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EGG QUALITY INFLUENCE ON INCUBATION RESULTS AND THEIR PHENOTYPE CORRELATION

SUMMARY

This study presents research results of quality and incubation values for Isa Brown hybrid eggs. Eggs were produced in the 33rd week of age at the production peak. Research was conducted on the sample of 252 incubation eggs (240 fertilized eggs). Chick hatchability compared to the number of inserted eggs was 86.51%, and compared to the number of fertilized eggs 90.83%. Average values for quality parameters of brooding eggs and incubation results were as follows: egg weight before insertion 58.41 g, egg length 5.49 cm, egg width 4.29 cm, egg shape index 78.16% and egg volume 53.14 cm^3, one day old chick weight was 39.15 g, absolute egg weight loss was 6.60 g, relative egg weight loss was 11.31% and relative chick share in the egg weight was 67,03%.

Statistically justified ($P<0.001$; $P<0.01$; $P<0.05$) correlation (complete one) was determined between egg weight and egg width (0.908), egg weight and egg volume (0.923) and egg weight and chick weight (0.918), very strong correlation was determined between egg weight and egg length (0.870), strong correlation was determined between egg weight and absolute egg weight loss (0.690), weak correlation was determined between egg shape index and egg width (0.395), and very weak correlation was determined between egg weight and egg shape index (0.188), egg weight and relative egg weight loss (-0.166), egg shape index and egg length (-0.147) and egg shape index and chick weight (0.189). Between egg weight and relative chick share in the egg weight, egg shape index and absolute egg weight loss, egg shape index and relative chick share in the egg weight no statistically justified ($P>0.05$) correlation was determined.

Key words: egg quality, incubation parameters, correlation.

INTRODUCTION

The success of industrial production of poultry and eggs is based on the breeding of various parent flocks of heavy and light line hybrids of hens. Keeping and exploiting parental flocks, as well as incubating eggs for brooding chicken, comprises of specific, highly specialized and complex phases in production processes. It should be kept in mind that the average production of

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one parent flock in the egg production for brooding hens and day-old chicks in practice is a combined result of the genetic potential of the breeds that are kept as well as breeding technology during production, and the egg incubation technology. Very often, all the merit or guilt for the level of production achieved is attributed to the genetic potential of the flock, but in practice a great share goes to non-genetic factors e.g. breeding technology, usage period – flock age, parent body weight, gender correlation, egg weight as well as technological procedures during the chick hatching.

Parent flock age at the start of egg laying is one of the major factors that have direct influence on incubation egg production success as well as on day old chick production. It is well known that laying intensity of fertilized eggs and chick hatchability from the number of incubated eggs gradually increases until it reaches its maximum, then it gradually decreases. Length of the time for achieving the maximum, apart from genotype, depends on a large number of non-genetic factors. The most important non-genetic factors are proper parent flock breeding technology, adequate storing of incubation eggs as well as storing time. Moreover, the proper and optimal technological procedures during artificial hatching of chicks is very important factor.

In the recent research results it can be seen that most of the authors in their research, have examined influence of genetic and non-genetic factors to laying intensity of fertile eggs during the production cycle, and especially to fertilization rate and hatchability of incubation eggs. These are the most significant factors that have direct influence on production success in poultry offspring production. However, most of the authors present research results which are related to the influence of specific factors (age, laying hen weight, laying period, season, incubation conditions, egg weight, shell permeability, weight of day old chicks) and their correlations to fertility success, hatchability and egg weight loss dynamics (correlation between egg weight and embryo growth during incubation period) for different chicken hybrids.

Because of the above mentioned, in the production of poultry eggs and in the order to achieve better reproductive results, it is necessary to examine the quality, i.e. the basic physical characteristics of the eggs for brooding hens. (Baboo et.al., 2013; Đermanović and Mitrović, 2013; Đermanović et.al., 2012, 2013, 2015; Kabir et.al., 2014a,b; Mitrović et.al., 2011; Usman et.al., 2014). Therefore, the aim of the paper was to determine the basic external quality characteristics of the light line hybrid Isa Brown breeding eggs, that were laid at the peak of production when highest egg fertility is expected as well as chick hatching.

MATERIALS AND METHOD

Egg incubation for parent flock light line hybrid Isa Brown was done in incubation station which is within the poultry farm “Jugokoka” Belgrade. The eggs that were produced at the production peak (33rd week of age) were placed in the incubator. The number and percentage of fertilized eggs was determined, the number and percentage of hatched chicks compared to the number of incubated (fertilized eggs), the number and percentage of eggs with dead embryo as well as dynamics of egg weight loss up to 18th day of incubation period were also determined. Before being placed into the incubator each egg was weighed and measured (length and width), and marked on husk. In addition to individual egg measuring before inserting in to incubator and after 18 days of incubation, each day old chick was measured too. Special attention in this study was given to the egg category from which healthy and vital chicks hatched.

Egg shape index (ESI) was determined using the formula: ESI = (EW/EL) x 100, EW – egg width and EL – egg length, while for egg volume we used following formula: $V = (\pi/6) \times L \times W^2$, V – egg volume; W – egg width; L – egg length; π - constant (3.1416).

On 25th day eggs were transferred to the hatchery where they were individually placed in the special separators in order to easily determine from which egg each hatched chick originated. At the end of the incubation period the weight of day old chicks was measured. Based on egg weight and chick weight relative chick share in the egg was determined using the following formula: PC = (CW/EWe) x 100.

For most of the monitored parameters arithmetic mean, arithmetic mean error, standard deviation and deviation coefficient were determined. In addition, using special formula phenotype correlation coefficients were determined for monitored traits.

$$r_{xy} = \sum x_i y_i - \frac{(\sum x \sum y)}{nxy} / \sqrt{(\sum x_i^2 - \frac{(\sum x)2}{n}) (\sum y_i^2 - \frac{(\sum y)2}{n})}$$

$$i = 1, 2, ..., k$$

Main data rendering was done using statistic software IBM SPSS statistics Version 22 (2013).

RESULTS AND DISCUSSION

The goal of the study was to determine incubation results for eggs of light line hybrid Isa Brown. Using random sample technology 252 eggs were chosen and they were individually measured and marked. After determining egg weight, absolute and relative parameters of the total number of incubated fertilized and non-fertilized eggs, same parameters for eggs with dead embryo were also determined, as well as relative hatchability parameters for chicks of both genders compared to the number of inserted and fertilized eggs, (Table 1).

From the data in the table 1 it can be seen that for parent flock analysis of light line hybrid Isa Brown, total number of 252 incubation eggs were taken. Egg fertility in the research period was 95.24%, i.e. 240 eggs while 12 eggs were not fertilized (4.76%). After the incubation process was finished it was determined that from 22 eggs (8.73% from total inserted number, 9.17% from fertilized eggs) did not hatch, i.e. embryo death was determined. The calculated hatchability of day old chicks of both genders compared to total number of inserted eggs was 86.51%, and compared to fertilized eggs was 90.83%.

Table 1. Egg fertility and hatchability of the parental flock in the 33rd week of age

Category of eggs	Eggs	Percentage
Total number of eggs inserted	252	100.00
Fertility of eggs	240	95.24
Non fertility of eggs	12	4.76
Egg with a dead embryo (A)	22	8.73
Egg with a dead embryo (B)	22	9.17
Hatchability chickens of both sexes (A)	218	86.51
Hatchability chickens of both sexes (B)	218	90.83

(A) From the number of inserted eggs; (B) From the number of fertilized eggs.

Depending on the age, i.e. parent flock laying period, when studying productive and reproductive traits of parent flocks of different line hybrids and chicken breeds, different results were obtained by many authors: Đermanović et.al (2008; 2009), Mitrović et.al (2005; 2009; 2010), Abanikannda and Leigh (2015), Aşcı and Durmuş (2015), Nikolova et al. (2011) i Denli et al. (2018).

One of the significant parameters for egg quality is egg weight. Egg weight increases with age of the flock - if proper diet, healthcare and breeding technology of parental flocks is provided. Average values and variability of basic egg quality parameters and incubation values in the period of analysis are shown in table 2.

Table 2. Variability and average values of egg traits from which chicks hatched

Indicators	$\bar{x}$	$S\bar{x}$	S	C.V.
Weight of eggs before incubation (g)	58.41	0.22	3.29	5.63
Length of the eggs (cm)	5.49	0.01	0.13	2.37
Width of the eggs (cm)	4.29	0.01	0.11	2.56
Egg shape index (%)	78.16	0.07	1.05	1.34
Volume of eggs (cm^3)	53.14	0.26	3.78	7.11
Loss of egg weight up to 18 days of incubation (g)	6.60	0.03	0.50	7.58
Loss of egg weight up to 18 days of incubation (%)	11.31	0.05	0.69	6.10
Weight of day-old chicks (g)	39.15	0.17	2.46	6.28
Relative share of chicken in the egg weight (%)	67.03	0.11	1.67	2.49

From the data in table 2 it is clear that average egg weight upon inserting was 58.41 g, egg length 5.49 cm, egg width 4.29 cm. Based on these parameters average shape index value was determined 78.16%, and egg volume of 53.14 cm^3 was determined. It is well known that during the incubation process eggs lose a certain part of their weight. Above mentioned shows that average absolute egg weight loss up to 18th day of incubation was 6.60 g, and relative 11.31%. The data in table 2 shows that average weight of hatched day old chicks of both genders was 39.15 g, and that average relative chick share in egg weight was 67.03%. If absolute and relative results are observed it can be concluded that obtained results were satisfactory, even though some unsatisfactory results for egg volume and absolute loss of egg mass up to 18th day of incubation (C.V. – 7.11 and 7.58) were found.

Most of the authors have conducted similar researches but mainly for heavy line hybrids. Therefore, Abanikannda and Leigh (2015), determined for three genotypes average egg weight of 61.33 g, length 58.02 mm, width 43.87 mm, egg shape index 75.73%, volume 59.03 mm^3. Similar egg weight values (60.3 g and 57.1 g) in the same production period for two genotypes of light type were determined by Denli et al. (2018). However, when it comes to egg shape index authors of both researched genotypes determined lower values (77.5% and 75.8%). Moreover, significant difference ($P \leq 0.05$) for researched parameters at the laying peak depending on genotype Lohmann Brown and Atak-S) was determined by Denli et al. (2018). Kocevski et al. (2011) in their research determined that egg weight at the laying peak was under significant ($P \leq 0.05$) influence of age, but not under the influence of genotype, even though eggs from Isa Brown were slightly heavier than DeKalb White hybrid.

By incubation egg value reference is made to it refers to the fertilization percent, i.e. percent of hatched chicks compared to the number of inserted eggs. Therefore, research in the field of egg weight loss during incubation and day old chick weight can give significant contribution for quality assessment. Determining correlation between researched parameters has special significance for determining incubation egg quality and achieved incubation results (Table 3).

Table 3. Coefficients of phenotypic correlation between egg weight, egg shape index and quality of eggs and chicks

Traits	**n**	$\mathbf{r_{xy}}$	Relationship	$\mathbf{t_{exp.}}$
EWe:EL	218	0.870^{***}	Very strong	22.665
EWe:EWi	218	0.908^{***}	Complete	31.998
EWe:ESI	218	0.188^{**}	Very weak	2.826
EWe:EV	218	0.923^{***}	Complete	35.253
EWe:ALEWe	218	0.609^{***}	Strong	11.336
EWe:RLEWe	218	-0.166^{*}	Very weak	2.485
EWe:CW	218	0.918^{***}	Complete	34.177
EWe:RSC	218	0.053^{ns}	Non	0.783
ESI:EWe	218	0.188^{**}	Very weak	2.813
ESI:EL	218	-0.147^{*}	Very weak	2.184
ESI:EWi	218	0.395^{***}	Weak	6.319
ESI:ALEWe	218	0.121^{ns}	Very weak	1.791
ESI:RLEWe	218	-0.022^{ns}	Non	0.323
ESI:CW	218	0.189^{**}	Very weak	2.829
ESI:RSC	218	0.061^{ns}	Non	0.898

EWe – egg weight (g); EL – egg length (cm); EWi – egg width (cm); ESI – Egg shape index (%); EV – egg volume (cm^3); ALEWe – absolute loss of egg weight up to 18th day of incubation (g); RLEWe – relative egg weight loss up to 18th day of incubation (%); CW – chick weight (g); RSC – Relative chick share in the egg weight (%). $^{ns}P>0.05$; $^{*}P<0.05$; $^{**}P<0.01$; $^{***}P<0.001$.

Based on obtained values for phenotype coefficient correlation and their significance (table 3) it can be determined that egg weight has some influence to physical traits and incubation results during the maximal egg production period (laying peak). Therefore, between egg weight and egg length, egg weight and egg width, egg weight and egg volume, egg weight and absolute egg weight loss and day old chick weight phenotype correlation coefficients were determined and they were at the level $P<0.001$, which means that strong, very strong and total correlations were determined. In addition, positive but very weak ($P<0.01$) correlation was determined between egg weight and egg shape index, and negative also very weak ($P<0.05$) correlation was determined between egg weight and relative egg weight up to 18th day of incubation. However, between egg weight and relative chick share in the egg no statistically significant ($P>0.05$) correlation was determined.

Unlike for egg weight, data from table 3 shows that between egg shape index and egg width, egg shape index and chick weight positive weak and very weak correlation was determined at the levels of $P<0.001$ and $P<0.01$, while negative very weak ($P<0.05$) correlation was determined between egg shape index and egg length. However, between egg shape index and other studied parameters determined correlations were not statistically confirmed ($P>0.05$).

In relation with egg shape index and egg weight correlation Duman et al. (2016) determined same values, but weaker correlation ($P<0.05$). Above mentioned results are in accordance with results obtained by Aygun and Yetisir (2010), while Olawumi and Ogunlade (2008) obtained completely opposite results and determined negative significant correlation between egg shape index and egg weight.

CONCLUSION

Based on this study it can be concluded that next to the egg weight other physical traits (length, width, shape index and egg volume) have a higher or lower rate influence to incubation results, during entire production cycle and especially during the peak egg production period. Average egg weight, during the insertion at studied period, was 58.41 g, length 5.49 cm, width 4.29 cm, egg shape index 78.16%, volume 53.14 cm^3. It is well known that during the incubation process eggs lose a certain amount of their weight. Above mentioned shows that average absolute egg weight loss up to 18th day of incubation was 6.60 g, and relative 11.31%. Average weight of hatched day old chicks of both genders was 39.15 g, and that average relative chick share in egg weight was 67.03%.

Based on the values of phenotype correlation coefficient and their significance it can be concluded that egg weight has some influence to physical traits and incubation results. Therefore, between egg weight and egg length, egg weight and egg width, egg weight and egg volume, egg weight and absolute egg weight loss and day old chick weight phenotype correlation coefficients were determined and they were at the level $P<0.001$, which means that strong, very strong and total correlations were determined. Between egg weight and egg length, egg weight and egg width, egg weight and egg volume, egg weight and absolute egg weight loss, as well as between egg weight and chick weight determined phenotype correlation coefficients were determined at the level P<0.001, i.e. strong, very strong and complete correlation was determined. Positive very weak (P<0.01) correlation was determined between egg weight and shape index, and negative also very weak (P<0.05) correlation was determined between egg weight and relative egg weight loss up to 18th day of incubation. However, between egg weight and relative chick share in egg weight no statistically justified correlation was determined (P>0.05). Unlike for egg weight, between shape index and egg width, and shape index and chick weight positive weak and very weak correlation was confirmed at the levels P<0.001 and P<0.01, while negative very weak (P<0.05) correlation was determined between egg shape index and egg length. However, between egg shape index and other researched parameters no statistically significant correlations were determined (P>0.05).

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