle diseases**

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Food safety, nutrition, lifestyle determine the state of health of the population. The current health policy is mainly oriented to the treatment, with limited action to prevent negligence or avoid poor nutrition. Moreover, the lack of proper application for natural sources of bio-substances leads to increase in lifestyle diseases, including those diet-related. This strategy elicits high cost of treatment, affects national budget resources contributing to the frustration of society. The civilization diseases mainly corresponded to neurodegenerative diseases affecting human brain (dementias), heart and circulatory abnormalities (hypertension) in addition to cancer, diabetes, obesity and osteoporosis.

The modern consumer is aware of selected food, which increases its compositional value, its functional characteristics, and above all of the potential health impacts of the product. Pro-healthy food allows for the development of functional foods market addressed not only to people suffering from various diseases, but also to consumers who want to eat food that provides them some welfare. Society is looking for natural nutraceuticals and biomedical preparations for prevention of lifestyle diseases instead of using pharmacological treatment. Among the natural sources of biomedical and nutraceutical formulations, eggs deserve special attention, as eggs are rich in all essential biological components able to create life.

Nature does not know any other food product being as perfect as the egg. When a normally laid and fertilized egg is provided with energy in the form of heat, it turns into a living organism, which continues growing and developing. Thus, all substances necessary for its creation are contained in the egg. This fact indicates high biological value of eggs and confirms the excellence of their components. The biological activity of a majority of substances contained in the egg matter is related to their anti-bacterial, anti-viral, anti-fungal and anti-cancer properties as well as immunogenic properties. Among the multitude of eggs bioactive components are particularly important: ovocystatin, lysozyme and immunoglobulin, Yolkin, phospholipids, bioactive peptides formed in the process of enzymatic hydrolysis. The novel splitting of egg components may result in wide application for medical prophylaxis as nutraceuticals and dietary supplements. Bioactive substances derived from eggs require innovative and integrated isolation technology including the use of membrane technology, supercritical extraction technology, nanotechnology, enzymatic processes, etc.

Details of the technology to obtain bio-substances from eggs, as well as putative use in biomedical applications, especially in nutritherapy are included in the text and presentation.

Keywords: egg splitting, biological function, human health

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