Impact of temperature during the storage of table eggs on the viability of Salmonella

Salmonellosis is a foodborne infection of major economic importance. Contamination of table eggs with Salmonella, especially *Salmonella enterica* serovar Enteritidis, is a major health concern worldwide. Recently, *S. enterica* serovar Virchow has emerged as a major pathogen in Israel, where it is among the 3 most prevalent serovars found in poultry and the second most prevalent serovar isolated from individuals with salmonellosis. Although there is ample knowledge regarding the role of *S. enterica* serovar Enteritidis in contamination of eggs, virtually nothing is known regarding the possible association of *S. enterica* serovar Virchow with table eggs. Therefore, the scientists at Kimron Veterinary Institute, Dagan, Israel examined the capability of serovar Virchow to contaminate chicken eggs. Commercial table eggs were inoculated independently with serovar Enteritidis and with serovar Virchow cells at a concentration of 10(5) cfu/egg, either on the shell surface or by injection into the yolk. The numbers of live Salmonella cells on the shell and within the egg were determined at various time points. At both low (6ºC) and room temperatures (25ºC), *S. enterica* serovar Virchow was not detected on the eggshell after 2 weeks, whereas *S. enterica* serovar Enteritidis could be detected only sporadically at 25ºC. In contrast, within the eggs, *S. enterica* serovar Virchow survived for up to 6 weeks at 6ºC, and it multiplied up to 10(9) cfu/ml of egg content from 2 to 8 weeks postinoculation at 25ºC. In comparison, *S. enterica* serovar Enteritidis survived within the eggs up to 8 weeks at 6ºC and at 25ºC. These results suggest that in cold storage, serovar Virchow is able to persist for long periods (6 weeks), and at room temperature, these bacteria can multiply within eggs and reach high concentrations. Therefore, eggs might be considered potential vectors for transmitting *S. enterica* serovar Virchow into the food chain [Lublin A and Sela S, The impact of temperature during the storage of table eggs on the viability of *Salmonella enterica* serovars Enteritidis and Virchow in the Eggs, *Poult Sci,* 2008, **87**(11), 2208-2214].

Storage of eggs in water affects internal egg quality, embryonic development and hatchling quality

The scientists at Wageningen University, the Netherlands investigated effects of storage of eggs in water on internal egg quality, embryonic development and hatchling quality. In experiment 1, unfertilized eggs were stored for 4 to 14 days in water (W) or air (control; C). In experiment 2, fertilized eggs were stored for 3 to 14 days in water or air and thereafter incubated for 9 days. In experiment 3, eggs were stored for 16 days in water or air and incubated for 1 to 9 days thereafter. In experiment 4, eggs were stored for 14 days in water or air, incubated thereafter, and hatching time and hatchling quality were determined. In all experiments, egg weight loss in the C treatment increased with duration of storage, whereas W eggs gained weight during storage. Albumen and yolk *p*H after storage and during incubation were greater in the C eggs compared with the W eggs. In experiment 3, embryonic development at day 4 and 9 was advanced in the W eggs compared with the C eggs. In experiment 4, the number of viable embryonic cells after storage and after trypsinization was lower in the C treatment than in the W treatment (30,188 vs. 69,618; $P<0.001$). Hatching time was postponed in the W treatment compared with the C treatment (501 vs. 495 h; $P<0.05$). Hatchling length was greater in the C treatment (19.7 vs. 20.3 cm; $P=0.01$), and residual yolk was less in the C treatment than in the W treatment (4.9 vs. 8.3 g; $P<0.001$). Thus it is concluded that storage of eggs in water for a prolonged period positively affects internal egg characteristics and early embryonic development, but negatively affects hatchling quality. The reason for the loss of the head start with progressing incubation needs further investigation [van den Brand H, Reijrink IA, Hoekstra LA and Kemp B, Storage of eggs in water affects internal egg quality, embryonic development, and hatchling quality, *Poult Sci*, 2008, **87**(11), 2350-2357].

Physical-mechanical modifications of eggs for food-processing during storage

Physical-mechanical properties of egg constituents and their modifications during storage and poststorage greatly influence the efficiency of food processing, such as the separation of white and yolk by mechanical shelling. Thick albumen height, Haugh unit, yolk index and vitelline membrane-yolk system strength of eggs from Hy-Line White and Lohmann Brown hens were analyzed by the scientists at University of Bologna, Italy during 7 months of storage at 0 degrees C performing 3 post-storage treatments: i) immediately after refrigeration, T1; ii) after a further 6h at 18°C after refrigeration, T2; and iii) after a week at 18°C after refrigeration, T3. For all qualitative parameters considered, this last poststorage treatment appeared to be the factor that produced the highest decrements; with respect to the first poststorage treatment, a further week at 18°C after refrigeration can involve mean decreases of about 19, 14, 14 and 16% in thick albumen height, Haugh unit, yolk index and vitelline membrane-yolk system strength (in terms of maximum force), respectively. During about 7 months of storage at 0 degrees C, the latter parameter decreases, on average, by 10%. Increasing the storage time, physical-mechanical behaviour was sometimes divergent from the observed trends [Berardinelli A, Ragni L, Giunchi A, Gradari P and Guarnieri A, Physical-mechanical modifications of eggs for food-processing during storage, *Poult Sci,* 2008, **87**(10), 2117-2125].

Egg quality and yolk polyunsaturated fatty acid status in relation to broiler breeder hen age and dietary n-3 oils

The effects of broiler breeder hen age and dietary n-3 oils on yolk n-3 and n-6 fatty acid composition, egg quality, fertility and hatchability were investigated by the scientists at Department of Animal Sciences, Oregon State University, Corvallis, USA. A total of 2,200 eggs were collected from Cobb breeder hens fed diets containing 1.75% fish oil + 1.75% yellow grease (low n-3) or 3.5% fish oil (high n-3). Eggs obtained from a commercial source were used as the control for n-6 and n-3 fatty acid composition and hatchability studies. A significant decrease in egg weight, yolk weight, shell weight and yolk colour was observed for high n-3 when compared with low n-3 eggs ($P<0.05$). No difference was noted in egg total fat content due to dietary treatments. However, egg fat was highest at 42 week for high and low n-3 eggs when compared with other weeks ($P< 0.05$). Total n-3 fatty acids, docosahexaenoic acid (DHA, 22:6 n-3), and the DHA: arachidonic acid (AA, 20:4 n-6) ratios were higher in high n-3 eggs when compared with low n-3 eggs. The incorporation of DHA was lowest at week 26 and highest at week 38 for low and high n-3 eggs ($P<0.05$). Low n-3 and high n-3 eggs at the oldest age had the highest level of AA ($P<0.05$). A positive correlation between hen age and egg yolk AA content was observed. The r(2) values for AA in low n-3 and high n-3 eggs were 0.91 and 0.90, respectively ($P<0.05$). The total content of long-chain (>18-C) n-6 PUFA (AA+ 22:4 n-6+22:5 n-6) constituted over 0.3g per commercial egg when compared with 0.09 and 0.07g in low and high n-3 eggs, respectively. The content of DHA in commercial eggs was negligible (<0.5%) when compared with low and high n-3 ($P<0.05$). The overall fertility was 98.6 and 97.4% and hatchability of fertile eggs was 80 and 83.8% for low and high n-3 eggs, respectively ($P>0.05$). The overall fertility was 96% and hatchability of fertile eggs was 80% for commercial eggs [Cherian G, Egg quality and yolk polyunsaturated fatty acid status in relation to broiler breeder hen age and dietary n-3 oils, *Poult Sci,* 2008, **87**(6), 1131-1137].

Development and validation of a mathematical model to describe the growth of *Pseudomonas* spp. in raw poultry stored under aerobic conditions

Poultry meat spoils quickly unless it is processed, stored and distributed under refrigerated conditions. The microbial spoilage rate is predominantly controlled by temperature and the spoilage flora of refrigerated, aerobically-stored poultry meat is generally dominated by *Pseudomonas* spp. Therefore, researchers at USA conducted studies to develop and validate a mathematical model that predicts the growth of *Pseudomonas* in raw poultry stored under aerobic conditions over a variety of temperatures.

Thirty-seven *Pseudomonas* growth rates were extracted from 6 previously published studies. Objectives, methods and data presentation formats varied widely among the studies, but all the studies used either naturally contaminated meat or poultry or *Pseudomonas* isolated from meat or poultry grown in laboratory media. These extracted growth rates were used to develop a model relating growth rate of *Pseudomonas* to storage or incubation temperature. A square-root equation was used to model the data. Model predictions were then compared to 20 *Pseudomonas* and 20 total aerobes growth rate measurements collected in the laboratory. The growth rates were derived from more than 600 bacterial concentration measurements on raw poultry at 10 temperatures ranging from 0 to 25°C.

The experimental data for *Pseudomonas* showed a 4.8% discrepancy with the predictions and a bias of +3.6%. Per cent discrepancies show close agreement between model predictions and observations, and the positive bias factor demonstrates that the proposed model over-predicts growth rate, thus, can be considered fail-safe. Both *Pseudomonas* spp. as well as total aerobes may be considered good indicators of poultry spoilage. A properly constructed and validated model for *Pseudomonas* growth under aerobic conditions can provide a fast and cost-effective alternative to traditional microbiological techniques to estimate the effects of storage temperature on product shelf-life. The model developed here may be used to determine the effect of both initial *Pseudomonas* concentration and storage temperature on shelf-life of poultry meat under aerobic storage conditions over temperatures from 0 to 25°C [Dominguez Silvia A and Schaffner Donald W, Development and validation of a mathematical model to describe the growth of *Pseudomonas* spp. in raw poultry stored under aerobic conditions, *Int J Food Microbiol*, 2007, **120**(3), 287-295].

Rosemary leaves as a dietary supplement for growth in broiler chickens

A study was conducted by researchers of Egypt to investigate the use of Rosemary leaves meal (RLM) as a natural growth promoter in broiler diets on bird performance and immunity. RLM was added in either grower (7-28 days) or finisher (29-49 days) diets at three concentrations (0.5, 1.0 and 2.0%). A total of 200 one-day old unsexed Arbor Acres chicks were assigned equally into four treatment groups, with five replicates of 10 chicks each. Chemical analysis of RLM showed a CF content of 19.4% of which 15.89% was present as cellulose. The essential oil of RLM ranged between 1.4-1.6% and the main active components were camphor (11-16%), alpha pinene (15-20%) and cineole (30-35%) which has a high degree of inhibition against many bacteria and fungi. Compared to control, chicks fed 0.5 % RLM exhibited higher body weights, greater weight gain and better feed conversion during the experimental period as well as better physical properties of the chicken meat. Moreover, 0.5% dietary rosemary increased plasma total protein, albumin and globulin while decreasing glucose, total lipids and cholesterol content. RLM additions did not affect enzymatic activity

related to liver and kidney functions. RLM stimulated thyroid function, as evidenced by increased plasma levels of T3, T4 compared to controls. Antibody production against sheep red blood cells was improved and the percentage of the lymphoid organs was increased compared to controls. Increasing the dietary level of RLM more than 0.5% lowered growth and the digestibility of most nutrients. Thus, low levels of dietary RLM could be safely used in broiler diets to promote growth and to impart healthful constituents to the consumer [Ghazalah AA and Ali AM, Rosemary leaves as a dietary supplement for growth in broiler chickens, *Int J Poultry Sci*, 2008, **7**(3), 234-239].

Effect of Anise and Rosemary on broiler performance

A study was conducted by researchers at Iraq to explore the usage of different level of Anise and Rosemary in broiler nutrition as a natural growth promotion. Different levels were added to a standard diet, to determine its effect on the daily feed intake, daily live weight and feed conversion ratio compared to a control group. Two hundred fifty day-old broilers (Arbor Acre) were divided into five equal groups as follows, Control group (no addition of Anise and Rosemary), Anise 0.5%, Anise 1%, Rosemary 0.5% and Rosemary 1%. The experiment carried out in 42 days. The feed intake was significantly ($P<0.05$) different between the groups. The highest was at Anise 1% group and the highest daily live weight gain observed in the same group Anise 1% (63.34g) followed by Anise 0.5% group (59.49g), Rosemary 1% group (59.30g), Rosemary 0.5% group (56.08g) and control group (50.99g). The results showed that Anise 1% and Rosemary 1% could be considered as a potential growth promoter for poultry [Ghalib Alwan Mohammed Al - Kassie, The effect of Anise and Rosemary on broiler performance, *Int J Poultry Sci*, 2008, **7**(3), 243-245].

Effect of dietary Zinc and Niacin on laying hens performance and egg quality

The experiment conducted at Egypt was designed to evaluate the effect of supplemented zinc (Zn) and niacin (Nia) on laying hen performance, egg quality, nutrient digestibilities and relative economical efficiency from 28-43 weeks of age. Bovans White Laying hens fed diets supplemented with four different levels of Zn (70, 105, 140 and 175 mg/kg diet) in combination with four different levels of Nia (30, 150, 300, 450 mg/kg diet) in a factorial arrangement design. The diets which contained on 70 mg Zn/kg and 30 mg Nia/kg considered as a control. The results indicated that supplemented Zn and Nia increased the egg production significantly ($P\leq0.05$) compared with the control group. The best feed conversion ratio was observed when diet supplemented with Zn and Nia at 175 and 30 or 175 and 450 mg/kg, respectively. Egg weight did not improve by supplementing Zn and Nia. Supplemented Zn at 105 mg/kg recorded the best serum total immunoglobulin titres (STIT), while, supplemented Nia at 300 mg/kg gave the best STIT. Supplemented Zn and Nia had significant effect on egg shell thickness, blood haemoglobin and nutrient digestibilities especially improving crude protein digestibility linearly parallel with dietary Zn levels increased. Supplemented Zn at level of 105 mg/kg with 30 mg Nia/kg or 175 mg Zn/kg with 30 or 450 mg Nia/kg gave the highest economical efficiency. Feeding laying hen on diet containing 105 mg Zn and 30 mg Nia/kg resulted in the best performance, egg quality and economical efficiency [El-Husseiny OM, Abd-Elsamee MO, Omara II and Fouad AM, Effect of dietary Zinc and Niacin on laying hens performance and egg quality, *Int J Poultry Sci*, 2008, **7**(8), 757-764].

Poultry

Production of Omega-3 fatty acid enriched eggs

Researchers at USA have previously reported that pearl millet (PM) could substitute corn and reduce the amount of flaxseed (8%, FS) needed to produce omega-3 enriched eggs in a 6 week trial, but reduced yolk pigmentation. In this study they evaluated egg fatty acid (FA) profile, yolk pigmentation, laying performance and liver integrity in a 12 week experiment using PM-based diets with lower levels of FS (4, 6 and 8%) and natural pigments (PG, 0.1 and 0.2%) in a factorial arrangement of treatments (six cage replicates per treatment). Diets were formulated to be isocaloric and isonitrogenous and to meet or exceed NRC requirements. Egg number and egg mass produced were measured and recorded on a daily basis, whereas BW and feed consumption measurements were recorded every two weeks. At the end of each two week period, three eggs were collected from each cage to measure egg trait parameters and then yolks were separated, pooled and lyophilized for FA determination by Gas Chromatography. At the end of the experiment, all the hens were euthanized to determine liver integrity. Egg traits and flock performance parameters, were not different among treatments, except in week 8, 10 and 12, when birds fed PM-based diets including 8% FS produced smaller ($P < 0.05$) eggs than hens fed 4% FS. The inclusion of the PG at 0.1% restored yolk pigmentation to marketable levels (above 7 on the Roche® color fan scale). In summary, birds fed a diet containing PM as the sole grain source and 6% FS, consistently produced eggs with more than 350 mg/egg of n-3 FA, which is the lower standard to market eggs as "omega-3 enriched", whereas hens fed the diet containing 8% FS produced eggs with about 500 mg/kg of n-3 FA. Liver integrity was not affected by dietary treatment. Thus, PM based diets with levels as low as 6% of FS and low levels of natural PG (0.1%) can be used to produce n-3 FA enriched eggs, preserving egg quality and restoring yolk colour, and maintaining hen health and productive performance [Amini K and Ruiz-Feria CA, Production of Omega-3 fatty acid enriched eggs using pearl millet grain, low levels of Flaxseed and natural pigments, *Int J Poultry Sci*, 2008, **7**(8), 765-772].

Pulp/Paper

Fungal treatment of sugarcane straw for organosolv pulping

The scientists at Engineering College of Lorena, Brazil and Faculty of Chemical Engineering, Colombia reported the effect of fungal pretreatment of sugarcane straw in the performance of the treated pulps. Fermentation time, fungal mycelium load and pretreatment scale were studied in the fungal treatment, and the best conditions were 15 days with 250mg/kg fungal mycelium per straw weight causing high lignin decomposition. At the largest scale tested (50g straw) lignin degradation exceeded cellulose degradation by 2.4-fold. Acetosolv pulping was carried out in a tank reactor at 120°C. The pulping kinetics showed that for biopulps the final lignin content was around 7.5% with a reduction of 40% in the pulping time to reach 12.5% pulp lignin, besides the factorial design showed that the biological pretreatment had a positive effect on the acetic acid reduction (21.5wt%) during pulping process [Saad MBW, Oliveira LRM, Cândido RG, Quintana G, Rocha GJM and Gonçalves AR, Preliminary studies on fungal treatment of sugarcane straw for organosolv pulping, *Enzyme Microb Technol*, 2008, **43**(2), 220-225].