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Comparative evaluation of the quality indicators of chicken and quail food eggs during storage in various conditions

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ABSTRACT

Background: There are many factors and environmental conditions that affect the quality and capacity of eggs obtained from birds. The aim of this study was to make a comparison between the preservation of quail eggs and chicken eggs at temperatures of 8-10 °C and 18-20 °C. We used 20 eggs of chicken and 30 eggs of quail. Both categories were stored at two different temperatures (at a temperature of 8-10 ℃, and at a room temperature of 18-20 ℃). Each category of eggs was stored for 20 days, and 3 eggs were opened every 3 days. The parameters studied were: mass, protein diameter, protein height (H), yolk height (h), yolk diameter, protein index, yolk index, and Haugh unit. Statistical processing of practical results was performed using the SPSS data analysis package. When stored for 20 days at a temperature of 8-10 °C, quail eggs lost about 3–7% of their original weight. At a temperature of 18-20 °C, when stored for 20 days, quail eggs lost about 11% of their original weight. On the part of chicken eggs, regardless of temperature (8-10 °C or 18-20 °C), weight loss was almost the same, i.e., by about 3-6%. Chicken eggs at a temperature of 18-20 °C, the yolk height was not stable. Unlike chicken eggs, quail eggs, of course, decreased over time. In conclusion, quail eggs were characterized by a relatively long period of freshness preservation than those of chickens, and their three-week storage and temperature exhibited little effect on the deterioration of the quality of quail eggs.

Keywords: Chicken, Quail, Egg, Storage, Quality.
Article type: Research Article.

INTRODUCTION

Nowadays, we can observe the growing interest of consumers in products that have a purposeful and desirable effect on the body, the so-called "functional products" (Alabdallah *et al.* 2021; Alabdallah *et al.* 2021). The good quality of such food and its beneficial effect on human health are due to the presence of biologically active substances in its composition that stimulate the desired effect of metabolic transformations (Alabdallah *et al.* 2021; Alabdallah *et al.* 2023). Also, the physiology of the internal organs and their changes have an impact on this (Foromo *et al.* 2023). Consequently, quail egg is becoming more popular, since it meet the criteria of a product with functional nutritional characteristics (Scott & Silversides 2000; Foromo *et al.* 2023). Quail eggs, compared with chicken eggs, contain more essential exogenous amino acids, mineral compounds, and elements such as iron, phosphorus, copper, and zinc. They have a high content of vitamins, especially provitamin A, thiamine, riboflavin, and cyanocobalamins (Gugołek *et al.* 2013; Roriz *et al.* 2016). With their chemical composition, they are not harmful to people who are allergic to albumin in chicken eggs. In addition, quail eggs are characterized by a lower cholesterol content than chicken eggs (Scott & Silversides 2000). The quality of eggs of various bird species

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depends on many genetic and environmental factors, including the origin of the birds, their age and stage of egg laying, feeding methods, as well as the environmental conditions of the farm, such as temperature and humidity, as well as the CO_2 content in the chamber methods of egg preservation (Song *et al.* 2000; Sahin *et al.* 2004). For the consumer, the qualitative characteristics of the egg are especially important, such as its size, weight, protein diameter, protein height (H), yolk height (h), yolk diameter, protein index, yolk index, and Haugh unit (Nowaczewski *et al.* 2010; Jin *et al.* 2011). In the formation of the quality of eggs, an important role is played, in particular, by the time and conditions of their storage due to the fact that eggs are subjected to a biological process. The aging process begins during their laying (Aygun & Sert 2013; Grashorn *et al.* 2016). The intensity of changes in the content of eggs occurring during their storage is determined to a high degree by mechanical damage as well as the impact of external factors on eggs, such as temperature, humidity, and sunlight (Nowaczewski *et al.* 2010; Angel Daniel *et al.* 2022). Several studies have shown that the spoilage of chicken and quail eggs at room temperature is greater than when refrigerated (Moura *et al.* 2008). In this sense, refrigeration is the main means of preserving the internal quality of the egg (Travel *et al.* 2010; Luka´S *et al.* 2013). Thus, in our study, we are going to make a comparison between the preservation of quail eggs and chicken eggs.

MATERIALS AND METHODS

Between 2019 and 2022, the study was conducted in research laboratories in experimental research laboratories of the Department of Veterinary Medicine at the Agricultural and Technological Institute of the People's Friendship University in Russia. We used 20 eggs from each category for chicken eggs, i.e., 20 for the second category (C2 = from 45 to 54.9 g) and 20 for the first category (C1 = from 55 to 64.9 g) as well as 20 pieces for the selected egg (C0 = from 65 to 74.9 g). Quail eggs were taken with a mass of at least 10 g. For the study, chickens of the Shaver white breed and quails of the Manchurian golden breed were used. All categories were stored at two different temperatures (at a temperature of 8-10 ℃, and at a room temperature of 18–20 ℃). Each category of eggs was stored for 20 days, and 3 eggs were opened every 3 days for possible changes in egg parameters during storage at the predetermined temperatures specified above. The parameters studied included mass, protein diameter, protein height (H), yolk height (h), yolk diameter, protein index, yolk index and Haugh unit. To see the change in various characteristics, the mass of each egg was measured every day of autopsy, i.e., every three days. Outside of the autopsy, we measured the mass, the diameter of the protein, the height of the protein (H), the height of the yolk (h), the diameter of the yolk, then calculated the protein index, the yolk index, and the units of Haugh to see the change in the indicators of chicken eggs and overfilled eggs under the influence of temperature over time. To assess the evolution of the egg mass, the eggs were weighed every day using a scale. To measure the diameter of the egg yolk and egg white, we used a caliper. To measure the height of the egg yolk, we used a "spider" type micro-meter.

Definition of the Haugh unit

The method has been widely used in scientific research and production as the most objective and reliable. When determining the contents of the egg, it was poured onto a smooth glass surface, and with the help of an altimeter-micro-meter, the height of a dense protein was determined. The determination of protein quality in Haugh Units is based on the ratio of the height of the dense protein and the weight of the egg. It is taken into account that the quality of the protein is not linear but logarithmic, depending on the height of the dense protein and the weight of the egg. The calculation is based on the Howe formula:

Unit of Haugh = HU= 100*Log (h+7.57) -(1.7 * W 0.37)

where H is the height of the dense protein, mm, and W is the mass of the egg (g).

Determination of the protein index

The index reflects the qualitative state of egg white with less reliability than the Haugh units. However, it is widely applicable due to its simplicity, convenience, and sufficient objectivity, by the following formula:

Ip = H/D

where H is the height of a dense protein, in mm, and D is the average diameter of a dense protein poured onto a smooth surface, calculated as the semi-sum of two measurements at right angles, in mm. When measuring the

height of a dense protein, the same rules are observed as for Haugh units. The diameter of the protein is measured with a caliper.

Determination of the yolk index

The qualitative state of the yolk is reliably characterized by its index (I), i.e., the ratio of the height of the yolk to its average diameter:

Iy = h/d

where h is the height of the yolk, in mm, and d is the average diameter of the yolk, in mm. The height of the yolk is determined by an altimeter-micrometer, and the yolk can be in its natural position when pouring the egg on a smooth surface (Sinanoglou *et al.* 2011).

RESULTS AND DISCUSSION

When stored for 20 days at a temperature of 8-10 °C, quail eggs exhibited 93-97% of their initial mass, i.e., they lost about 7% of their initial mass. On the other hand, at a temperature of 18-20 °C, when stored for 20 days, quail eggs lost about 11% of their original weight. It should be noted that the change in the mass of eggs occurs in the same way for all eggs. This is indicated by small values of the coefficient of variability - 4-8% (Dudusola 2009; Raji *et al.* 2009; Angel Daniel *et al.* 2022) as shown in Table 1.

Table 1. Change in weight of quail eggs during storage (g).

Storage time (day)	Quail eggs			
	T (+8-10 °C)		T (+18-20 °C)	
	M ± m	Cv (%)	M ± m	Cv (%)
1	10.96 ± 0.48	4.9	12.42 ± 0.58	5.4
4	10.77 ± 0.42	5.1	12.39 ± 0.43	6.2
7	10.63 ± 0.36	4.3	11.74 ± 0.41	6.4
10	10.53 ± 0.45	6.2	11.26 ± 0.37	6.8
13	10.34 ± 0.45	5.7	11.23 ± 0.48	7.3
16	10.21 ± 0.49	6.3	11.11 ± 0.44	7.5
20	10.11 ± 0.54	7.5	11.10 ± 0.49	8.4
Reduction ratio (%)	92.25	-	89.37	-

On the part of chicken eggs, it can be found that regardless of the grade (C1, C2, CO) or temperature (8-10 °C or 18-20 °C), weight loss is almost the same, i.e., by about 3-7% ($p < 0.05$). Thus, we can say that within 20 days, the temperature certainly affected the weight of eggs and their mass decreases. However, at a temperature of 18-20 °C, they were exposed to more and significantly lost their weight. The reduction ratio of eggs stored at 18-20°C was 0.72% lower (Roriz *et al.* 2016) as shown in Table 2. In the case of other parameters, i.e., the yolk, the protein in chicken eggs at a temperature of 18–20 °C, the height of the yolk was not stable, regardless of the categories (CO, C1, and C2). However, it was noticed that, at about the same time, on the 20th day of storage, the height of the protein was near zero, i.e., the chemical decomposition of solid protein layers was faster in eggs of categories C1 and C2 (Barbosa *et al.* 2008; Figueiredo *et al.* 2011; Gugołek *et al.* 2013) as shown in Table 3. At a storage temperature of +18-20°C, the decrease in protein height was approximately three times faster compared to +8-10°C. In the case of chicken eggs at a temperature of 8–10 °C, we observed a gradual decrease in parameters such as protein height. Eggs of category C0 on the 20th day of storage exhibited a height that was 40% of the original height ($p < 0.01$). In category C1 eggs on the 20th day of storage, the height of the egg white was 45% of the initial height, while in category C2, it is 50% of the initial height ($p < 0.01$) (Gugołek *et al.* 2013; Nowaczewski *et al.* 2010; Table 3). At a temperature of +18–20 C, the change in the height of the protein was similar, but the numerical values were three times less. In contrast to chicken eggs, in quail eggs, of course, the height of the protein decreased over time, but the chemical decomposition of solid protein layers did not go quickly and was always observed on the 20th day of solid layers. (Baylan *et al.* 2011; Moura *et al.* 2010; Table 4). The height of the yolk in quail eggs during the storage period also decreased and on the 20th day of storage at a temperature of + 8-10 °C, the reduction ratio was 80%, while at + 18-20 °C it was 76% ($p < 0.05$). The quality parameters of the protein and yolk of a chicken egg sharply decreased during the storage period. On the 20th day of storage at a temperature of 8–10 °C, eggs retained 47% of the height of the protein, unlike chicken eggs, which retained 38%

of the height of the egg white. By the addition of egg yolk, quail eggs retained 73% of their original size. Compared to chicken eggs, we can say that quail eggs and chicken eggs retained almost the same resistance to egg yolks (Tables 3 and 4; $p < 0.05$) (Nowaczewski *et al.* 2010; Genchev *et al.* 2012). However, of course, given that the egg as a whole has beneficial nutritional properties, only protein accumulates all the benefits. It mainly consists of water (almost 88%), which is necessary for the body, involving in maintaining our muscles, and in many processes, such as oxygen transportation in the body or digestion. Therefore, on the 20th day of storage, it is better to use eggs from categories C1 and C2, since they contain more egg white than category C0. At a temperature of 8-10 ℃, the height of the yolk decreased, but it was well preserved in category C0 (Table 3).

Table 2. Change in weight of chicken eggs during storage (g).

Storage time (day)	**T (+8-10 °C)**		
	CO	**C1**	**C2**
		M ± m	
1	71.11 ± 0.56	61.58 ± 0.56	52.74 ± 0.62
4	70.92 ± 0.61	61.31 ± 0.54	52.29 ± 0.68
7	69.80 ± 0.53	60.43 ± 0.60	51.35 ± 0.83
10	69.56 ± 0.70	60.37 ± 0.58	51.11 ± 0.86
13	68.80 ± 0.86	59.77 ± 0.62	50.86 ± 0.91
16	68.11 ± 0.80	59.34 ± 0.80	50.45 ± 0.87
20	67.09 ± 1.01	58.67 ± 0.93	49.83 ± 0.96
Reduction ratio (%)	94.34	95.27	94.48
Storage time (day)		T (+18-20 °C)	
	CO	C1	C2
		M ± m	
1	70.33 ± 0.52	61.27 ± 0.66	51.86 ± 0.64
4	69.37 ± 0.61	60.93 ± 0.59	51.17 ± 0.72
7	67.25 ± 0.59	61.15 ± 0.63	50.10 ± 0.69
10	67.13 ± 0.72	60.27 ± 0.67	50.06 ± 2.81
13	66.69 ± 0.84	59.88 ± 0.76	49.48 ± 0.88
16	66.36 ± 0.93	59.49 ± 0.88	49.04 ± 0.92
20	65.99 ± 1.19	58.11 ± 0.94	48.36 ± 1.03
Reduction ratio,%	93.82	94.84	93.25

Table 3. Change in the height of white and yolk in chicken eggs

Storage time (day)	**T +8-10 °C**					
	CO		**C1**		**C2**	
	h protein (mm)	**h yolk (mm)**	**h protein (mm)**	**h yolk (mm)**	**h protein (mm)**	**h yolk (mm)**
1	5.42 ± 0.21	17.11 ± 0.85	5.02 ± 0.19	15.82 ± 1.06	4.53 ± 0.20	16.49 ± 0.99
4	5.37 ± 0.24	16.97 ± 0.74	4.93 ± 0.20	15.76 ± 0.99	4.42 ± 0.28	16.02 ± 1.12
10	4.77 ± 0.36	16.85 ± 0.92	4.63 ± 0.26	15.42 ± 1.07	4.26 ± 0.24	15.53 ± 1.18
13	3.71 ± 0.32	16.16 ± 1.08	4.12 ± 0.31	15.01 ± 1.15	3.89 ± 0.32	15.21 ± 1.14
16	2.52 ± 0.27	15.92 ± 1.22	3.56 ± 0.43	14.35 ± 1.22	3.37 ± 0.40	14.25 ± 1.28
20	2.16 ± 0.37	14.01 ± 1.38	2.25 ± 0.45	12.22 ± 1.44	2.24 ± 0.43	13.01 ± 1.37
Reduction ratio (%)	39.85	81.88	44.82	77.24	49.44	78.89
			T +18-20 °C			
1	5.32 ± 0.25	16.63 ± 1.04	4.85 ± 0.19	15.70 ± 1.12	4.41 ± 0.22	15.62 ± 1.18
4	5.21 ± 0.26	16.58 ± 1.11	4.81 ± 0.21	15.74 ± 1.19	4.38 ± 0.20	15.57 ± 1.23
10	4.67 ± 0.31	15.93 ± 1.18	4.45 ± 0.28	15.37 ± 1.26	3.65 ± 0.31	14.84 ± 1.35
13	3.05 ± 0.38	15.08 ± 1.25	3.55 ± 0.32	13.51 ± 1.24	2.96 ± 0.39	13.86 ± 1.46
16	0.92 ± 0.17	12.53 ± 1.38	1.72 ± 0.21	11.47 ± 1.37	2.39 ± 0.28	13.37 ± 1.32
20	0.84±0.19	11.67±1.54	0.53±0.23	11.43±1.44	0.54±0.24	11.73±1.35
Reduction ratio (%)	15.78	70.17	10.92	72.80	12.24	75.09

Egg yolk is a protein condensate for the body; it is rich in vitamin D, phosphorus, and zinc. Egg yolk contains choline, which has a protective and stimulating effect on memory. It contains lutein and zeaxanthin, which are protective antioxidants for cataracts. Therefore, after the 20th day of taking vitamins D and zinc from egg yolk, it is better to use egg yolk (Grashorn *et al.* 2016). The quality of protein and yolk in bird eggs is better shown by indicators such as protein index and yolk index. Tables 5 and 6 depicts the dynamics of these indexes during

storage. At a temperature of +8-10 C, the protein index decreased by about 2 times, and at a temperature of +18-20 C by 3 times. The yolk index decreased by 1.3 and 1.2 times, respectively.

Table 4. Change in the height of White and Yolk in quail eggs.

Storage time (day)	**T (+8-10 °C)**	
	h protein, mm	**h yolk, mm**
1	4.85 ± 0.23	10.17 ± 1.24
4	4.69 ± 0.29	10.06 ± 1.20
10	4.24 ± 0.21	9.53 ± 1.34
13	4.19 ± 0.36	8.94 ± 1.56
16	3.79 ± 0.38	8.52 ± 1.49
20	3.29 ± 0.44	8.21 ± 1.69
Reduction ratio (%)	59.48	80.72
	T (+18-20 °C)	
1	4.78 ± 0.33	10.35 ± 1.15
4	4.59 ± 0.24	10.11 ± 1.27
10	4.04 ± 0.31	9.33 ± 1.48
13	3.79 ± 0.41	8.56 ± 1.66
16	3.09 ± 0.38	8.13 ± 1.43
20	2.51 ± 0.52	7.88 ± 1.32
Reduction ratio (%)	52.51	76.13

Table 5. Change in white and yolk indices in chicken eggs

Storage time (day)	**T +8-10 °C**					
	CO		**C1**		**C2**	
	protein index	**yolk index**	**protein index**	**yolk index**	**protein index**	**yolk index**
1	0.063	0.52	0.064	0.53	0.064	0.53
4	0.052	0.50	0.059	0.49	0.060	0.50
10	0.050	0.47	0.051	0.42	0.056	0.42
13	0.044	0.45	0.050	0.39	0.052	0.36
16	0.041	0.34	0.041	0.35	0.047	0.34
20	0.033	0.31	0.034	0.29	0.032	0.28
Reduction ratio (%)	52.38	59.61	56.25	54.72	50.00	62.83
			T +18-20 °C			
1	0.061	0.54	0.062	0.52	0.062	0.53
4	0.050	0.50	0.057	0.51	0.055	0.50
10	0.046	0.44	0.051	0.43	0.049	0.43
13	0.040	0.39	0.046	0.39	0.045	0.37
16	0.033	0.31	0.032	0.32	0.036	0.33
20	0.020	0.29	0.025	0.28	0.023	0.26
Reduction ratio (%)	32.78	53.70	40.32	53.84	37.10	49.06

Table 6. Change in white and yolk indices in quail eggs.

Storage time (day)	**T (+8-10 °C)**	
	protein index	**yolk index**
1	0.083	0.72
4	0.074	0.67
10	0.069	0.60
13	0.059	0.54
16	0.051	0.49
20	0.043	0.46
Reduction ratio (%)	51.81	63.88
	T (+18-20 °C)	
1	0.081	0.71
4	0.070	0.65
10	0.062	0.59
13	0.049	0.43
16	0.039	0.41
20	0.033	0.39
Reduction ratio (%)	40.74	54.92

On the 20th day of storage at a temperature of 8–10 °C, quail eggs retained 48% of the index of the protein, unlike chicken eggs, which retained 47% of the index of the egg white ($p < 0.01$). By the addition of egg yolk, quail eggs retained 74% of their original size ($p < 0.05$). The quality of the egg (dense protein) was conveyed very well by the Haugh unit (Table 7). We observed a sharp deterioration in the quality of dense protein. The decrease in the values of Haugh units in chicken eggs at a storage temperature of +8-10 °C was 72% (average for categories), while in quail eggs was 10.0%. At a temperature of +18-20 °C on the 20th day of storage, the calculation of Haugh units in chicken eggs was impossible. In quail eggs, the decrease in Haugh units was 33.1%.

Table 7. Change in Haugh units in eggs.

Storage time (day)	**T +8-10 °C**			
	chicken eggs			**quail eggs**
	CO	**C1**	**C2**	**-**
1	67.7	68.0	67.5	90.9
4	67.3	67.3	66.7	90.2
10	61.9	64.8	65.6	88.9
13	49.8	59.9	62.2	88.8
16	29.8	53.5	56.7	82.6
20	22.3	33.3	41.3	73.6
Reduction ratio (%)	32.93	48.97	61.18	80.96
	T +18-20 °C			
1	67.1	66.5	66.8	90.5
4	66.5	66.3	66.8	89.5
10	62.1	63.1	60.1	87.2
13	41.1	53.1	52.2	83.7
16	-	19.9	44.4	71.3
20	-	-	-	57.4
Reduction ratio (%)	-	-	-	63.42

CONCLUSION

Storage of chicken and quail eggs at a temperature of 18–20 °C significantly affects the parameters of eggs since these parameters are very variable and unstable. However, this is even more noticeable in chicken eggs than in quail ones. These results suggest that quail eggs are characterized by a relatively longer period of freshness preservation than chicken eggs, and their 3-week storage does not affect the deterioration of quality. At a temperature of 8-10 °C, the parameters of eggs are preserved better than at a temperature of 18-20 °C.

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