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# RESEARCH ON LAYING HEN CROSS DOMINANT BIOLOGICAL EGG COMMERCIAL PRODUCTION USING VARIOUS TYPES OF FEED

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## ABSTRACT

The demand for ecologically-friendly food produce, including those of animal nature, e.g. hen eggs, is increasing continuously in Latvia as well as all across the world. Research objective is to determine the most productive and most suitable for Latvian environment laying hen crosses that can be kept for bio-egg commercial production, as well as to decide upon most suitable biologically produced and economically efficient feed for these hen crosses. The research was held in Kandava municipality, Kandava rural territory, “Kurzemes olas” Ltd. laying hen farmstead “Upkalnu ferma”. The research involved three Dominant laying hen crosses: Dominant Barred D 959, Dominant Tinted D 723 and Dominant Red Barred D 459. All in all, there were 6 groups, each of them consisting of 100 birds. One group of each hen cross was fed with manufactured complete bio-feed (group numbers D723K, D459K and D959K), while the second group – with home-made bio-feed designed for laying hens (group numbers D723S, D459S and D959S). The maximum results that were reached during the entire research period were as follows: D723K – 71% in September (26-29 weeks old), D723S – 82% October (30-34 weeks old), D459K – 56% November (35-38 weeks old), D459S – 58% October (30-34 weeks old), D959K – 54% November (35-38 weeks old) and D959S – 62% October (30-34 weeks old). The best productivity indicators on average were demonstrated by laying hen cross D723 ($p$<0.05). The cross D459S produced eggs with  higher average weight and better proteins, correspondinly by 3.81 g and 11.15 Haugh units than D459K. The amount of dry matter, crude protein and fat in egg mass was equivalent and met physiological norm indications. Reproductive tract organs in all groups but D459K were developed evenly. Liver mass in all groups showed no visible pathologies.

**Keywords:** *Laying hen, egg production, egg quality, reproductive tract, liver mass.*

## INTRODUCTION

The demand for ecologically-friendly food produce, including those of animal nature, is increasing continuously in Latvia as well as all across the world. One of the produce varietes that make customers' choice, which is based upon production sustainability and produce origin, are hen eggs. As the least harmful to both human health and the natural environment, are considered the eggs produced at bio-farms, though this type of production at a larger scale is rather restricted in Latvia, as there is a lack of information about the most suitable hen breeds and crosses for bio-production. Traditionally, for commercial production, they use various laying hen crosses which were bred using precise selection, with the purpose to develop a certain characteristics, e.g. egg quantity, shel colour, egg size, feed application efficiency, start of laying, etc. It should be noted that there are certain complications for bio-farms to secure and maintainin productivity which are related to complete animal feed supply that complies with scientifically recommended feed rations (Vītiņa, Jemeļjanovs, Mičulis, 2004; Jemeļjanovs, Mičulis *et al.,* 2004). The problem is often caused by bio-feed availability in large quantities and its relatively high price for both complete feed mixes and raw materials, especially for protein sources like beans, peas, soy beans, etc. Research objective is to determine the most productive and most suitable for Latvian environment laying hen crosses that can be kept for bio-egg commercial production, as well as to decide upon most suitable biologically produced and economically efficient feed for these hen crosses.

## MATERIALS AND METHODS

The research was held in Kandava municipality, Kandava rural territory, "Kurzemes olas" Ltd. The research involved 3 laying hen crosses: Dominant Barred D 959, Dominant Tinted D 723 and Dominant Red Barred D 459, starting with one-day old chicken till the beginning of laying cycle. In each cross, the birds were divided into two groups, where the first one was fed with commercially produced complete bio-feed for chicken, growers and layers (K – commercial; group numbers D723K, D459K un D959K) from JSC "Dobeles dzirnavnieks". The other group was fed with home-made complete bio-feed for chicken, growers and layers (S- home-made; group numbers D723S, D459S un D959S) made after especially designed recipes. All in all, there were 6 groups, 100 birds in each. The research was held from May 2019 till March 2021. 24-hour-old chicken were purchased from internationally recognised Czech enterprise Dominant Genetika official representatives in Latvia farmstead "Veckūkuri". The testing farm's designed bio-feed mix included the following ingredients: barley, rye, pea meal, soy cakes, fodder yeast, fish meal, calcium carbonate mineral feed (Profimix) and natrium chloride. JSC "Dobeles dzirnavnieks" comercially produced complete bio-feed contained the following ingredients: wheat, barley, oats, soy beans, beans, soy cakes, calcium carbonate, fodder yeast, pre-mix and other feed additives.

Table 1. Supply of nutrients to laying hens, %.

| Analytical components | Home-made bio-feed mix | Commercially produced complete bio-feed mix |
|---|---|---|
| Dry matter | 88.76 | 88.00 |
| Crude protein | 17.17 | 17.34 |
| Crude fiber | 4.24 | 4.58 |
| Calcium | 3.18 | 3.91 |
| Phosphorus | 0.83 | 0.67 |
| Lysine | 0.85 | 0.85 |
| Methionine | 0.31 | 0.24 |
| Threonine | 0.58 | 0.61 |
| Tryptophan | 0.18 | 0.22 |

Keeping conditions were the same for all groups of layer crosses. Upon reaching laying age, the birds were moved to the permanent accomodation for egg laying in separate compartments in the same 6 groups. Those were secured with all the free-range keeping conditions necessary for layers, including easy outdoor access through special entrance/exit doors. For feeding the birds, feeding equipment was used, while drinking water was freely accessible from the round drinking bowl. Throughout the entire growing period, the bords were kept on the floor in separate boxes, using wooden chips as manipulable material. Hen laying quality was evaluated in compliance with internationally accepted methodology, i.e. determining the amount of eggs and calculating laying intensity from the existiing number of hen (Yilmaz Dickmen *et al.*, 2016). Egg quality was determined using morphological indicators (shell mass, shell thickness, shell durability, egg white's height and yolk's colour) as well as biochemical indicators, such as dry material, crude protein and fat, taking as samples 30 eggs from D459K and D459S hen groups. Upon slaughtering, there was a random choice of hens from each group, and internal organs were taken for lab analysis. Liver and reproductive tract were assessed macroscopically. The liver was measured for its mass using Casbee MW-1200, US (precision 0.1 g), while the reproductive tract was exposed to various measurements (Gongruttananun, 2011). Oviduct length was measured with electronic vernier limit (precision 1 mm) as well as its mass. Ovaries were weighed, follicules tat are 10 mm or bigger were determined, counted and weighed (Waddington *et al.*, 1985). Feed chemical analysis was performed by Latvia University of Life Sciences and Technologies Biotechnology scientific laboratory following the accredited ISO standard methods. Feed recipe development involved a special computer program "Hybrimin". Egg quality analysis was performed by JSC "Balticovo". Chemical laboratory, using standard methods. The acquired data were analysed using descriptive statistics method, calculating data mean value and standard deviation, and inferential statistics. To determine the two measured parameters' correlations, with no relation to a certain research group, Pearson's correlation test was applied. To compare the results across the groups, Mann-

Whitney U test was used, while T test – for comparing laying intensity across the groups. Calculations and analysis are performed using MS Excel, while Mann-Whitney U test used SPSS data analysis program.

## RESULTS AND DISCUSSION

Layers crosses Dominant started laying rather early – 13 to 17 weeks old (in June). Early beginning of laying period is related to the birds' fast growing and maturity, that brings along heavier body mass than of those chicken of the same age, but which are grown at a normal pace
(Robinson *et al*., 2001).

Dominant CZ cross standard (Dominant CZ Programs) determines age when laying productivity is 50% as one of the characteristic features, and this age for Dominant layer crosses begins at about 22-23 weeks. During the trial, 50% productivity was determined: for cross D 723 in July, when the chicks were 17 to 21 weeks old, and for D 459 and D 959 crosses in August, correspondingly (at the age of 22 to 25 weeks) and September (26 to 29 weeks).

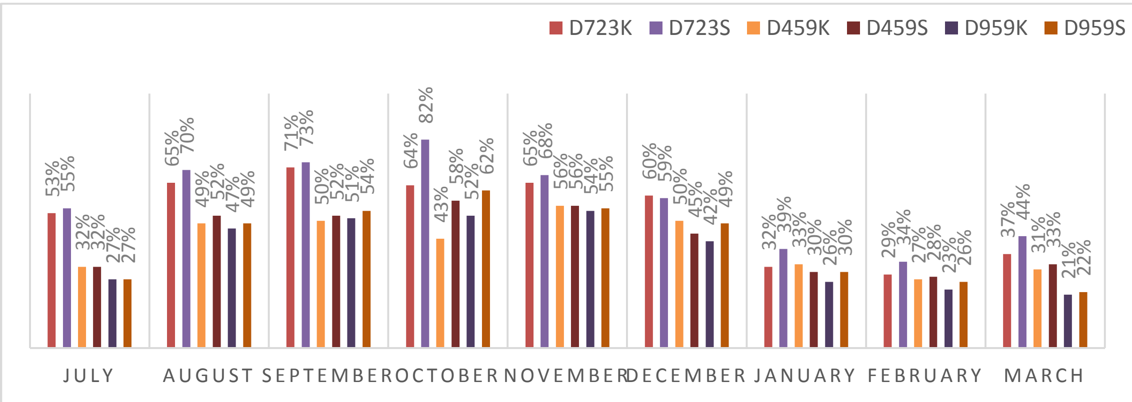

Figure 1. Productivity of layers, %.

Material differences among crosses, that were fed with different feed types, were not determined. According to standard notions, Dominant cross laying hen reach their max. productivity at the age of 29 to 30 weeks (up to 90%) D 723 - 93-95% and D 459 and D 959 – 91-94%. Maximum results reached during the trial ae as follows: D 723K – 71% in September (26-29 weeks old), D 723S – 82% in October (30-34 weeks old), D 459K – 56% in November (35-38 weeks old), D 459S – 58% in October (30-34 weeks old), D 959K – 54% in November (35-38 weeks old) and D 959S – 62% in October (30-34 weeks old).

Assessing the egg quality morphological indicators in group D 459S, aerage egg weight was 66.01 g, i.e. 3.81 g heavier than in D 459K group. There is physiological correspondence when at lower laying intensity the eggs have bigger mass (Vītiņa, 2006). Another important egg quality indicator is egg shell mass and thickness. These indicators determine broken egg quantity (Vītiņa, Latvietis, 2000). During the trial, the egg shel mass in group D495K was a little higher, 8.43 g upon average, while in group D459S it was 8.39 g upon average. This makes 12.71-13.55% from egg mass, though the difference in per cent was not too relevant $p<0.05$). Egg shell thickness in both bird groups was similar and within optimal norms (0.4-0.6 mm). This indicates that both home-made and commercially produced feed mixes contain ingredients that facilitate the egg shell thickness and durability.

Table 2. Egg morphological and biochemical analyses.

| Indices | D 459 | |
|---|---|---|
| | D 459S | D 459K |
| Number of eggs, pcs. | 30 | 30 |
| Average egg weight, g | 66.01±5.29 | 62.20±2.81 |
| Shell mass, g<br>% of eggs mass | 8.39±0.96<br>12.71 | 8.43±0.80<br>13.55 |
| Shell thickness, mm | 0.49±0.08 | 0.51±0.04 |
| Shell strength, Newtons | 40.30±14.57 | 45.30±10.38 |
| Albumen height, mm | 6.84±0.93 | 5.36±1.27 |
| Albumen height, Haugh units | 80.41±6.22 | 69.26±13.13 |
| Yolk color, Roche scale | 2.80±0.62 | 2.80±0.48 |
| Dry matter, % | 23.48±0.86 | 24.19±0.85 |
| Crude protein, % | 11.65±1.06 | 11.96±1.29 |
| Crude fat, % | 8.61±0.63 | 9.50±0.88 |

Egg shell quality is basically determined by the bird's health, feed ingredients aand its quality aspects, as well as its accessibility and availability. However, highly producttive layers in their $2^{nd}$ laying phase (45 weeks old and later) may experience fatigue of the reproductive system which is responsible for egg-forming from the nutritive elements. This is especially important for egg-shell formation. According to various researchers (Rama Rao, Nagalakshmi, Redoly, 2002; Juan Gomez – Basauri, 1998; Robert, Schwartz, 1997), egg shell quality is determined not only by major elements – calcium, phosphorus and vitamin $D_{3,}$ but also the amount of manganese and chloride in the feed mix. Egg shell quality is also determined by various stres factors, such as: transporting, lodging refurbishment, pecking agression from other birds, etc. The stress traces are still felt 8 to 10 days after averting the problem. Also, such an issue as bird inflammation with such diseases as avian encephalomyielitis, infectious bronchitis, Newcastle disease, and mycoplasm leave a negative effect on the egg shell quality. Mycotoxins that penetrate into feed mixes (e.g., *Fusarium moniliforme* and *Fusarium proliferatum*), which produce fumonisin $B_1$, that is is strongly toxic and completely blocks metabolic processes performered by vitamin D, deteriorated the egg shell quality (Grant Richards, 1998; Dewegowda, Aravind, 2002). Shell strenght in group D 459S was within optimal ranges (at least 40 N), but the indicators were a little higher in group D 459K – 45.30 N, upon average, 5 N higher than in group D 459S. Albumen height was bigger in group D 459S – 6.84 mm (optimal is 6 to 10 mm) and 80.41 Haugh units (optimal is 80 to 100 Haugh units), correspondingly, the indicators were higher by 1.48 mm and 11.15 Haugh units, which shows better egg quality than in group D 459K. Egg yolk colour was equally pale (2.80 grades) after Roche scale. Egg yolk quality depends on protein and vitamin content in the feed. A vitamin is transformed unevenly, i.e. increasing the concentration of vitamin A will result only in a fair increase in colour. Increasing vitamin A proportion in egg yolk will decrease the amount of carotenoids (paler yolk), as well as the concentration of vitamin $B_2$ (Nudiens, 1999). Biochemical indicators of eggs were not affected by either feeding layers with commecially produced or home-made feed mixes. Dry matter, crude protein and crude fat in eggs were well-balanced and complied with physiologic normative indications.

After reproductive tract organs measurements, one can determine the hens' recent, present and further laying potential (Rahman, 2018). The measurements identified the longest oviduct in group D 959K – average 626 mm, while the shortest – in group in group D 459K – 382 mm. The heaviest oviducts were found in group D 723S – 51.5 g, the lightest – in group D 459K – 19.0 g. The majority of birds that demonstrated heaviest oviducts were those that were fed with home-made feed mix. The highest ovary mass was indicated in group D 723S – 53.7 g, and the lowest – in group D 459K – 16.4 g. Groups D 723S and D 959K had more big follicles – 6.3 and 6.5 pieces correspondingly, while the lowest amount was detected in group D 459K – 2.0 cases.

Table 3. Reproductive tract and organs measurements.

| Definite organ parameter | Grupa | | | | | |
|---|---|---|---|---|---|---|
| | D 723K | D 723S | D 459K | D 459S | D 959K | D 959S |
| Oviduct length, mm | 527±84 | 563±68 | 382±149 | 587±44 | 626±36 | 592±50 |
| Oviduct weight, mm | 28.3±15.6 | 51.5±9 | 19.0±23.1 | 43.7±16.7 | 40.0±12.4 | 44.5±13.4 |
| Ovary weight, g | 22.0±9 | 53.7±7.1 | 16.4±18.5 | 41.8±11.1 | 49.3±10 | 43.5±7 |
| Big folliculle amount, pcs. | 3.0±1.5 | 6.3±0.5 | 2.0±2.8 | 5.2±1.2 | 6.5±1.8 | 5.7±0.5 |
| Big follicle mass, g | 12.6±10.4 | 43.2±6.1 | 11.1±16.8 | 31.1±11.1 | 41.2±12.1 | 35.4±6.7 |
| Liver weight, g | 44.7±7.1 | 48.2±5.3 | 44.4±10.9 | 52.2±4.6 | 53.8±4.4 | 46.5±4.2 |

Comparing reproductive organ development across various feeding groups, average oviduct and ovary weight, big folicle amount and their mass indicators were significantly higher ($p<0.05$) for the hens that were fed with home-made feed mix. The research determined a strong positive correlation between oviduct length and its weight ($r$=0.755, $p$<0.05), as well as average correlation between ovary weight and the amount of big follicles (correspondingly $r$=0.89, $p$<0.05 un $r$=0.91, $p$<0.05). Layers that have more active ovaries that produce more folicles, also have longer oviducts, while those birds that have not yet reached the reproductive age, and their ovaries are not active, or older birds that have scarse ovulation, have relatively shorter oviducts (Rahman, 2018).

Reproductive tract organs for all hen groups, except for group D 459K, were well-developed. Group D 459K birds had smaller measurements of all. As a reason, there were birds with smaller reproductive tract organs which reached hatching phase that could have influenced the size of reproductive tract organs, but were deprived of laying (Gongruttananun, 2011).
Visual assessment of hen liver did not identify any macroscopically identifiable pathological changes of tissues in either group. The highest liver weigh was determined in group D 959K – 53.8 g, the lowest – in group D459K, 44.4 g. Comparing the bird groups that were fed with home-made feed mix with those that were were fed with commercially produced feed mix, there were no statistically notable differences identified in liver mass (p>0.05).

## CONCLUSIONS

In all layer groups, where the birds were fed with home-made biological feed, showed higher laying intensity in comparison to those that were fed with commercially produced bio-feed. During the research preiod, layer Dominant crosses did not reach the maximum potential laying intensity, yet the highest productivity indicators were shown by layer cross Dominant Tinted D 723.
D 495S hen group got larger and more qualitative eggs with average weight of 66.01 g and higher albumen height of 80.41 Haugh units than the birds from group D 495K. The amount of dry matter, crude protein and crude fat was equal in both groups D 495S and D 495K and complied with the physiological norm specifications.
Reproductive tract organs for all groups but group D 459K, were developed evenly. Liver mass across the groups was above average, though macroscopic analysis did non reveal any visible pathologies.

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