Acta Agraria Kaposváriensis (2010) Vol 14 No 2, 75-81
Kaposvári Egyetem, Állattudományi Kar, Kaposvár
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The effect of production type and age of hens on the major egg components

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ABSTRACT

The aim of the research was to find out the differences in the major egg components between egg and meat types of hens. Three traditional breeds of egg-type and three traditional breeds of meat-type hens were included into the experiment. The comparison was carried out at six different ages. Eggs from meat-type hens were significantly (P<0.05) heavier, albumens, yolks and shells were heavier too while the proportion of yolk and diameter as well as yolk : albumen ratios were higher in comparison to egg-type hens. The proportion of albumen was significantly higher in eggs from egg-type hens while the thickness and proportion of shell did not differ between the types of hens. The last two mentioned traits were not significantly affected by age. The breed has a significant effect on all traits except percentage albumen and percentage yolk. In both types of hens the weights of albumen, yolk and shells were positively related to egg weight. The relation between yolk : albumen ratio and egg weight was positive but not significant in meat-type hens.
(Keywords: egg-type hens, meat-type hens, egg components, yolk to albumen ratio)

INTRODUCTION

An egg is a perfect creation of nature and its composition depends primarily on breed of hen, its age and nutrition. Despite the fact that eggs have been blamed due to cholesterol content the experts state that eggs contain a lot of nutrients (like vitamins of B complex, vitamin D, lecithin, unsaturated fatty acids, antioxidants) that diminish the negative effect of cholesterol. In a study with 40 thousand men and 80 thousand women *Hu et al.* (1999) proved that one consumed egg a day does not increase the risk of cardiovascular diseases and stroke in healthy women and men. Cholesterol and its esters are present in yolk (*Liu et al.,* 2010). The results of a few studies show that the amount of cholesterol is higher in eggs with heavier yolks and with a higher yolk to albumen ratio (*Hussein et al.,* 1993; *Campo,* 1995). Considering this fact the egg consumers should choose eggs with a lower yolk proportion and a higher albumen proportion. On the other hand, eggs with higher percentage yolk are appreciated in food industry that uses yolks as the basic component of some products, like mayonnaise (*Suk and Park,* 2001). The aim of the research was to find out the differences in proportions of main components (shell, albumen, yolk) in eggs produced by egg-type hens and meat-type hens.

MATERIALS AND METHODS

Three Slovenian traditional egg-type breeds (Slovenian Brown hen, Slovenian Silver hen, Slovenian Barred hen) and three Slovenian traditional meat-type breeds (Slovenian

Early Feathered hen, Slovenian Late Feathered hen and Slovenian Fattening hen) were included into the experiment. All breeds were subjected to deep litter system rearing and fed on complete feeding mixture for egg-type laying hens. Egg-type hens were fed *ad libitum* while meat-type hens were fed restrictively. A random sample of 30 eggs was taken from each flock and measured on the same day. Samples of eggs were analyzed every four weeks, to begin with the 28th week. The last sample of eggs was taken at the age of 48 weeks. Each egg was weighted, broken and we separated the yolk from albumen. The yolk was weighted and its diameter measured. Egg shells with membranes were weighted and on three samples from equatorial part of egg we measured the thickness with a micro meter and calculated the average. Data on egg weight, yolk weight and shell weight served to calculate the albumen weight. We knew the weight of each egg as well as its components; therefore the weight of albumen, yolk and shell was expressed as the percentage of egg weight. Data were statistically processed by SAS/STAT software (*SAS,* 2003). For the regression and correlation analysis we used REG and CORR procedure, and GLM procedure for analysis of variance using the following statistical model: $y_{ijk}= m + P_i + A_{ij} + B_{ik} + e_{ijkl}$ where: y= observed trait; m= mean population value; P_i= effect of production type i; Aij= effect of age j within production type j, B_{ik}= effect of breed k within production type i; e_{ijkl}= residue.

RESULTS AND DISCUSSION

Table 1 shows the effects of production type of hen, its age and breed within the type on the studied traits. The production type and age showed a significant effect ($P<0.05$) on other traits except the shell thickness and shell proportion. *Basmacioglu and Ergul* (2005) did not report on significant effect of genotype on the shell thickness and shell proportion. Data on impact of hen age on the quality of egg shell often differ. *Silverside and Scott* (2001) and *Campo et al.* (2007) reported that the quality of shell worsen with aging while on the other hand *Yannakopoulos et al.* (1994) and *Van den Brand et al*. (2004) reported that hen age did not affect the shell thickness. The effect of breed within the production type was significant for most of the studied traits except the percentage albumen and percentage yolk where no significant differences were recorded between three meat-type and three egg-type hens (*Table 1*).

Table 1

Statistical significance of three effects on some egg components (P-values)

Trait	Production type of hen	Age within production type	Breed within production type
Egg weight (g)	0.0001	0.0001	0.0001
Albumen weight (g)	0.0016	0.0001	0.0001
Yolk weight (g)	0.0001	0.0001	0.0001
Shell weight (g)	0.0001	0.0001	0.0001
Shell thickness (mm)	0.3090	0.3894	0.0348
Percentage albumen (%)	0.0019	0.0001	0.4717
Percentage yolk (%)	0.0001	0.0001	0.1228
Percentage shell (%)	0.0510	0.2043	0.0001
Yolk : albumen ratio	0.0001	0.0001	0.0001
Diameter of yolk (cm)	0.0001	0.0001	0.0001

Differences between production types in each egg component, as well as the yolk : albumen ratio and yolk diameters are shown in *Table 2.* Eggs from egg-type hens have a low yolk : albumen ratio which is in comparison to the meat-type hens the result of relatively low yolk weight (*Table 2*).

Table 2

The effect of production type of hen on egg components, on the yolk : albumen ratio and on the yolk diameter ((LSM±SE)

Trait	Egg-type	Meat-type
Egg weight (g)	$58.28^{a} \pm 0.18$	$61.89^{b} \pm 0.20$
Albumen weight (g)	$36.45^{a} \pm 0.16$	$37.20^{b} \pm 0.17$
Yolk weight (g)	$15.19^{a} \pm 0.05$	$17.76^{b} \pm 0.05$
Shell weight (g)	$6.67^{a} \pm 0.02$	$6.93^{b} \pm 0.02$
Shell thickness (mm)	$0.376^{a} \pm 0.014$	$0.354^{a} \pm 0.015$
Percentage albumen (%)	$62.07^{a} \pm 0.42$	$60.10^{b} \pm 0.46$
Percentage yolk (%)	$26.41^{a} \pm 0.31$	$28.66^{b} \pm 0.34$
Percentage shell (%)	$11.58^{a} \pm 0.11$	$11.24^{a} \pm 0.12$
Yolk: albumen ratio	$0.414^{a} \pm 0.002$	$0.480^{b} \pm 0.002$
Diameter of yolk (cm)	$3.516^{a} \pm 0.007$	$3.690^{b} \pm 0.008$

[a, b] Mean values within each line that do not have equal superscript are statistically significantly different at $P<0.05$

Eggs of meat-type hens significantly differed ($P<0.05$) from eggs from egg-type hens. Eggs had heavier albumens and yolks, yolk diameter was greater and shells were heavier (*Table 2*). Referring to previous studies (*Hussein et al.,* 1993; *Harms and Hussein,* 1993) the differences were expected. Eggs from meat-type hens contained 60.10% of albumen and 28.66% of yolk while eggs from egg-type hens contained 62.07% of albumen and 26.41% of yolk. Eggs from meat-type hens contained 1.97% less albumen and 2.25% more yolk than eggs from egg-type hens. In absolute amounts, the eggs from meat-type hens contained 0.75 g more albumen and 2.57 g more yolk than eggs from egg-type hens. Eggs from meat-type hens with heavier yolks and a higher yolk : albumen ratio contained more cholesterol (*Tavčar,* 2009).

Albumen weight as well as yolk weight and shell weight are positively related to egg weight even though the regression and correlation analyses show that the relation between albumen weight and egg weight is stronger (R^2 0.80–0.85; coefficient of correlation 0.89-0.90) than the relation between egg weight and yolk weight (R^2 0.49–0.56; coefficient of correlation 0.70–0.75) as well as the relation between egg weight and shell weight (R^2 0.31–0.49; coefficient of correlation 0.55–0.70) (*Table 3*). *Harms and Hussein* (1993) and *Fletcher et al.* (1983) found out that the albumen weight is more related to egg weight than yolk weight. In egg-type hens we found a weak but significant relation between the yolk : albumen ratio and egg weight while this relation was not significant in meat-type hens. The relation between egg weight and yolk weight and proportion, respectively shows that a selection on higher egg weight within the egg-type hens results in higher yolk weight but a lower relative proportion in the whole egg weight. On the contrary, the selection to higher egg weight in meat-type hens increase the yolk weight and proportion in the whole egg weight (*Table 3*).

Table 3

Regression and correlation analyses for some egg components with regard to egg weight

Production type of hens	Trait	Regression analysis		Correlation analysis	
		Regression equation	P-value	Pearson coefficient of correlation	P-value
Egg-type	Albumen weight	Y = -2.063 + 0.660x R^2=0.85	0.0001	0.90	0.0001
	Albumen proportion	y = 23.514 + 0.659x R^2=0.08	0.0001	0.29	0.0001
	Yolk weight	y = 1.079 + 0.242x R^2=0.49	0.0001	0.70	0.0001
	Yolk proportion	Y = 53.828 - 0.470x R^2=0.08	0.0001	- 0.28	0.0001
	Shell weight	y = 0.983 + 0.097x R^2=0.49	0.0001	0.70	0.0001
	Yolk : albumen ratio	y = 0.213 + 0.003x R^2=0.08	0.0001	0.28	0.0001
Meat-type	Albumen weight	Y = -0.621 + 0.610x R^2=0.80	0.0001	0.89	0.0001
	Albumen proportion	y = 59.451 + 0.010x R^2=0.0004	0.6319	0.02	0.5720
	Yolk weight	Y = -2.080 + 0.320x R^2=0.56	0.0001	0.75	0.0001
	Yolk proportion	Y = 24.891 + 0.061x R^2=0.01	0.001	0.13	0.0018
	Shell weight	y = 2.702 + 0.068x R^2=0.31	0.0001	0.55	0.0001
	Yolk : albumen ratio	Y = 0.423 + 0.0009x R^2=0.006	0.0678	0.07	0.0714

The changes in studied traits that depend on age of a hen are shown in *Tables 4 and 5* for both production types of hens. In both types eggs were significantly heavier ($P<0.05$) at the end of the trial (age 48 weeks). Yolks and shells were heavier, the yolk proportions were higher as well as the yolk : albumen ratio in comparison to eggs from the beginning of the trial (age 28 weeks) (*Table 4, 5*). Several authors reported on increase of the egg weight over the age of hens (*Johnston and Gous,* 2007; *Rizzi and Chiericato,* 2005; *Van den Brand et al.,* 2004).

Contrary to above mentioned authors *Zemkova et al.* (2007) did not report that the hen age affected significantly the egg weight. The reason for a significant increase of the yolk : albumen ratio with age could be the fact that the yolk weight increased more quickly with hen age than albumen weight which did not significantly increase in the egg-type hens.

Table 4

Weights of eggs, albumens, yolks and shells and shell thickness in two types of hens (LSM values)

Age (weeks)	Egg weight (g)		Albumen weight (g)		Yolk weight (g)		Shell weight (g)		Shell thickness (mm)	
	Egg type	Meat type	Egg type	Meat type	Egg type	Meat type	Egg type	Meat type	Egg type	Meat type
28	$57.38^{a,A}$	$56.49^{a,A}$	$37.02^{a,A}$	$35.21^{a,A}$	$13.97^{a,A}$	$14.70^{b,A}$	$6.53^{a,A}$	$6.57^{a,A}$	$0.362^{a,A}$	$0.362^{a,A}$
32	58.09^{a}	58.83^{a}	36.70^{a}	36.03^{a}	14.72^{a}	16.19^{b}	6.66^{a}	6.60^{a}	0.356^{a}	0.344^{a}
36	59.69^{a}	61.04^{a}	37.45^{a}	36.81^{a}	15.64^{a}	17.34^{b}	6.77^{a}	6.89^{a}	0.352^{a}	0.348^{a}
40	60.45^{a}	63.35^{b}	37.58^{a}	37.74^{a}	16.11^{a}	18.45^{b}	6.75^{a}	7.15^{b}	0.497^{a}	0.357^{a}
44	60.92^{a}	65.24^{b}	36.91^{a}	38.61^{a}	16.77^{a}	19.68^{b}	7.23^{a}	7.02^{a}	0.362^{a}	0.361^{a}
48	$61.91^{a,B}$	$66.37^{b,B}$	$37.26^{a,A}$	$38.81^{a,B}$	$17.58^{a,B}$	$20.18^{b,B}$	$7.06^{a,B}$	$7.37^{b,B}$	$0.353^{a,A}$	$0.351^{a,A}$
SE	± 0.50	± 0.50	± 0.42	± 0.42	± 0.14	± 0.14	± 0.06	± 0.06	± 0.03	± 0.03

$^{a-b}$ Mean values within each line and trait that do not have equal superscript are statistically significantly different at P<0.05; $^{A-B}$ Mean values within each column (28th and 48th week of age) that do not have equal superscript are statistically significantly different at P<0.05

Table 5

Albumen, yolk and shell proportions, yolk: albumen ratio and diameters of yolks in two types of hens (LSM values)

Age (weeks)	Albumen proportion (%)		Yolk proportion (%)		Shell proportion (%)		Yolk : albumen ratio		Diameter of yolk (cm)	
	Egg type	Meat type	Egg type	Meat type	Egg type	Meat type	Egg type	Meat type	Egg type	Meat type
28	$64.46^{a,A}$	$62.23^{a,A}$	$24.41^{a,A}$	$26.08^{a,A}$	$11.39^{a,A}$	$11.67^{a,A}$	$0.376^{a,A}$	$0.420^{b,A}$	$3.55^{a,A}$	$3.68^{b,A}$
32	63.13^{a}	61.17^{a}	25.38^{a}	27.57^{a}	11.48^{a}	11.25^{a}	0.403^{a}	0.452^{b}	3.58^{a}	3.72^{b}
36	62.70^{a}	60.28^{a}	26.24^{a}	28.41^{a}	11.34^{a}	11.29^{a}	0.417^{a}	0.472^{b}	3.63^{a}	3.85^{b}
40	62.11^{a}	59.52^{a}	26.71^{a}	29.17^{a}	11.17^{a}	11.30^{a}	0.431^{a}	0.491^{b}	3.59^{a}	3.65^{a}
44	60.49^{a}	59.10^{a}	27.61^{a}	30.21^{a}	11.89^{a}	10.78^{a}	0.458^{a}	0.513^{b}	3.43^{a}	3.51^{a}
48	$56.53^{a,B}$	$58.32^{a,B}$	$31.10^{a,B}$	$30.50^{a,B}$	$12.36^{a,B}$	$11.16^{a,A}$	$0.451^{a,B}$	$0.528^{b,B}$	$3.60^{a,B}$	$3.69^{a,A}$
SE	± 1.13	± 1.13	± 0.83	± 0.83	± 0.30	± 0.30	± 0.007	± 0.007	± 0.02	± 0.02

$^{a-b}$ Mean values within each line and trait that do not have equal superscript are statistically significantly different at P<0.05; $^{A-B}$ Mean values within each column (28th and 48th week of age) that do not have equal superscript are statistically significantly different at P<0.05

Between the age 28 weeks and 48 weeks the albumen weight increased by 0.65% (egg type), 10.22% (meat type); while in the same period the yolk weight increased by 25.84% (egg type) and 37.27% (meat type). The absolute and relative amounts of yolk increased over hen age. The relative amount of albumen in egg decreased over the hen age. The result is in accordance with the studies of *Van den Brand et al.* (2004), *Rizzi*

and Chiericato (2005) and *Lukaš et al.* (2009) who in different genotypes of hens confirmed the decrease of albumen proportion with increase of hen age. The percentage shell significantly increased over the age ($P<0.05$) in egg-type hens while in the meat-type a lower decrease that was not significant was noticed. The mentioned finding is not in accordance with the report of *Curtis et al.* (1986) who in six lines of egg-type laying hens found a decrease of shell proportion over hen aging. In all ages the yolk : albumen ratio was significantly higher ($P<0.05$) in eggs from meat-type hens. Their eggs were significantly heavier at the age of 40 to 48 weeks in comparison to eggs from egg-type hens.

CONCLUSIONS

Due to higher ratio of yolk to albumen the eggs of meat-type hens ought to be used for such production where yolks are separated from albumens while eggs from egg-type hens ought to be used as table eggs in shells.

Within both types of hens the ratio of yolk to albumen increases over hen age, therefore eggs from younger hens of any type are more suitable for sale in shells while eggs of older hens could used for processing.

The selection of hens to higher egg weight within the meat-type hens does not increase the ratio of yolk to albumen.

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