Key words: hen laying cycle, calcium intake, eggshell properties, egg morphology flaws, internal egg quality

SUMMARY

OF THE THESIS

Influence of the diet calcium level upon the productive performances, egg qualities and mineral balance in laying hens

The thesis starts with the chapter "Introduction", which presents the importance of the theme, the main particularities of the metabolism of calcium and phosphorus, as well as the problems of calcium and phosphorus metabolism in commercial laying hens with high productive performances.

Part I analyzes the literature data on the subject of the thesis, the data being discussed, commented and systematized in three chapters:

1. Functional organization and physiology of the reproductiv system in hen
2. Nutritional requirements of calcium and phosphorus and their providing by food
3. Quality conditions of the eggs from the laying hens and factors affecting egg quality.

Part II of the thesis starts with the Chapter Material and methods in which there are described the biological material used in experiments, the structure and composition of the experimental diets used for feeding of the hens, the working equipment and the methods used for measurements or biochemical determination. The experiments were carried out on Hy-Line var. Brown hens risen in industrial system, on ground. Four experimental variants (groups) of hens were constituted, every group being fed by its own diet, which essentially differed by the calcium content: a control group fed on a commercial diet and three experimental groups fed on diets with calcium contents under or over the control level. These diets allowed the ingestion of the following average amount of calcium per laying cycle (g/cap./day): 2.81 and 3.43 in variants I and II respectively, 4.19 in the control and 4.67 in variant III.

Hens were monitored from the pubertal period (20 weeks of age) to 68 weeks of age (when they were reformed through slaughter). Monitoring of the hen groups consisted of: food consumption, egg production, external egg qualities (egg weight, shell thickness, shell weight, shell breaking strength, morphology shell defects, shell color), and internal egg qualities (albumen consistency and yolk color). Calcium balance was also analysed by determining the amount of calcium ingested, calcium absorbed, blood calcium level, calcium exonerated by the egg and by faeces. Phosphorus balance was also analysed by determining the amounts of ingested phosphorus, phosphorus absorbed, phosphorus exonerated by dejections, blood plasma phosphorus and phosphorus content of the egg shell.

The shell breaking strength was determined using the EGG FORCE READER. Determination of the consistency of the albumen was performed using an EGG Analyzer unit and was expressed in Haugh units. The color of the yolk was determined by two combined methods: a method that uses the "Roche Yolk Color Fan" color palette of values from 1 to 15 and a method based on the same EGG analyzer unit. Serum calcium was determined by a titrimetric method. Dosage of serum phosphorus was performed by the technique of reducing the phosphomolybdenic complex by ascorbic acid. Total eggshell protein contens was determined by the modified Gornall method. Determination of calcium and phosphorus in forages, dejections and egg shell was performed by inductively coupled mass spectrophotometry.

The obtained results were statistically processed, analysing the mean, standard error of the mean and standard deviation, and the differences between groups were compared based on statistic tests.

The effect of different calcium levels of the diets upon the productive performance concerned in that, after 30 weeks of age, the group of variant I (with the lowest calcium content in the diet) had a percentage of laying constant over the other variants. This position was maintained until 68 weeks of age, which can be attributed to a higher energy level of diet of this this group.

An increase in calcium intake from 2.76 g/day/cap. to 3.38 g/day/cap. was followed by a significant decrease in the percentage of broken eggs (0.57%). Further increase in calcium intake, from 3.38 g/day/cap. to 4.16 g/day/cap. was not followed by a significant decrease in the percentage of broken eggs.

The egg weight grew steadily throughout the laying cycle; again distinguishing the group of the variant I with the highest growthing percentage of the egg weigh.

Regarding the effect of the diet calcium level on the weight of the eggs, the group I (with the lowest consumption of calcium) position is constantly higher after the age of 30 weeks, by comparing to the other three experimental groups. It is also noted that the evolution of the egg weight in the group III is constantly lower after the age of 24 weeks, this group being fed by the highest calcium vs. the other three groups. The weight gain of the eggs during the laying cycle was again higher in the groups which ingested a lower calcium diet.

Egg shell weight followed an ascending path during the laying cycle for all experimental variants. Diets with lower calcium supplements (2.72 and 3.35 g/cap./day, respectively) caused higher increases in the weight of the egg shell. The eggshell weight/whole egg weight ratio increased proprotional with the amount of ingested cacium.

The thickness of the shell presented the peak values at the start of the cycle, decreasing gradually as the hens grew. After 34 weeks of age, groups that ingested a lower amount of calcium showed a more pronounced decrease in the thickness of the shell, the consequent increase in calcium intake having some effect of "inhibiting" the decrease in the thickness of the shell during the laying cycle. It is noted that large ingested calcium levels no longer significantly change the thickness of the eggshell.

The shell breaking strength has increased from the 24 to 36 weeks of age. The increase was higher in experimental variants that ingested less calcium. From 36 to 68 weeks of age, shell breaking strength decreased, the decrease being lower in groups that ingested less calcium. The results reveal that lower levels of calcium in food will improve the shell breaking strength. A positive correlation of shell breaking strength was found with the level of protein in the diets.

Regarding the frequency of eggs with morphology shell defects, as the amount of calcium ingested increases, there is an increase in the percentage of eggs with such defects of the shell. The highest percentages of defects are done by the deformed eggs, those with additional calcium deposits and cracked eggs. Also, the increase in ingested calcium leads to the predominance of certain types of shell defects.

The color of the shell decreases in intensity (increases the refractometric value) as the cycle of laying takes place. Influences of the ingested calcium level on the color inensity of the shell are expressed relatively slowly. They are quantified by increasing the refractometric values. Increased color intensity has been attributed to the appearance of shell defects such as extra calcium deposits, which are of a lighter hue, leading to the increase of the values of refractometric absorption.

Among the internal qualities of the eggs, they were analysed the consistency of the albumen and the color of the yolk. The higher levels of calcium in food decreases the consistency of the egg in older hens, passed by the laying peack. The consistency of the albus is strongly correlated with the hen's age. The number of Haugh units decreases as the age of birds increases in all experimental variants. Increasing calcium levels in the diet have an effect of reducing the color of yolk. Effects of differents levels of ingested calcium occur as early as the laying process starts. As ageing, hens produce eggs with a lighter yellow yolk and the influence of the calcium level in food on the color of yolk decreases.

With regard to the influence of the diet calcium level on the calcium balance, of the total ingested calcium, a significant part is not absorbed (or, if absorbed, it is eliminated by urine and faeces). The percentage of unabsorbed calcium and exonerated by faeces is higher at the beginning and end of the laying cycle and the minimum in the peak of laying. Ingested calcium levels above some values (according to hen ages and level of laying) are no longer followed by an increase in the rate of absorption. This claims a limit value for calcium absorption, depending on the age of the hens, and an adaptive absorption capacity, according to the requirements of the level of egg production. The ratio between the absorbed calcium and the excreted calcium is about 1/1 on the peack of the laying and decreases on both sides of this period.

Because the amounts of calcium excreted by the faeces and urine increase as the amount of calcium ingested increases, this exonerated calcium in the diet can be considered as an unnecessary surplus, once the calcium in question is not absorbed or the quality of the eggs is not positively changed by the surplus.

The calcium content of the shell increases with the amount of calcium ingested. Increase is not directly proportional with the amount of calcium ingested. The increase of the

calcium content of the shell stops when calcium intake is over 3.43 g/cap./day. The calcium concentration of the eggshell is higher in hens with higher intake of calcium.

Serum calcium showed higher values in hen groups with higher intake of calcium, but this time, increases from one group to another were not proportional to ingested calcium, and they were lower in hen groups with higher intake of calcium.

The amount of phosphorus absorbed and phosphorus exonerated was influenced by the amount of phosphorus in the diet, and by the physiological particularities of the hens, manifested distinctly along the laying cycle. The lowest percentages of absorbed phosphorus are found in the hen groups that ingested lower amounts of phosphorus and lower amounts of calcium.

Analysis the effects of the age of the hens of the absorbed phosphorus reveals lower phosphorus absorption values in young and old hens, with a peak of the absorption at the top of the laying (about 34 weeks of age).

Low levels of calcium in food seem not to influence the absorption of phosphorus and plasma phosphate levels, respectively. In contrast, elevated levels of calcium in food influence positively the absorbed phosphorus level as well as blood plasma phosphate level also in a positive sense (increase of the levels).

The amount of phosphorus eliminated through the egg shell presented a general trend of increasing, largely in agreement with the increase in the amount of ingested calcium and phosphorus, respectively.

The thesis also contains a chapter of Final conclusions and ends with the Bibliography chapter, with a number of 184 bibliographic references.

The entire work spread over 192 pages.