CERTAIN EGG QUALITY PARAMETERS OF GRAY GUINEA FOWL IN EXTENSIVE REARING

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Abstract. This paper presents results of determination of certain quality parameters and its phenotypic correlation in eggs originated from extensively reared gray variety of Guinea fowl. A total of 150 egg collected by sampling 30 eggs in each of five analyzed laying months were used for egg quality evaluation and statistical analysis by methods of descriptive statistics and simple linear correlation. Average egg weight, shape index and shell thickness was 38.14 g, 76.03% and 0.49 mm, respectively. Average shell, yolk and albumen weight was 5.83, 12.16 and 20.23 g, respectively, and its proportion was 15.23, 32.10 and 52.69%, respectively. Average values of yolk height, diameter, index and color were 16.54 mm, 39.95 mm, 41.50%, and 13.76, whereas values for albumen diameter, index and height as well Haugh units were 59.30 mm, 9.62%, 5.67 mm, and 82.58, respectively. Majority of examined quality parameters showed significant correlation with other parameters. Egg weight was positive correlated ($p<0.01$) with egg length (0.76) and width (0.92), shape index (0.22), shell thickness (0.60), shell weight (0.81) and proportion (0.44), albumen (0.92) and yolk weight (0.77) and yolk index (0.23), but in negative connection ($p<0.01$) with yolk proportion (-0.54), yolk/albumen ratio (-0.41) and albumen index (-0.25). Determined egg quality indicated good potential of this species in extensive rearing, which could be improved and used in more favorable rearing conditions.

Key words: Guinea fowl, egg quality, phenotypic correlation

Introduction

Guinea fowl (*Numida meleagris*) is one of rarely reared poultry species, usually kept in extensive or semi-intensive conditions. Regardless of its long presence in Bosnia and Herzegovina, Guinea fowl is still kept as an exotic bird, with unrecognized production potential. Egg productivity of gray variety of Guinea fowl in those conditions reaches nearly 100 eggs or less *(Kuzniacka et al., 2004; Nickolova, 2009; Bernacki et al., 2013)* with specific quality characteristics (e.g.

lower egg weight, pyriform egg shape, thicker and stronger shell) different from eggs of other poultry species *(Song et al., 2000)*. Differences in egg production and quality among different varieties *(Nowaczewski et al., 2008; Bernacki et al., 2013)* as well variations in egg quality during laying season *(Nickolova, 2009)* in semi-extensive conditions or during egg storage *(Banaszewska et al., 2015)* are observed. However, recent studies regarding egg quality in extensive rearing of this species are rare, especially in conditions of Bosnia and Herzegovina. Therefore, aim of this study was to determine certain egg quality parameters and its phenotypic correlation in gray Guinea fowl reared in extensive conditions.

Materials and methods

Study was performed from May to August 2015, using one flock of grey Guinea fowl reared in extensive condition in mountain region of western part of Republic of Srpska – Bosnia and Herzegovina. Birds were kept in provisional object under natural light, with all day open access to forested field and feed only with cereals given in morning hours. During five examined laying months, a total of 150 eggs were used for quality analysis. In the last week of every month 30 eggs were collected and then individually marked and stored one day at 6°C prior to analysis. Egg weight was measured with electronic scale (0.00 g), and egg height and width with electronic caliper (0.00 mm). Those data were used for calculation of egg shape index, according to formula: Egg shape index (%) = (egg width / egg length) x 100. Eggs were then broken and the following internal quality parameters were measured: yolk and albumen height, with tripod micrometer (0.00 mm), yolk diameter and albumen minimal and maximal diameter, with electronic caliper (0.00 mm) and yolk color, with yolk color fan. Obtained data were used for following calculations: Yolk index (%) = (yolk height / yolk diameter) x 100; Yolk / Albumen ratio = yolk weight / albumen weight; Albumen index (%) = [albumen height / (minimal + maximal albumen diameter / 2)] x 100 and Haugh unit = 100 log x (albumen height + 7.57 – 1.7 x egg weight $^{0.37}$) *(Haugh, 1937)*. Electronic scale (0.00 g) was used for measuring of yolk weight after its separation from albumen and shell weight after one day long drying at room temperature. Weight and proportion of egg components was calculated as: Albumen weight (g) = Egg weight – (yolk weight + shell weight); Yolk proportion (%) = (yolk weight / egg weight) x 100; Albumen proportion (%) = (albumen weight / egg weight) x 100 and Shell ratio (%) = (shell weight / egg weight) x 100. Shell thickness was measured at blunt, equatorial and sharp region with electronic caliper (0.00 mm). Shell parameters were calculated as follows: Average shell thickness = (thickness of blunt part + thickness of equatorial part + thickness of sharp part) / 3; Shell weight per unit surface (g/cm^2) = shell weight / shell surface area (*Curtis et al*., 1985). Statistical analysis was performed using methods of descriptive statistics and simple linear correlation in software package SPSS.

Results and Discussion

External quality parameters of examined Guinea fowl eggs are presented in table 1. Average value for egg weight in our study was relatively lower when compared to results got in eggs from extensive rearing in study of *Kuzniacka et al. (2004)*. Higher average weight are reported for eggs originated from semi-intensive, e.g. 39.19 g *(Wilkanowska and Kokoszyński, 2010)*; 40.14 g *(Alkan et al., 2013)* and 40.38 g *(Nickolova, 2009)* and intensive conditions, e.g. 48.9 g *(Ancel and Girard, 1992)*. Mean egg length and width found in this study was comparable with 49.4 and 37.47 mm found by *Wilkanowska and Kokoszyński (2010)*, or 49.47 and 37.89 mm reported by *Alkan et al. (2013)*. Especially higher values of egg length and width (55.4 and 51.7 mm) were reported by *Ancel and Girard (1992)*.

Table 1. Parameters of egg external quality

Parameters	Mean	Min	Max	SE	CV
Egg weight (g)	38.14	30.32	45.99	0.355	10.02
Egg length (mm)	49.24	44.67	52.10	0.136	2.98
Egg width (mm)	37.42	34.58	40.04	0.105	3.03
Egg shape index (%)	76.03	71.27	80.71	0.184	2.61
Shell thickness (mm)	0.49	0.29	0.64	0.006	14.10
Shell weight per surface area (g/cm^2)	0.11	0.06	0.14	0.002	14.82

Egg shape index values indicate normal shape of analyzed eggs, which is comparable with average of 76.60% reported by *Alkan et al. (2013)*. Lower findings are 73.7% in meat or 74.7% in domestic type of Guinea fowl, reported by *Nowaczewski et al. (2008)*, but there are also higher values in the literature, as 77.8% found by *Kuzniacka et al., (2004)* or 79.4% *(Ancel and Girard, 1992)*. Average shell thickness and shell weight per surface area and their coefficients of variation were the highest among all external parameters in this study. Similar values for thickness (0.48 mm) are reported by *Kuzniacka et al. (2004)*. Lower value of egg shell thickness (0.440 mm) was found by *Bernacki et al. (2013)*, but higher (0.55 mm) by *Nickolova (2009)*. Average unit surface shell weight was equivalent to 0.11 found by *Alkan et al. (2013)* or 102 in white and 101 mg/cm^2 in pearl variety *(Bernacki et al., 2013)*.

Weight and proportions of egg parts are presented in Table 2.

Table 2. Weight and proportion of egg parts

Parameters	Mean	Min	Max	SE	CV
Shell weight (g)	5.83	2.84	8.14	0.101	18.62
Albumen weight (g)	20.23	13.97	24.60	0.241	12.19
Yolk weight (g)	12.26	9.27	14.48	0.098	8.21
Shell share (%)	15.23	8.94	19.85	0.198	14.03
Albumen share (%)	52.69	43.60	59.20	0.267	5.19
Yolk share (%)	32.10	28.77	38.05	0.215	6.87

Average egg structure, regarding shell, albumen and yolk weight, and their shares was similar to results found by *Nowaczewski et al. (2008)* with 15.6, 53.0 and 31.4%, respectively, *Banaszewska et al. (2015)* with 15.63, 51.66 and 32.71%, respectively, as well as *Alkan et al. (2013)* and *Bernacki et al. (2012)*. Higher shell (22.0%) and lower albumen proportion (46.1%) were found by *Kuzniacka et al. (2004)*, while *Nickolova (2009)* got higher shell (20.18%) and lower yolk proportion (29.29%).

Quality parameters of yolk and albumen are presented in table 3.

Table 3. Parameters of internal egg quality

Parameters	Mean	Min	Max	SE	CV
Yolk height (mm)	16.54	14.20	18.30	0.086	5.51
Yolk diameter (mm)	39.95	34.66	42.77	0.135	3.63
Yolk index (%)	41.50	35.15	47.21	0.237	6.06
Yolk color	13.76	10.00	15.00	0.103	8.05
Albumen diameter (mm)	59.30	47.59	71.56	0.435	7.87
Albumen height (mm)	5.67	4.50	6.78	0.040	7.66
Albumen index (%)	9.62	6.99	12.08	0.086	9.60
Haugh units	82.58	74.72	89.75	0.265	3.46
Yolk/albumen ratio	0.61	0.49	0.87	0.007	11.57

Average yolk height and diameter were comparable to findings of several authors, as 16.4 and 37.3 mm in study of *Bernacki et al., (2012)*, 15.7 and 38.2 mm found by *Kuzniacka et al. (2004)* or 15.20 and 39.83 mm found by *Banaszewska et al. (2015)*. Average yolk index in our study indicated satisfying quality of analyzed eggs. Lower values were reported by *Wilkanowska and Kokoszyński (2010)* for pearl (37.86%) and white variety of Guinea fowl (39.80%). *Bernacki et al. (2012)* found higher values in white (43.4%) and pearl variety (44.0%). Yolk color was

darker, compared with findings of 9.69 *(Bernacki et al., 2012)* or 10.25 *(Nickolova, 2009). Banaszewska et al. (2015)* also found darker color (14.60), similar to our findings.

Average value of albumen height in our study was similar to report of *Kuzniacka et al. (2004),* who got average value of albumen height of 5.6 mm, while *Alkan et al. (2013)* found average albumen height of 4.77 mm. Average value of albumen index in our study was higher than 7.05%, found in pearl, or 8.29%, found in white variety *(Wilkanowska and Kokoszyński, 2010)* or 6.79% found by *Alkan et al. (2013)*. Haugh units in this research indicated high egg quality, comparable with values of 82.1 found in white or 82.7 found in pearl variety by *Bernacki et al. (2012)*, and was better than value of 74.97 found by *Alkan et al. (2013). Nickolova (2009)* got values of Haugh units above 95.61 during entire laying season. Calculated mean yolk/albumen ratio in our study was higher than 0.55 observed by *Song et al. (2000)*, or 0.51 in meat and 0.59 in domestic type, found by *Nowaczewski et al. (2008)*. Higher mean yolk/albumen ratio (0.68) was found by *Alkan et al. (2013)*.

Phenotypic correlation among internal and external egg quality parameters are presented in table 4.

Table 4. Coefficients of simple correlation (r) between egg quality parameters

	EL	EW	SI	ST	SW	SP	AW	AP	YW	YP	YA	YI	AI	HU
EM	.76**	.92**	.22**	.60**	.81**	.44**	.92**	.11	.77**	-.54**	-.41**	.23**	-.25**	-.09
EL		.62**	-.39**	.28**	.53**	.20*	.70**	.07	.68**	-.27**	-.21*	.13	-.21*	-.07
EW			.48**	.52**	.75**	.42**	.82**	.03	.75**	-.43**	-.30**	.22**	-.27**	-.13
SI				.30**	.28**	.26**	.18*	-.04	.11	-.20**	-.12	.11	-.08	-.06
ST					.89**	.89**	.36**	-.42**	.46**	-.33**	-.03	.02	-.28**	-.35**
SW						.88**	.59**	-.32**	.62**	-.44**	-.14	.13	-.28**	-.24**
SP							.16	-.59**	.35**	-.22**	.13	.01	-.22**	-.31**
AW								.49**	.53**	-.73**	-.70**	.25**	-.16	.08
AP									-.37**	-.66**	-.88**	.13	.14	.40**
YW										.12	.22**	.14	-.27**	-.26**
YP											.93**	-.17*	.03	-.19*
YA												-.17*	-.04	-.31**
YI													.31**	.22**
AI														.65**

EM – egg weight; EW – egg width; EL – egg length; SI – shape index; ST – shell thickness; SM – shell weight; SP – shell proportion; AW – albumen weight; AP - albumen proportion; YW – yolk weight; YP – yolk proportion; YA – yolk/albumen ratio; YI – yolk index; AI – albumen index; HU – Haugh units. * $p<0.05$; ** $p<0.01$

The lowest coefficients of correlation in our study was found for albumen proportion vs. yolk/albumen ratio and the highest for yolk proportion vs. yolk/albumen ratio. Egg weight was positive correlated with egg length and width, which is in agreement with *Bernacki et al. (2012)*, *Tebesi et al. (2012)* and *Alkan et al. (2013)*. Moreover, positive correlation of egg weight with shape index in this research are analogous with *Kuzniacka et al. (2004)*, *Bernacki et al. (2012)* and *Alkan et al. (2013)*, but contrary to *Nowaczewski et al. (2008)*. Significant correlation of egg weight with shell, albumen, and yolk weight was also found by *Bernacki et al. (2012)*, *Nowaczewski et al. (2008)* and *Alkan et al. (2013)*. Regarding egg part proportions, egg weight was in positive correlation with shell and in negative correlation with yolk, which is also described by *Alkan et al. (2013)*. *Kuzniacka et al. (2004)*, *Bernacki et al. (2012)* and *Nowaczewski et al. (2008)* reported different positive and negative correlation of egg weight with egg part proportions. Positive correlation was also detected for egg weight with shell thickness and yolk index. Positive correlation of egg weight with shell thickness is also reported by *Nowaczewski et al. (2008)* and *Alkan et al. (2013)*. Negative connections of egg weight in this study were found with yolk/albumen ratio and albumen index. Negative correlation of egg weight with yolk/albumen ratio was also noticed by *Nowaczewski et al. (2008)*.

Increase in shell index in this study was followed with increase in egg width and decrease in egg length. This is in accordance with results of *Bernacki et al. (2012)*, *Alkan et al. (2013)* and *Tebesi et al. (2012)*. Also, shell index was in positive correlation with shell thickness, weight and proportion, as well as with albumen weight, but was in negative correlation with yolk proportion. Positive correlation of shape index with shell and yolk weight was found by *Alkan et al. (2013)*. Increase in shell, albumen, and yolk weight as well as shell thickness, according to *Nowaczewski et al. (2008)*, resulted in decrease of egg shape index.

Our results showed that shell weight was good predictor for egg length, egg width, shell thickness, shell proportion and albumen weight. *Alkan et al. (2013)* found parallel increase in shell weight with egg width and length, shell thickness and proportion, but also inverse direction with albumen proportion. Positively correlated parameters with shell weight were albumen weight, shell thickness and proportion *(Bernacki et al., 2012)*, yolk and albumen weight, shell proportion and thickness *(Nowaczewski et al., 2008)*, egg length, shell proportion and thickness *(Tebesi et al., 2012)*. Negative correlation with shell weight was found for albumen and yolk proportion, as well as albumen index and Haugh units. Negatively correlated parameters with shell weight were yolk proportion in study of *Bernacki et al. (2012)*, yolk proportion and yolk/albumen ratio, according to *Nowaczewski et al. (2008)*, and shape index *(Tebesi et al., 2012)*.

Albumen weight was in positive correlation with egg length and width, albumen proportion, yolk weight, yolk index and shell thickness. Negative correlation of albumen weight was found for yolk proportion and yolk/albumen ratio. *Bernacki et al. (2012)* found positive connection among albumen weight with egg length, shape index and albumen proportion, but also negative with egg width, yolk and shell proportion and Haugh units. *Alkan et al. (2013)* found positive correlation with egg width and albumen index, but negative with yolk/albumen ratio, albumen and yolk proportion. *Nowaczewski et al. (2008)* recorded shell and yolk weight, albumen proportion and shell thickness as positive, and yolk proportion and yolk/albumen ration as negative correlated to albumen weight. *Kuzniacka et al. (2004)* reported that weight and proportion of albumen and yolk was positive correlated, but shell proportion was negative correlated to albumen weight. *Tebesi et al. (2012)* found that egg width and length, and albumen proportion are in positive, whereas yolk weight and proportion, yolk and albumen index, and Haugh units were in negative correlation to albumen weight.

Yolk weight was in positive correlation with egg length and width, shell weight and proportion, albumen weight, shell thickness, and yolk/albumen ratio. Negative relation of yolk weight was with found with albumen proportion, albumen index and Haugh units. *Bernacki et al. (2012)* reported that yolk weight had positive correlation with egg width and length, and yolk proportion, but negative with albumen and shell proportion. *Alkan et al. (2013)* found that yolk weight had positive direction with egg width and length, shell weight and thickness, shape index, shell and yolk proportion, and yolk/albumen ratio, but negative with albumen proportion. Positively correlated parameters to yolk weight were albumen weight, and shell weight and thickness *(Nowaczewski et al., 2008)*; or shape index, albumen weight, and shell and yolk proportion *(Kuzniacka et al., 2004)*. *Tebesi et al. (2012)* found egg length and Haugh units as positive, and albumen weight and proportion as negative correlated to yolk weight.

Conclusion

Evaluation of Guinea fowl egg quality showed satisfactory result obtained by determination of standard parameters such as Haugh units, albumen and yolk index or yolk color. Also, these results indicated good potential of this species in extensive rearing, which could be improved and used in more favorable rearing conditions. Significant phenotypic correlations observed among majority of quality parameters can be used in indirect egg quality evaluations. This research contributes to knowledge on Guinea fowl egg quality and therefore can be useful for breeders in field of reproduction or table egg production in order to improve productivity of this species.

Pokazatelji kvaliteta jaja sive biserke u ekstenzivnom gajenju

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Rezime

U radu su prikazani rezultati određivanja pokazatelja kvaliteta i njihove fenotipske korelacije kod jaja sivog soja biserke gajene u ekstenzivnim uslovima. Trideset jaja je sakupljeno u svakom od pet ispitivanih meseci nošenja, tako da je ukupno 150 jaja korišćeno za određivanje kvaliteta i statističku analizu primenom metoda deskriptivne statistike i proste linearne korelacije. Prosečna masa jaja, dužina jaja, širina jaja, indeks oblika ljuske, debljina ljuske i masa ljuske po jedinici površine iznosili su 38,14 g; 49,24 mm; 37,42 mm; 76,03%; 0,49 mm i 0,11 g/cm^2, redom. Prosečna masa ljuske, belanca i žumanca bila je 5,83; 20,23 i 12,26 g, redom, a njihov udeo 15,23; 52,69 i 32,10%, redom. Prosečna visina, prečnik, indeks i boja žumanca iznosili su 16,54 mm; 39,95 mm; 41,50% and 13,76, redom. Prosečan prečnik, indeks i visina belanca, kao i Haughove jedinice i odnos žumance/belance iznosili su 59,30 mm; 9,62%; 5,67 mm; 82,58 i 0,61, redom. Većina ispitivanih pokazatelja kvaliteta pokazala je značajnu fenotipsku korelaciju sa drugim pokazateljima. Masa jaja bila je u pozitivnoj korelaciji (p<0,01) sa dužinom (0,76), širinom (0,92) i indeksom oblika jaja (0,22), zatim debljinom (0,60), masom (0,81) i udelom ljuske (0,44), masom belanca (0,92) i žumanca (0,77), te indeksom žumanca (0,23), ali u negativnoj (p<0,01) sa udelom žumanca (-0,54), odnosnom žumance / belance (-0,41) i indeksom belanca (-0,25). Kvalitet jaja biserke određen u ekstenzivnom gajenju upućuje na njen dobar potencijal koji bi se mogao unaprediti i koristiti u povoljnijim uslovima gajenja.

Ključne reči: biserka, kvalitet jaja, fenotipska korelacija

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