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CHANGES OF CERTAIN QUALITY CHARACTERISTICS OF GUINEA FOWL'S EGGS DEPENDING ON STORAGE CONDITIONS

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Abstract. The aim of the study was to assess quality traits of guinea fowl's eggs as well as the influence of storage length and conditions on these features. The study material consisted of 50 grey guinea fowls kept in free range. The first study group consisted of eggs assessed as fresh ones two days after laying (10 eggs). The remaining 40 eggs were divided into two groups, 20 eggs in each. One of them was stored in a fridge at 6°C whilst the other was stored at a room temperature (24°C). The analysis was conducted on ten eggs from the two groups after 14 days and on the remaining ten eggs from each group after 28 days. The mean mass of the analysed eggs ranged from 42.10 to 43.11 g and the shape index ranged from 1.18 to 1.29. In the fresh eggs the shell constituted 15.63%, protein 51.66% and yolk 32.71% of the mass. During storage there were changes observed in morphological content: the yolk proportion increased and the egg white decreased. Also the eggs' mass decreased significantly, whilst the air cell size increased. The length of the storage period and temperature conditions influenced certain characteristics of eggs' components, including the area of dense white spread, an increase in yolk diameter and a decrease in its height.

Key words: guinea fowl, eggs, storage

INTRODUCTION

The quality of eggs depends on genetic factors (species, breed, variety) and environmental factors (feeding, living conditions, age), which is confirmed by

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numerous research [Ayorinde 1991, Stadelman and Cotterill 1995, Świątkiewicz and Koreleski 2007, Biesiada-Drzazga and Janocha 2009]. Guinea fowl's eggs are very distinct from eggs of other poultry species, including hen's eggs [Bernacki and Heller 2003, Bernacki et al. 2013]. The mass of a fowl's egg ranges fom 35 to 52 g with mean values of 40–43 g [Kozaczyński 1999, Nowaczewski 2011a]. In the peak of the egg laying season (May and June) there is higher yolk proportion and lower shell proportion in the eggs' mass, however, their quality was reported as lowest at that time [Bernacki and Heller 2003]. The density of a guinea fowl's egg is on average just above 1.100 $g \cdot cm^{-3}$ and it is higher than hen's eggs. The mass and morphological content varies depending on the colour variety of guinea fowl [Ayorinde 1991, Stadelman and Cotterill 1995, Song et al. 2000, Baéza et al. 2001, Kuźniacka et al. 2004, Wilkanowska and Kokoszyński 2010, Nowaczewski 2011b, Bernacki et al. 2013, Kgwatalala et al. 2013]. The shells of fowl's eggs are relatively thick and durable compared to outer poultry species of similar body size and have mean thickness of 0.46 mm [Song et al. 2000].

The present study was conducted to fill in the void in research on the influence of storage conditions and length on certain characteristics of eggs. The aim of the research included the evaluation of the factors' influence on certain quality characteristics of guinea fowl's eggs.

MATERIAL AND METHODS

The research material consisted of eggs of grey guinea fowl kept in free range. The study was conducted on a sample of 50 eggs. All of the eggs were assessed externally (i.e. the assessment of their mass and lengths of axes was carried out). The first study group consisted of eggs assessed as fresh ones two days after laying (10 eggs). The remaining 40 eggs were divided into two groups, 20 eggs in each. One of them was stored in a fridge at 6°C and 60% relative humidity, whilst the other was stored at room temperature (24°C) and 45% relative humidity. The analysis was conducted on ten eggs from the two groups after 14 days and on the remaining ten eggs from each group after 28 days.

The standard eggs assessment was carried out according to Mroczek's method [1997], i.e. assessment of a whole egg and after its breaking onto a glass tile.

The assessment of a whole egg included the following aspects:

- the mass of an egg;
- the length of the long and short axes of the egg;
- the height of the air cell.

The assessment after breaking an egg onto a glass tile include the following internal features:

- the mass and thickness of a shell;

- the mass of thin external and internal whites;
- the mass and length and width of dense white spread area;
- the mass, height and colour of yolk (according to 15-point La Roche's scale).

The mass of a whole egg, white and yolk was assessed using electronic scales (Radwag WTB 2000, Radom, Polska) with 0.01 g uncertainty. The lengths of the transverse and longitudinal axes as well as the dense white spread area was measured with an electronic caliper (Stainless Hardened 0–150 mm) with 0.01 mm uncertainty. The height of the air cell was assessed through an egg illumination and with use of a special scale, whilst the shell thickness with a micrometer screw (MMZb-C 0-25/0.01 mm DIN 863-1, HELIOS.PREISSER, Germany) along the short egg axis.

The results were statistically processed: mean values and standard deviations were calculated (StatSoft, Inc 2001). The statistical significance between the means were determined using the Tukey test.

RESULTS AND DISCUSSION

Table 1 shows the results of the eggs assessment depending on the storage conditions and length. The fresh eggs had the mean mass of about 43 g, therefore they can be classified as large eggs according to some authors [Moreki and Mothei 2013] (Table 1). The mass of the eggs assessed by the mentioned authors ranged from 39 to over 42 g. Similar mass of guinea fowl's eggs was observed by Alkan et al. [2013], who observed the average mass of 40 g, but some of the eggs were heavier than 45 g. The present study found that the length of the eggs ranged from 49.36 to 50.41 mm and their width ranged from 38.67 to 41.88 mm (significant statistical differences). Alkan et al. [2013] obtained similar results as in their research the mean egg length reached 49.47 mm and width – 37.89 mm. There was no correlation observed between higher mass and increased length or width of the eggs, which might have been caused by the characteristic shape of guinea fowl's eggs. The examined eggs had correct shape indices (1.18–1.29), characteristic for the species. The egg shape index is always determined for hatching eggs and for table eggs it has a minor significance. It should be emphasised that in Poland guinea fowl's eggs are generally used for hatching, mainly in the wild.

The air cell is a determinant of an egg's freshness and is created in the moment of an egg laying. The air space increases in size as a result of ageing processes and as the content of an egg dries out. The present study revealed the height of the air cell reaching 2.30 mm. The incubation time increased the air space in both cases, however the increase was significantly lower in 6°C compared to 24°C (Table 1). The statistical differences were significant at $P \leq 0.01$.

Table 1. Mean mass and shape of the eggs depending on the storage conditions and length

Tabela 1. Wartości średnie masy i kształtu jaj w zależności od długości i warunków przechowywania

Feature Analizowana cecha		Eggs – Jaja				
		Fresh after lying Świeże po zniesieniu	14 days in storage 14 dni przechowywania		28 days in storage 28 dni przechowywania	
			6°C	24°C	6°C	24°C
Mass of an egg, g Masa jaja, g	x̄ Sd	43.11 3.40	42.94 3.31	42.71 2.92	42.62 3.31	42.10 2.42
Lenght of an egg, mm Długość jaja, mm	x̄ Sd	49.39 1.20	49.38 1.39	49.36 0.93	50.38 2.24	50.41 1.14
Width of an egg, mm Szerokość jaja, mm	x̄ Sd	38.67^{a} 1.13	39.48 1.06	41.88^{b} 4.18	39.19 0.85	39.73 0.95
Shape index – Indeks kształtu		1.28	1.25	1.18	1.29	1.27
Height of sir space, mm Wielkość komory powietrznej, mm	x̄ Sd	2.30^{A} 0.97	2.50^{A} 0.61	3.60^{B} 0.55	3.60^{B} 0.86	5.60^{C} 0.55

a, b – statistically significant differences between the groups at $P \leq 0.05$, A, B – at $P \leq 0.01$.
a, b – statystycznie istotne różnice między grupami przy $P \leq 0,05$, A, B – przy $P \leq 0,01$.

Table 2 shows mean values of selected morphological features of the examined guinea fowl's eggs. The shell mass ranged from 6.74 to 7.51 g, the mass of total white (thin and thick) ranged from 18.85 to 22.27 g. Similar results were obtained by Alkan et al. [2013], who reported that the mean shell mass reached 6.48 g. A considerably high increase of the area of the dense white spreading was observed in the eggs stored at 24°C. The area of the white spread is, after the air cell size, the most important feature indicating the freshness level.

The shells of guinea fowl's eggs are relatively hard and durable compared to other poultry species and they reach mean thickness of 0.46 mm [Song et al. 2000]. Comparing to guinea fowl's eggs, the shell of hen's eggs' thickness ranges from 0.25 to 0.45 mm [Biesiada-Drzazga and Janocha 2009] and depends on the site of measurement. The shells are the thickest at the sharp end of eggs, medium-thick at the blunt end and the thinnest at the equator, at the short axis. According to Malec et al. [1999] the shell thickness depended mainly on genetic factors, however, environmental factors could also significantly influence it. This opinion was confirmed by several authors [Świątkiewicz and Koreleski 2007, Biesiada-Drzazga and Janocha 2009]. The results of the present study revealed that the thickness of guinea fowl's eggs' shells ranged from 0.44 to 0.56 mm, which was consistent with the results of Alkan et al. [2013], Song et al. [2000] and Wilkanowska and Kokoszyński [2010]. It should be added that the shell plays a significant role in an embryo development. In case of table eggs the shell thickness is also significant as it limits the amount of eggs broken both in a poultry

Table 2. Mean values of selected morphological features of guinea fowl's eggs depending on the storage conditions and length

Tabela 2. Wartości średnie wybranych cech składników morfologicznych jaj perlicy w zależności od czasu i warunków przechowywania

Feature Analizowana cecha		Eggs – Jaja				
		Fresh after lying Świeże po zniesieniu	14 days in storage 14 dni przechowywania		28 days in storage 28 dni przechowywania	
			6°C	24°C	6°C	24°C
Mass of a shell, g	x̄	6.74	7.01	7.29	6.92	7.51
Masa skorupy, g	Sd	1.25	0.52	0.77	0.79	0.59
Thickness of a shell, mm	x̄	0.52	0.44^{a}	0.56^{b}	0.48	0.51
Grubość skorupy, mm	Sd	0.07	0.22	0.05	0.03	0.02
Mass of thin external white, g	x̄	7.31^{A}	7.21^{A}	6.92^{A}	4.74^{B}	6.17^{A}
Masa białka rzadkiego zewnętrznego, g	Sd	1.23	1.04	1.16	1.72	1.27
Mass of thin internal white, g	x̄	4.73^{a}	3.39^{b}	3.07^{b}	5.56^{a}	3.26^{b}
Masa białka rzadkiego wewnętrznego, g	Sd	1.11	0.98	0.93	1.43	1.01
Mass of dense white, g	x̄	10.23	10.88	11.24^{a}	10.46	9.42^{b}
Masa białka gęstego, g	Sd	2.11	1.45	1.16	2.04	1.43
Mass of total white, g	x̄	22.27^{a}	21.48^{a}	21.23^{a}	20.76^{a}	18.85^{b}
Masa białka ogółem, g	Sd	1.89	1.22	2.01	1.65	1.08
Length of dense white spread, mm	x̄	83.02^{aA}	77.43^{aA}	94.81^{B}	70.0^{b}	92.40^{B}
Długość rozlewu białka gęstego, mm	Sd	4.29	4.14	5.21	3.54	4.88
Width of dense white spread, mm	x̄	63.56^{Aa}	59.84^{Aa}	68.44^{C}	55.6^{Ba}	74.60^{C}
Szerokość rozlewu białka gęstego, mm	Sd	5.32	3.65	4.92	3.78	7.96

a, b – statistically significant differences between the groups at $P \leq 0.05$, A, B – at $P \leq 0.01$.
a, b – statystycznie istotne różnice między grupami przy $P \leq 0,05$, A, B – przy $P \leq 0,01$.

house and during transport or sale. This feature of guinea fowl's eggs may be a big advantage in their trading.

The hatching of chicks of different poultry species depends inter alia on the shell quality, i.e. on its durability, mass and thickness. Arad and Marder [1982], Christensen [1983], Dohnal et al. [1990] and Puchajda et al. [2000] all analysed eggs of turkey, hens and goose and found that better hatching results were observed in the eggs with thicker shell compared to the eggs with thinner shell. Other authors [Moreki and Mothei 2013] suggested that thick shell was a reason for low hatching results (64%) of guinea fowl kept in free range in African conditions. As mentioned before, the shell of guinea fowl's eggs is relatively thick and additionally the under-shell and white membranes are also thicker and more durable compared to hen's eggs.

Table 3 shows selected characteristics of yolk. The mass of yolk in guinea fowl's egg ranged from 14.10 to 15.47 g with the mean of 34.0% of the eggs' mass. Similar results were obtained by Wilkanowska and Kokoszyński [2010] in pearly grey fowl. The diameter of yolk ranged from 38.77 to 46.91 mm and its height from 10.50 to 15.20 mm (the significance of the differences was statistically

confirmed). With the storage length the height of yolk decreased and its diameter increased. It was especially clear after long storage time (28 days) at a room temperature.

Table 3. Mean values of selected yolk features depending on storage conditions and length

Tabela 3. Wartości średnie wybranych cech żółtka jaj w zależności od długości i warunków przechowywania

Feature Analizowana cecha		Eggs – Jaja				
		Fresh after lying Świeże po zniesieniu	14 days in storage 14 dni przechowywania		28 days in storage 28 dni przechowywania	
			6°C	24°C	6°C	24°C
Mass of yolk, g Masa żółtka, g	x̄ Sd	14.10^{a} 2.11	14.45^{a} 1.88	14.19^{a} 2.03	14.94^{a} 2.00	15.74^{b} 1.07
Diameter of yolk, mm Średnica żółtka, mm	x̄ Sd	39.83^{a} 4.55	38.77^{a} 3.92	42.73^{a} 1.65	41.46^{a} 5.65	46.91^{b} 2.81
Height of yolk, mm Wysokość żółtka, mm	x̄ Sd	15.20^{Ac} 2.01	15.20^{Ac} 1.34	12.00^{a} 1.98	12.90^{a} 2.81	10.50^{Bb} 0.71
Yolk index – Indeks żółtka		2.62^{A}	2.55^{A}	3.56^{B}	3.21^{B}	4.46^{C}
Yolk colour Barwa żółtka	x̄ Sd	14.60^{Aa} 3.01	14.40^{Aa} 0.99	13.00^{b} 0.71	13.00^{b} 1.21	12.40^{B} 0.55

a, b – statistically significant differences between the groups at $P \leq 0.05$, A, B – at $P \leq 0.01$.
a, b – statystycznie istotne różnice między grupami przy $P \leq 0,05$, A, B – przy $P \leq 0,01$.

The yolks of all of the examined eggs were well coloured. The colour was assessed with the 15-point LaRoche scale and ranged from 12.40 to 14.60 points. The storage length changed the yolk's colour to brighter, from 14.60 to 12.40, which could have been caused by carotenoids breakdown.

Table 4 shows the proportions of morphological components in the total egg mass. The mass of the shell in guinea fowl's eggs ranged from 15.63 to 17.84%, the white mass from 44.77 to 51.66%, the yolk mass from 32.71 to 37.39%. In a fresh egg the shell is 15.63% of the whole egg, the white is 51.66% and the yolk 32.71%. It was observed that there was less white and slightly more yolk after storage, regardless of the storage conditions. The increase in the mass of the yolk might have been caused by weakening of the vitelline membrane and water influx from the white. Calik [2013] reported that the water content in yolk was about 48–50% and it could increase to even 56% during storage, which resulted in an increased mass of yolk as observed in the examined eggs. If the water content in yolk exceeds 53% the vitelline membrane may rupture during egg breaking. High air humidity increased water flux into yolk, as its viscosity decreased. The present study revealed that storage conditions were an important factor influencing morphological content of guinea fowl's eggs. Storing eggs at a room temperature clearly increased the proportion of the shell in the egg's mass compared to storing

them in a fridge and decreased the share of the white, which was certainly caused by increased evaporation. It should be noted that despite a very long storage period (28 days) at a room temperature, it was still possible to distinguish between basic white fractions and the yolk was not spilled. Some authors say that guinea fowl's eggs can be stored at a room temperature for three months without significant decrease in their quality [Ross and Golzar 2012].

Table 4. Morphological components proportions in eggs' mass depending on storage conditions and length, %

Tabela 4. Udział składników morfologicznych w masie jaja w zależności od okresu i temperatury przechowywania, %

Feature Analizowana cecha	Eggs – Jaja				
	Fresh after lying Świeże po zniesieniu	14 days in storage 14 dni przechowywania		28 days in storage 28 dni przechowywania	
		6°C	24°C	6°C	24°C
Egg mass – Masa jaja	100.00	100.00	100.00	100.00	100.00
Shell mass – Masa skorupy	15.63[a]	16.32[a]	17.06[b]	16.23[a]	17.84[b]
White mass – Masa białka	51.66[a]	50.03[a]	49.72[a]	48.72[a]	44.77[b]
Yolk mass – Masa żółtka	32.71[a]	33.65[a]	33.22[a]	35.05[b]	37.39[b]

a, b – statistically significant differences between the groups at $P \leq 0.05$.
a, b – statystycznie istotne różnice między grupami przy $P \leq 0,05$.

The results indicated that compared to hen's eggs, guinea fowl's eggs are more useful to long-term storage as the content of the eggs was not changed even after four weeks of storage at a room temperature. Similar conclusions were drawn by Ikani and Dafwang [2004] and Ross and Golzar [2012]. Due to low cholesterol content and low energy (75–95 kcal per egg) guinea fowl's eggs are an attractive dietary product [Świerczewska and Stępińska 1996]. The analysis carried out by these authors showed that guinea fowl's eggs contained 15.5 g of cholesterol in 1 g of yolk. Guinea fowl's eggs also contained more dry mass, vitamin A and carotenoids, B group vitamins as well as micro- and macronutrients than hen's eggs.

CONCLUSIONS

The mean mass of guinea fowl's eggs ranged from 42.10 to 43.11 g and their shape index ranged from 1.18 to 1.29. In the fresh eggs the shell constituted 15.63%, white 51.66% and yolk 32.71% of the egg's mass. Long time storage decreased the eggs' mass, increased the size of the air cell and caused the change in the proportions of the morphological components in eggs: it decreased the white and increased the yolk proportions. The storage length (28 days) and temperature

influenced certain internal features of the eggs, including the dense white spread area, an increase in yolk diameter and a decrease in its height. Guinea fowl's eggs are more useful than hen's eggs for a long-time storage as their composition remains almost the same when stored in cooling conditions.

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ZMIANY WYBRANYCH CECH JAKOŚCIOWYCH JAJ PERLICY W ZALEŻNOŚCI OD WARUNKÓW ICH PRZECHOWYWANIA

Streszczenie. Celem badań była ocena jaj perlic użytkowych w kierunku nieśnym oraz wpływu długości i warunków ich przechowywania na wybrane cechy jakościowe. Materiał badawczy stanowiło 50 jaj perlic szarych utrzymywanych w chowie przyzagrodowym. Pierwszą grupę badawczą stanowiły jaja poddane ocenie jako jaja świeże (10 szt.), w drugim dniu od zniesienia. Pozostałe 40 jaj podzielono na 2 partie po 20 jaj. Pierwszą partię jaj przechowywano w lodówce w temperaturze 6°C, a drugą partię w temperaturze 24°C. Następnie poddano badaniu po 10 jaj z każdej partii, po 14 oraz 28 dniach przechowywania. Średnia masa ocenianych jaj wynosiła od 42,10 do 43,11 g , a ich indeks kształtu od 1,18 do 1,29.W świeżym jaju skorupa stanowi 15,63, białko 51,66, a żółtko 32,71% masy jaja. Przechowywanie jaj zmieniło udział składników morfologicznych w jaju zwiększając w nich udział żółtka i zmniejszając udział białka w jaju, przy istotnym zmniejszeniu masy jaj oraz istotnym zwiększeniu komory powietrznej. Długość okresu przechowywania jaj (do 28 dni od zniesienia) oraz warunki termiczne ich przechowywania wpływają na niektóre cechy składników wewnętrznych, w tym na powierzchnię rozlewu białka rzadkiego zewnętrznego i gęstego, zwiększenie średnicy żółtka z jednoczesnym zmniejszeniem jego wysokości.

Słowa kluczowe: perlice, jaja, przechowywanie

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