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PhD Dissertation abstract:

„RESEARCHES CONCERNING THE IMPROVEMENT POSSIBILITIES OF THE CHICKEN EGGSHELL QUALITY THROUGH FEEDING”

Author: Drd. Ing. Cristina Gabriela ŞESTALIUC (Married RADU-RUSU)

Scientific leadership: Prof. Dr. Ioan Mircea POP

The egg was always considered as a basis aliment, with an excellent nutritional value for any human consumer. It is one of the highly used aliment. Its composition, considered to be especially stabile and not affected by husbandry and feeding condition, could be nevertheless influenced, being able to be enriched with some nutrients highly required by human nutrition: essential fatty acids (EFA), antioxidants and vitamins.

The min egg purpose is to provide the whole amount of nutritional supplies to the chicken formation and development. The role itself exceptionally explains the inner nutritional quality of this aliment. The egg is poor in energy but rich in exactly balanced proteins. Consequently, it could be considered that the biological value of the proteins in egg is slightly higher to those in the maternal milk, especially when this aliment was used to the suckling infant. Therefore, the egg was considered as a reference and ideal aliment by the World Health Organisation experts.

Eggshell represents a natural physical barrier which denies any penetrations of microbial origin. Meantime, the shell provides the normal development of the future day old chicken, through the gaseous exchanges it allows. Consequently, it contributes to the preservation of the egg inner quality during storage. However, the existence of the pathogen flora on the shell will finally lead, if any shell unconformity (cracks and so on) occurs, to the contamination of the inner content, thus to the increasing of the foodborn infections infestation and development. Even if the shell is the only

not edible egg part, its integrity influences the inner egg integrity and safety as food. This fact justifies all the researches that have been run in order to improve its quality.

During last decades, multiple trials of nutritional, genetic or technological kind have been done in order to improve shell resistance, to cut of any risks of foodborn infections or to alleviate the involved economic losses.

All the experiments tried to put away those different reasons that could negatively affect and originate eggshell unconformities. Despite this, the worldwide incidence of the declassed eggs keeps at an 8% level. Thus, the eggshell improvement involves high economic, sanitary and biological interests.

The study on the scientific references revealed data related to hen egg structure, composition or to its formation physiology and some data concerning the way that feeding could influence several parameters of the consumption eggs: size, eggshell, content of fatty acids, cholesterol, vitamins, pigments, oligoelements and its sensorial features, as well.

Nutritional factors could be optimised, in order to reduce the influence of other factors on the shell quality decreasing, such as: fowl age, inappropriate technological conditions during consumption eggs production, manipulation and storage.

Considering these aspects, the goal of the doctoral dissertation was to assess the effects produced by certain feed additives on the production performance achieved by the laying hens during the laying ending and especially the assessment of those results concerning shell quality.

The researches have been organized during two experimental series, each of them lasting 4 weeks, the biological material being accommodated and reared within the Animal Science Experimental Farm in Iasi city. ISA Brown hens (aged 57-60 weeks old) have been used during all experiments, allocated in homogenous groups, considering fowl age, body weight, health status and husbandry features. Each experimental group comprised 30 laying hens.

The feed additives used during the original researches consisted in: ascorbic acid (250 mg/kg feed), sodium bicarbonate (1%), prebiotics – mananoligosacharids kind (BioMos 0,1%), mycotoxin binder (Mycosorb 0.2%), prebiotic – acidifiant type (Biotronic – Se Forte 0.3%) and a blend of probiotic, prebiotic and botanicals (IMBO 0.1%).

The parameters studied during the experiences referred to: *production* parameters (body weight dynamics, eggs yield and laying intensity, feed intake and feed conversion rate), *egg quality parameters* (weight of the eggs and of their compounds, shape index, volume, specific gravity, Haugh index) and shell quality parameters (surface, shell index, thickness, breaking strength, incidence of the eggs presenting anomalies.

Consequently to the original researches run across both experimental series, issued a series of conclusions, shortly listed below:

➳ During the **Experimental series I,** the results achieved through the **ascorbic acid (**250 mg/kg feed) and **sodium bicarbonate** (1%) usage, in the laying hens feeding at the end of the production period, under thermal stress conditions, are listed below:

1. *Production indexes* have been influenced by the experimental factors. Thus, the usage of 250 mg/kg feed of ascorbic acid (L1 group) and of 1% sodium bicarbonate (L2 group) in feed, under the previously specified conditions, generated several improvements of the studied factors:

- *fowl body weight* (kg) decreased with 2.56%, compared to the initial value, at the control group, while, at the L1 and L2 groups, it increased with 5,5% and 7%;
- *laying intensity* (%) was 4.1% improved in L1 group and 4.7% better in L2 group;
- *average daily egg mass yield* (g/hen/day) was 8% improved in the first experimental group, respectively with 11.7% at the second one;
- *feed conversion ratio* decreased at those groups fed with supplemented recipe (-6.6% in L1 group and -7.5% in L2 group).

2. Generally speaking, the experimental factors induced stimulating effects on the *average eggs weight*, and of their *components weight*. The results achieved in the experimental groups, compared to the control one are listed below:

- *eggs weight* (g) was 0.9% (L1)...1.8% (L2) higher, the differences being statistically significant;
- *yolk weight* (g) progressively increased during the experiments, existing +1.3% percentage differences, between the experimental and control groups;
- *shell weight* (g) was also improved, with best results after sodium bicarbonate usage, under thermal stress conditions; thus, in L1 group, it was observed a 3.9% higher value, compared to the control group, respectively a 7.3% better value in the L2 group. The data concerning shell weight led to the calculation of certain values for shell quota in whole egg formation: 9.3% in control group, 9.5% in L1 group and 9.8% in the L2 one.

3. Some *morphological and physical eggs quality indexes* were also modified (shape index, volume, specific gravity, Haugh index), resulting higher values in the experimental groups, as compared to those achieved in the control group, even if not statistical significance occured:

- *shape index* was comprised between 74.3% (L2 group) and 75.4% (control group), the values being slightly higher than the average specified for the eggs produced by the studied species (73-74%);
- *volume (cm^3)* of the eggs oscillated straight proportional with weight dynamics, being measured within the 58.64cm^3 and 59.75 cm^3 in experimental groups 1 and 2, compared to 57,04 cm^3 (control group);
- *specific gravity* was modified in accordance with the values for shell participation/whole egg, existing an 1.078 (control) … 1.082 (L2) variation interval;

- the average values computed for the *Haugh index* were situated at the upper limit (87.6-87.9 H.U.) of the interval specified by the scientific references (75.4-89.5 H.U.).

4. *Egg quality* results are shown below:

- improved values for the *shell thickness (mm)* have been measured at the experimental groups, as compared to the control group. Thus, 4.6% to 6 % higher values were observed at the groups received feed supplemented with ascorbic acid and sodium bicarbonate. The measured values (0.353mm … 0,375mm) have been comprised within the interval specified by the references;
- *Eggshell breaking strength (mg/cm^2)* strongly depended on the shell thickness, thus, during the studied period (57-60 weeks flock age), the average values were comprised between 81.13 mg/cm^2 in control group and 86.14 mg/cm^2 at the hens fed with a supplement of 1% sodium bicarbonate. The differences of +4.1…+6.2%, calculated between the experimental groups an the control one, proved to be statistically distinguished significant;
- Improvement of shell thickness and strength induced the decreasing of the proportion of eggs with unconformities, from the whole egg production, respectively -28.4% (the group fed with + 250 mg ascorbic acid/kg, respectively -40.1% at the fowl received + 1% sodium bicarbonate in feed.

5. The computation of the *economical efficiency* after ascorbic acid sodium bicarbonate usage in laying hens feeding, under thermal stress conditions, revealed a slightly revenue improvement in the experimental groups, compared to the control one: +1.02% for the L1 group (250mg ascorbic acid/kg feed) and +0.14% for the L2 group (1% $NaHCO_3$).

The beneficial results achieved could be mainly due to the sodium bicarbonate feed supplementation (+1%), knowing its physiological significance of this chemical compound on the uterine shell calcification processes, providing thus enough bicarbonate ions amounts required by the buffering of the protons delivered during shell synthesis.

Experimental series II:

a) usage of a prebiotic (BioMos +0.1%) and of a mycotoxins binder (Mycosorb +0.2%) in the laying hens feeding, during the end of the production period:

1. The *production indexes* have not been significantly influenced by the experimental factors action. However, the values observed at the experimental treatments have been better than those from the control one, as listed below:

- the *body weight* (kg) of the hens preserved relatively constant in the control group, during the 4 experimental weeks, while, for the other groups, it increased with 3.04% (A1 +0.1% BioMos), respectively with 1% (A2 + 0.2%Mycosorb);
- *laying intensity* (%) increased with almost 2.2% in A1 group or with 1.4% in A2;

- the average daily *egg mass production* (g/hen/day) has been also improved, with 1.7% in the first experimental series (prebiotic add), respectively with 3% in the second experimental treatment;
- the *feed conversion ratio* values have been reduced in those groups received fed supplemented with the studied feed additives (-1.9% in A1, respectively -6.6% in A2).

2. The *average weight of the eggs and of their components* was modified, relatively to the studied experimental factor:

- *eggs weight* (g) presented close values at the three studied groups (65.1 g in control, 65.4 g in A1 and 65.5 g in A2), the differences being statistically not significant;
- *yolk weight* (g) had the highest values within the group receiving Mycosorb +2%, meaning a 1.8% difference, while, at the A1 group, the average value of the parameter was closer to the control one (just 0.6% difference);
- *average shell weight* (g) for all of the 4 experimental weeks have been comprised within the 6.04 g (control) and 6.25-6.26 g (A2 and A1) interval. Even not statistical differences occurred between the averages calculated for the whole experimental period, during the 4th experimental week, the differences between the experimental and control group have been statistically significant.

3. The *morphological and physical eggs quality indexes* (shape index, volume, specific gravity, Haugh index) have been also improved in the experimental groups, compared to the control one:

- *shape index* average values were found to be +1.35% (A1 group), respectively +0.57% (A2 group) higher than the control group, the differences being statistically significant (control x A2, A1 x A2), or distinguished significant (control x A1);
- the mean values calculated after *volume* measurements (cm^3) have been 0.4%, respectively 2.3% higher in the experimental groups A2 and A1, as compared to the control group, not statistical significance occurring;
- *specific gravity* presented average value within the interval 1.077 (control) … 1.087 (A1) (+0.1% BioMos);
- *the Haugh Index* presented close values for all groups (M=87.71 U.H., A1=87.82 U.H. and A2=88.81 U.H.); the experimental did not significantly affect this parameter;

4. *Shell thickness and its breaking strength* have been positively influenced by the action induced by the BioMos (0.1%) and Mycosorb (0.2%) feed additives, the percentage differences between the control and the experimental treatments being presented below:

- *shell thickness (mm)* increased with 2.8% in A1 group and with 3.9% in A2 group;
- *shell breaking strength (mg/cm^2)* has been improved with +3.6% … +5.9%, the differences being statistically significant.

The results related to shell quality had incidence on eggs production quality, meaning the decreasing of proportion of those eggs with shell unconformities. Thus, in the group fed with 0.1% prebiotic, the proportion of sold eggs reached 94.6% from whole eggs productions, while in the group received 0.2% mycotoxins binder, it reached 93.5%. Both values were higher than that calculated for control group (just 91.6% eggs without shell unconformities).

5. *The economic results* have been influenced by the experimental factors, which produced different values for both feed intake and eggs quantity, produced and sold, generating thus different values for the revenue. The revenue of the experimental groups, compared to that achieved in control group, was 11.37 % higher (A1 +0.1% BioMos), respectively 9.75% higher (A2 +0.2% Mycosorb).

The ways of action for the studied feed additives are not fully elucidated; the researches quoted in scientific references do not give enough data concerning the intimate endogenous action mechanism. However, it is supposed that prebiotics and detoxifiants beneficially acts toward the general health status and especially on the gut health, facilitating thus the absorption and mobilisation of those nutrients required during eggshell synthesis.

b) usage of a prebiotic-acidifier product (Biotronic SeForte +0.3%) and of a probiotic-prebiotic-fitogenic blend (Biomin IMBO + 0.1%), in lazing hens feeding, during the end of the production period:

1. The inclusion of Biotronic Se Forte® (+ 0.3%) (B1) and of IMBO® (+ 0.1%) (B2) products in laying hens feeding generated various results concerning *production performances*:

- *body weight* dynamics (kg) – close values were found between the experiment onsed and ending moments, for all studied groups;
- eggs yield, expressed through the *egg mass* production (g/hen/day) increased with 5.4%, respectively with 5.20% in B1 and B2 groups, compared to the M one;
- *feed conversion (kg feed/kg egg mass)* ratio has been reduced at the hens belonging to the experimental treatments, meaning -4.4% (B1 + 0.3% Biotronic Se Forte) and -3.3% (B2 + 0.1% IMBO), revealing the beneficial influence of the used additives on feed intake and in its conversion.

2. *Weight of the eggs and of their components (g)* proved to be higher in the experimental groups, compared to the control one:

- *eggs weight*, expressed as average values calculated for all 4 experimental weeks, was 2% higher, respectively 1.5% higher in groups B1 and B2;
- *yolk weight* was 2.6%-3.3% higher than in the control group;
- *shell weight* was 3.08…5.3% higher in the experimental groups; still, the differences between the means for the overall period were not statistically significant. However, strating from

the 3rd and 4th week of additives usage, the differences between the studied groups became statistically significant.

3. Concerning *the morphological and physical egg quality indexes* (shape index, volume, specific gravity, Haugh index), increased values have been observed as consequences of the usage of the studied feed additives, although no statistical significance occurred when the average values/whole experimental period were compared:

- *shape index (%)* – the average values were 0.5% (B1 group), respectively 1.37% (B2 group) higher than those of the control group;
- eggs *volume* oscillated straight related to the eggs weight, within the interval of 58.80cm^3 and 59.65 cm^3 in B2 and B1 groups, compared to 56.32 cm^3 (control group);
- *specific gravity* values have been proportionally modified, as the proportion of shell/whole egg did it, exiting an variation interval of 1.077 (control) … 1.087 (B1);
- the average calculated values for the *Haugh index* have been found between the limits of 87.71 U.H. (control group) and 89.19 U.H. (B1 group).

4. The results concerning *shell thickness (mm)* revealed improved values in the experimental treatments. Thus values 1.8% to 3.4 % higher could be observed at the eggs produced by those groups whose feed was supplements with acidifier (Biotronic Se Forte) or with the blend of probiotic, prebiotic and botanical additive (Biomin IMBO).

The differences of +1.7% … 3.4%, regarding *shell breaking strength (mg/cm^2)*, in the experimental groups, compared to the control one, proved to be statistically significant, leading to a decreasing of 29.8% - 33.3%, from the proportion of eggs with unconformities in B1 and B2 groups.

5. The beneficial effects induced by the feed additives on the quantitative and qualitative eggs production generated an improved income, respectively a higher revenue in the experimental groups, compared to the control one: +7.94% for B1 group (0.3% Biotronic SeForte) and +10.59% for B2 group (0.1% Biomin IMBO).

Although the commercial and economical effects produced by the usage of certain kinds of feed additives (minerals, vitamins, probiotics, prebiotics and detoxifiants) were visible in the quantitative and qualitative eggs production, the physiological phenomenon which states as basis of shell improvement due to the additives action remains poorly known, constituting themselves as future alternatives and ways of research in animals nutrition and feeding.

The usage of certain feed additives could be a viable way to reinforce the natural protection barrier of the eggs – the mineral shell. The results achieved during the original researches recommend the usage of the sodium bicarbonate as feed additive when hens are exploited under thermal stress conditions, respectively of the prebiotic kind additives (mananoligosacharids and acidifiers), in order to improve shell quality when hens are reared within normal conditions and to decrease the economic losses generated by the consumption eggs disqualifications.