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Changes of Selected Egg Quality Traits Depending on the Laying Period of Semi-Intensively Raised Guinea Fowl Hens

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Abstract

The aim of this study was to evaluate selected egg quality traits depending on the laying period of pearl grey guinea fowl hens reared in semi-intensive system. In each of three evaluation terms (the second, fourth and sixth month of laying period) 40 eggs were collected, with the total of 120 eggs were used for quality evaluation. Methods of descriptive analysis and one-way ANOVA were used for data analysis. Overall values of three evaluation terms for egg weight, shell thickness, yolk to albumen ratio, Haugh units and yolk colour were 40.63 ± 0.27 g, 0.50 ± 0.01 mm, 0.58 ± 0.01, 75.37 ± 0.41 and 12.74 ± 0.11, respectively, whereas overall values of shell, albumen and yolk proportion were 15.32 ± 0.15, 53.75 ± 0.16 and 30.94 ± 0.17%, respectively. Significant differences were found for values of egg quality traits depending on the laying period, but the average value was generally comparable with literature data reported for similar rearing conditions for this Guinea fowl variety.

Key words: Guinea fowl, egg quality, semi-intensive rearing

Introduction

Guinea fowl (*Numida meleagris*) in Bosnia and Herzegovina is mainly reared in extensive or semi-intensive conditions, usually as small backyard flocks. Pearl grey variety is the most common variety of this species, whereas white, black or lavender varieties are considerably less represented in local populations.

The laying season of pearl grey Guinea fowl lasts for five to six months, and up to 100 eggs can be produced per a laying hen in extensive or semi-intensive conditions (Kuzniacka et al., 2004; Nickolova, 2009; Bernacki et al., 2012). These eggs are known for their specific physical quality, particularly egg shape and shell thickness (Adamski, 2008), as well as for high preservation of internal quality during storage (Banaszewska et al., 2015). Physical quality traits are considered as important factors which determine suitability of eggs, either for hatching or consumption. Hatchability could be influenced by several quality traits, such as egg weight or shell and albumen quality (Bernacki et al., 2012; Moreki & Mothei, 2013). Also, consumers' perception of egg quality is based on egg weight, shell strength and color, albumen consistency and yolk colour (Hernandes et al., 2005). Certain differences in physical quality traits of Guinea fowl eggs could be observed between different varieties (Nowaczewski et al., 2008; Bernacki et al., 2012; Kgwatalala et al., 2013), during the laying period (Adamski, 2008; Nickolova, 2009; Premavalli et al., 2015), or could be related to hen nutrition (Nahashon et al., 2007). Literature data on egg quality in rearing conditions of Bosnia and Herzegovina are scarce, although they could be interesting for poultry breeders or consumers. Therefore, the aim of this study was to determine physical quality parameters of eggs depending on laying period of pearl grey Guinea fowl hens reared as one small flock in semi-intensive conditions.

Material and Methods

A total of 120 eggs were collected from one flock of pearl grey variety of native Guinea fowl maintained without selection or breeding program and reared in semi-intensive conditions in the north region of the Republic of Srpska (Bosnia and Herzegovina). Egg quality evaluation was performed three times: during the second week of the second, the fourth and the sixth month of the laying season (April, June and August 2018, respectively) using a sample of 40 eggs for each term. Egg weight (g) was determined using electronic scale (0.01 g). Shell colour was measured on blunt region of eggs using colorimeter (Konika Minolta, CR400, Japan) and presented as values of L* (lightness), a* (redness), and b* (yellowness). Then, eggs were broken on flat surface in order to measure albumen height (mm) with micrometer (0.01 mm) and to determine yolk colour using Roche yolk colour fan with 15 point scale. Yolk weight (g) was measured after albumen separation using electronic scale (0.01 g), whereas weight of shell with membranes (g) was measured after 24 hours of drying at the room temperature. Shell thickness (mm) was measured on three different parts of blunt, equatorial and sharp region by an electronic calliper (0.01 mm).

Results of direct measurements were used for calculation of the following parameters according to formulas given by Alkan et al. (2013): Shell surface area (cm^2) = 3.9782 x egg weight $^{0.75056}$; Shell weight per surface unit (g/cm^2) = shell weight / shell surface area; Average shell thickness (mm) = (average thickness of blunt region + average thickness of equatorial region + average thickness of sharp region) / 3; Albumen weight (g) = egg weight – (yolk weight + shell weight); Shell proportion (%) = (shell weight / egg weight) x 100; Albumen proportion (%) = (albumen weight / egg weight) x 100; Yolk proportion (%) = (yolk weight / egg weight) x 100; Yolk to albumen ratio = yolk weight / albumen weight; Haugh units = 100log [albumen height – (1.7 x egg weight $^{0.37}$) + 7.57]. Methods of descriptive analysis and one-way ANOVA with *post hoc* Tukey's HSD test were used for statistical data analysis.

Results and Discussion

External quality traits of pearl grey Guinea fowl eggs are presented in Table 1. Egg weight can be influenced by rearing conditions, variety, body weight or laying intensity of Guinea fowl hens (Nahashon et al., 2007; Nowaczewski et al., 2008; Obike & Azu, 2012; Bernacki et al., 2013).

Tab.1. Egg weight and shell quality traits (M ± SE)
Маса јаја и својства квалитета љуске јаја (аритметичка средина ± стандардна грешка)

Quality trait		Evaluation terms 1	2	3	Total
Egg weight, g		40.80 ± 0.42	40.97 ± 0.49	40.10 ± 0.48	40.63 ± 0.27
Shell color	L*	67.17 ± 0.60^{B}	69.94 ± 0.55^{A}	71.41 ± 0.64^{A}	69.51 ± 0.38
	a*	12.85 ± 0.36^{A}	13.77 ± 0.33^{A}	9.85 ± 0.44^{B}	12.16 ± 0.27
	b*	14.94 ± 0.60^{B}	20.07 ± 0.47^{A}	19.94 ± 0.49^{A}	18.32 ± 0.45
Shell thickness in mm	sharp region	0.55 ± 0.01^{A}	0.50 ± 0.01^{B}	0.48 ± 0.01^{B}	0.51 ± 0.01
	eq. region	0.55 ± 0.01^{A}	0.49 ± 0.01^{B}	0.47 ± 0.01^{B}	0.50 ± 0.01
	blunt region	0.53 ± 0.01^{A}	0.46 ± 0.01^{B}	0.44 ± 0.01^{B}	0.48 ± 0.01
Average shell thickness, mm		0.54 ± 0.01^{A}	0.48 ± 0.01^{B}	0.47 ± 0.01^{B}	0.50 ± 0.01
Shell weight per surface unit, g/cm^2		0.104 ± 0.001^{A}	0.097 ± 0.001^{B}	0.091 ± 0.002^{B}	0.097 ± 0.001

Note: ^{AB} – values in the same row with different letters in superscript are statistically different at p<0.01

Average egg weight for all period in this research was 40.63 g with no significant differences among evaluation terms ($p>0.05$). This value is comparable with average egg weight for the entire laying period, reported by Nickolova (2009) (40.38 g) and Bernacki et al. (2013) (40.80 g) in semi-intensive rearing. Egg weight in extensive rearing conditions was 40.10 g in the study by Kuzniacka et al. (2004) or 38.14 g in the study by Vekić et al. (2018). Significant changes in egg weight during the laying season were observed by Adamski (2008), Nickolova (2009) and Premavalli et al. (2015). This trait is one of hatchability factors, so it is an important quality trait for breeders. Moreki and Mothei (2013) found that hatchability of medium-sized hatching eggs (39-42 g) was higher than in smaller or larger eggs.

Concerning shell colour, average values in total sample for L*, a* and b* were 69.51, 12.16 and 18.32, respectively. Also, significant variations of shell colour expressed in CIELab indicators were determined depending on the evaluation term ($p<0.01$). Average values of L* (74.38) and b* (20.71) reported by Eleroğlu et al. (2016) in the eggs of 42-week-old Guinea fowl were comparable to our results, but value of b* (4.61) was lower. Shell coloration in brown laying hens is a process influenced by a housing system, hen age, hen strain, diet, stressors, and certain diseases, as reviewed by Samiullah et al. (2015).

Well-known shell thickness of Guinea fowl is probably relict from a selective evolution, designed to protect eggs from predators. However, years of selection in some domestic varieties decreased thickness by 20% (Ancel & Girard, 1992). Average values of shell thickness measured on blunt, equatorial and sharp region for total sample were 0.48, 0.50 and 0.51 mm, respectively, whereas average shell thickness was 0.50 mm. Ancel & Girard (1992) obtained slightly lower values of regional shell thickness (0.471, 0.489, 0.496 mm, respectively), whereas Alkan et al. (2013) reported higher values (0.53, 0.54, 0.55 mm, respectively). Some authors found shell thickness values higher than 0.50 mm (Adamski, 2008, Nowaczewski et al., 2008; Nickolova, 2009; Alkan et al., 2013). Contrary to this, lower values were reported by Kuzniacka et al. (2004) and Vekić et al. (2018). Regional values of shell thickness, as well as average shell thickness were higher in the first term compared to the values in the second and the third evaluation terms ($p<0.01$). Variation of shell thickness during the laying period was also observed by Nickolova (2009), but without statistical significance, while Adamski (2008) measured significantly thicker shell in the early stage compared to peak and late stages of the laying period, which is in accordance with our findings. Thicker shell is usually considered as unsuitable in hatching eggs (Bernacki et al., 2013), but Yamak et al. (2016) achieved similar hatchability results in eggs categorized as thin-, medium- and thick-shelled (<0.31, 0.31-0.35 and >0.35 mm, respectively).

Average shell weight per surface was 0.097g/cm^2 for total sample, but significantly higher value was determined in the first compared to the second and third evaluations terms ($p<0.01$). Bernacki et al. (2013) obtained values of 101 and 102 mg/cm^2 in gray and white variety of Guinea fowl, respectively, whereas the value of 0.11 g/cm^2 was reported by Alkan et al. (2013) and Vekić et al. (2018).

Egg structure and internal egg quality traits are presented in Table 2. Average weight of shell, albumen and yolk was 6.23, 21.84 and 12.55g in the total sample, respectively. Albumen and yolk weight were not affected by the evaluation term ($p>0.05$), while this was not observed for shell weight ($p<0.01$). Regarding egg component weight, Adamski (2008) observed only lower yolk weight in the early phase, while shell and albumen weights were comparable in early, peak and late phases of the laying period. Nickolova (2009) reported significant changes of all egg component weights during six month-long laying season.

Tab. 2. Egg structure and internal quality traits (M ± SE)
Структура и својства унутрашњег квалитета јаја (аритметичка средина ± стандардна грешка)

Quality trait	Evaluation terms			Total
	1	2	3	
Shell weight, g	6.67 ± 0.10^{Aa}	6.25 ± 0.13^{ABb}	5.78 ± 0.14^{Ba}	6.23 ± 0.08
Albumen weight, g	21.63 ± 0.27	22.37 ± 0.28	21.52 ± 0.29	21.84 ± 0.16
Yolk weight, g	12.50 ± 0.16	12.36 ± 0.18	12.81 ± 0.12	12.55 ± 0.10
Shell proportion, %	16.36 ± 0.19^{A}	15.22 ± 0.21^{Ba}	14.37 ± 0.25^{Bb}	15.32 ± 0.15
Albumen proportion, %	53.00 ± 0.29^{B}	54.62 ± 0.28^{Aa}	53.63 ± 0.24^{ABb}	53.75 ± 0.16
Yolk proportion, %	30.64 ± 0.23^{B}	30.16 ± 0.31^{B}	32.00 ± 0.26^{A}	30.94 ± 0.17
Yolk to albumen ratio	0.58 ± 0.01^{ABa}	0.55 ± 0.01^{Bb}	0.60 ± 0.01^{A}	0.58 ± 0.01
Haugh units	79.17 ± 0.58^{A}	75.37 ± 0.58^{B}	71.58 ± 0.34^{C}	75.37 ± 0.41
Yolk color, Roche points	13.55 ± 0.16^{A}	12.68 ± 0.17^{B}	12.00 ± 0.12^{C}	12.74 ± 0.11

Note: ^{AB} – values in the same row with different letters in superscript are statistically different at $p<0.01$
Note: ^{ab} – values in the same row with different letters in superscript are statistically different at $p<0.05$

Average shell, albumen and yolk proportion in our research were 15.32, 53.75 and 30.94%, respectively, and were influenced by the evaluation term ($p<0.01$; $p<0.05$). These values are close to values reported by Nowaczewski et al. (2008) (15.6, 53.0 and 31.4%, respectively) or Bernacki et al. (2013) (14.0, 53.0 and 33.0%, respectively). Higher shell and lower yolk proportion were reported by Nickolova (2009). Adamski (2008) found identical egg component proportions in early, peak and late phases of the laying period, which is opposite to the results of Nickolova (2009).

The average value of yolk to albumen ratio for total sample was 0.58, but significant variations were observed among the evaluation terms ($p<0.01$; $p<0.05$). This value is lower than 0.68 and 0.61, reported by Alkan et al. (2013) and Vekić et al. (2018), respectively, but close to 59.3% found by Nowaczewski et al. (2008).

Haugh units, as a commonly used indicator of egg quality, in this study were 75.37 for the total sample, but the values were influenced by the evaluation term ($p<0.01$). Similar values were reported by Alkan et al. (2013) (74.97) and Wilkanowska and Kokoszyński (2010) (75.58), whereas higher values were reported by Bernacki et al. (2012) (82.7), Vekić et al. (82.58) and Nickolova (2009) (95.61). Haugh units higher than 72 indicate quality grade AA (USDA, 2000), i.e. high albumen quality and good suitability for long storage. Albumen quality is primarily influenced by the age of laying hens, as reviewed by Williams (1992), so that Haugh unit scores decrease while variability of scores increases with the ageing of hens. Variations of Haugh units due to age of Guinea fowl hens were confirmed by Premavalli et al. (2015).

Regarding yolk colour, overall value in this research was 12.74 points, and this trait showed significant variation depending on the evaluation term ($p<0.01$). Lighter yolk colours, mostly around 10 points, were found by Adamski (2008), Nickolova (2009) and Bernacki et al. (2012), while darker colours were found by Banaszewska et al. (2015) and Vekić et al. (2018). Variation in yolk colour, possibly due changes in feed composition and feed intake, during the laying period was also reported by Adamski (2008), Nickolova (2009) and Premavalli et al. (2015). The yolk colour intensity is primarily affected by content and ratio of yellow and red carotenoids in feed, although ability to transport these pigments into yolk can be individual the characteristic of laying hens, as reviewed by Karunajeewa et al. (1984).

Conclusion

Results of this study show that some egg quality traits have significant variations during the laying period as consequences of aging of Guinea fowl hens, as well as environmental conditions, which can be a subject of further research. Lower values of shell and albumen quality traits as well as yolk colour found in the late stage indicate reduced egg quality compared to the early stage of the laying period. Average values of egg quality traits in this research were generally in the range of acceptable values, and in accordance with literature data.

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Промјене одабраних показатеља квалитета јаја зависно од периода ношења бисерке у полуинтензивном гајењу

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Сажетак

Циљ овога истраживања био је да се утврде одабрани показатељи квалитета јаја у зависности од периода ношења бисерке гајене у полуинтензивним условима. У сваком од три термина оцјене квалитета (други, четврти и шести мјесец ношења) сакупљено је по 40 јаја, тако да је анализиран квалитет укупно 120 јаја. Подаци су обрађени методама дескриптивне анализе и једноструке анализе варијансе. Просјечна вриједност у три термина оцјене за масу јаја, дебљину љуске, однос жуманца и бјеланца, Хау јединице и боју жуманца износила је 40,63 ± 0,27 g; 0,50 ± 0,01 mm; 0,58 ± 0,01; 75,37 ± 0,41 и 12,74 ± 0,11, редом, док су вриједности за удио љуске, бјеланца и жуманца биле 15,32 ± 0,15; 53,75 ± 0,16 и 30,94 ± 0,17%, редом. Значајне разлике су утврђене за вриједности показатеља квалитета јаја у зависности од периода ношења, док су просјечне вриједности биле генерално упоредиве са литературним подацима добијеним у сличним условима гајења.

Кључне ријечи: бисерка, квалитет јаја, полуинтензивно гајење

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