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Alterations in the mass of quail eggs of different densities during storage

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ABSTRACT

There are many factors and environmental conditions affecting the quality and capacity of eggs produced by quail birds. We assessed the effect of storage on the mass dynamics of quail eggs after they were produced by the birds. The study was performed on quail eggs to ensure their quality using a formula to calculate the theoretical value of the quail egg volume (cm^3): V = 0.485 × D × d × d/1000, where D is the longitudinal diameter (mm); d is the transverse diameter (mm). Statistical processing of practical results was performed using the data analysis package (SPSS). It was found that when eggs are stored for 10 days after laying at a temperature of 10-15 °C, the egg weight decreased on average by 2.6%, and the density by 2.1%. Eggs are considered one of the most important products due to containing a rich source of protein. Storing eggs in quails negatively affects the quality of eggs.

Keywords: Quail, Mass, Egg volume, Storage.
Article type: Short Communication.

INTRODUCTION

Density is one of the most important indicators of the quality of a quail egg, which is measured by the ratio of its mass (g) to its volume (cm^3), including an indirect indicator of the strength of the shell. There are differences in the range of density values of fresh eggs in different representatives of hatching birds. So, the value of the density of chicken eggs varies in the range of 1,065-1,095; ducks: 1,075-1,090; guinea fowl: 1,115-1,130 g cm^{-3}. The density of quail eggs ranges from 1.069 to 1.079 g cm^{-3} (Adeniyi *et al.* 2016**;** Reijrink 2010**;** Song *et al.* 2000; Terčič & Smerdu 2015). It is known that during the storage of eggs, there is a decrease in the weight of the eggs. At a temperature of 15 °C and relative humidity of 75% for each day of storage, the density of a chicken eggs decrease by about 0.0015 g cm^{-3} (Grashorn *et al.* 2016; Ondrušíková *et al.* 2018). The eggs density decreases as the temperature elevates and the relative humidity decreases (Nasri *et al.* 2020; Tona *et al.* 2003). In breeding poultry farming, when laying eggs in an incubator, the egg density value should not be differed significantly. In adition, feeding quail birds plays a role in the productivity and quality of eggs through its effect on the physiology of the body (Alabdallah *et al.* 2021; Alabdallah *et al.* 2021). The purpose of the research is to study the dynamics of the mass of quail eggs during storage for 10 days after laying.

MATERIALS AND METHODS

Experimental data were obtained in the period from March 15 through March 30, 2021. Eggs were obtained from adult 4-month-old laying hens of Manchurian quail of the meat and egg productivity direction, kept in the conditions of the vivarium of the Peoples ' Friendship University of Russia. Keeping birds in cages, feeding with industrial compound feed from the Ramensk feed mill with the inclusion of fresh vegetables in the diet. The mass of eggs was found on an electronic scale HR-200, with an accuracy of 0.01 g. The egg diameters were measured with a digital caliper STAYER 34410-150 with an accuracy of 0.01 mm. The method of determining the density

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of a body of complex shape is associated with the determination of its volume. To determine the theoretically calculated egg volume, the following formulas were used:

1) The Pearl and Serfos formula for an elongated spheroid
   V = ((π·L·B^2/6) – 0,022(π·L·B^2)/6))/1000

where L is the longitudinal diameter (mm); B is the transverse diameter (mm).

1) the formula for calculating the geometric parameters of eggs, proposed by V. G. Perrushin
V = (0.6057 - 0.0018 × d) × D × d × d /1000

2) the formula for calculating the geometric parameters of eggs of V. G. Narushin with a refined constant for brood birds
V = 0.523 × D × d × d /1000

where D is the longitudinal diameter (mm); d is the transverse diameter (mm).

The theoretical egg density was calculated as the ratio of the egg mass to the theoretically calculated egg volume. The standard method for determining the actual density of eggs was considered to be the method for determining the density by weighing eggs in air and in water. In this case, the density was calculated using the following formula: P = m / (m – m1), where P is the density of the egg; m is the mass of the egg in the air; m1 is the mass of the egg in the wáter (Narushin 2005). Statistical processing of practical results was carried out in accordance with the guidelines for the design of the results of measurement materials and data processing algorithms, using the data analysis package SPSS.

RESULTS AND DISCUSSION

At the first stage, based on the data on the measurement of weights of eggs, the theoretical volume of eggs in cubic centimeters was calculated using the selected formulas and compared with the results of the standard method. The results on the deviation of the theoretically defined values of the "egg volume" from the standard value showed that the deviations did not exceed 10%. The nature of the deviations was comparable for all the formulas, which indicates a good repeatability of the results obtained. Analysis of the deviations of the theoretically calculated volume values resulting from the actually calculated volume showed that the smallest values were obtained when using the formula of (Narushin 2005) to calculate the geometric parameters of eggs with a refined constant for brood birds (formula 3). In this case, the average difference was 3.9%. When using formulas 1 and 2, the average deviations were 7.6 and 6.2%, respectively.
Using various constants in this formula, we could have increased the calculation accuracy to an average of 2.91% and offer the following formula for calculating the volume of quail eggs:

V = 0,485 × D × d × d / 1000,
where D is the longitudinal diameter (mm); d is the transverse diameter (mm). The quail eggs were formulated like an asymmetrical ellipse or "Cassinian " oval, with one end slightly blunt than the other. This is indicated by the value of the egg shape index, which averaged 78.4% (Nowaczewski *et al.* 2010). A quail egg immediately after laying, as a rule, has a mass of 9-14 g. The results of the morphometric assessment of eggs are presented in Table 1. A preliminary assessment of the weight indicators of hatching eggs shows that the eggs, as a rule, met the accepted regulatory requirements (Nowaczewski *et al.* 2010)

Table 1. Dynamics of mass and density of Manchurian quail eggs (n = 150)

Indicator	Day of storage				
	1	3	5	7	10
	M ± m	M ± m	M ± m	M ± m	M ± m
Egg mass (g)	12.57 ± 0.087	12.52 ± 0.091	12.46 ± 0.094	12.40 ± 0.095	12.24 ± 0.104*
Coefficient of variability by egg mass (%)	9.4	9.3	9.4	9.4	9.3
Mass to volume ratio (density; g cm^{-3})	1.087 ± 0.003	1.083 ± 0.002	1.077 ± 0.005	1.073 ± 0.004	1.067 ± 0.004*
Coefficient of variability in egg density (%)	8.2	7.9	8.4	8.6	7.7
Egg shape index (%)	78.4 ± 0.22	-	-	-	-

A gradual decrease in egg mass was observed. So, after 10 days of storage, the mass decreased by an average of 2.6%, particularly the first 5 days by 0.8%, and but moderately the second 5 days was observed a decrease by a value of 1.8% (Roriz *et al.* 2016). By the loss of egg mass during storage, their density also decreased. For 10 days of storage, the difference was 0.01 g cm^{-3}, the density decreased by an average of 2.1%, including for the first 5 days by 0.9%, and for the second 5 days by 1.2%. The density of quail eggs per day of storage decreased by an average of 0.002 g cm^{-3} and by the end of the storage period fell below the standard indices. Noteworthy are the rather high values of the density of eggs immediately after the laying of the egg, which characterizes the high saturation of the egg with nutrients, as well as, probably, the relatively large thickness of the shell (El Tarabany *et al.* 2015). Noteworthy, there was a very low variability in both the dynamics of egg mass and egg density over the entire storage period. Data on the dynamics of mass and density in quail eggs of different shapes were of interest (Table 2). In accordance with the frequency tables, three variation classes were identified for the 'egg shape index'. The class interval was set at 1.5 standard deviation values (4.05%). The first class included the value of the egg shape index less than 74.5%, the second one included the values of the egg shape index from 74.5 to 82.4%, and the third one included the values of the egg shape index over 82.4%. (Nowaczewski *et al.* 2010; Nowaczewski *et al.* 2010). The results of the study show that the eggs classified in the first variation class had the highest weight when laid. Notably, a very low variability was observed both in the dynamics of the egg mass and in the density of eggs over the entire storage period (Roriz *et al.* 2016).

Table 2. Dynamics of the mass of quail eggs of different shapes.

Indicator	**Variation class**	**Day of storage**				
Egg mass (g)		**1**	**3**	**5**	**7**	**10**
		M ± m	M ± m	M ± m	M ± m	M ± m
	1st	13.43 ± 0.314	13.33 ± 0.312	13.23 ± 0.326	13.10 ± 0.312	12.97 ± 0.305
	2nd	12.58 ± 0.101	12.53 ± 0.105	12.47 ± 0.101	12.42 ± 0.105	12.35 ± 0.102
	3rd	11.65 ± 0.560*	11.60 ± 0.560*	11.57 ± 0.560*	11.53 ± 0.550*	11.47 ± 0.550*

They were larger than the eggs of the second variation class by 6.7%, and 15.3% larger than the eggs of the third class. The more rounded the egg, the less its mass. The greatest loss of egg weight during the storage period was noted in the first variation series (5.5%). At the second and third variation series, the weight losses were 1.2% and 1.6%, respectively. (Nowaczewski *et al.* 2010; Roriz *et al.* 2016). The densities of the eggs were 1.107, 1.089 and 1.073, respectively, according to the variation series. We noted a fairly high variability of density (18%). At the first variation series, which may indicate the need for additional correction of the formula for calculating the volume for especially large quail eggs with a relatively elongated shape (Ondrušíková *et al.* 2018).

CONCLUSIÓN

Quail eggs are a rich source of protein that humans benefit from. Through our study, we found the importance of storing it to maintain its quality because this affects the extent of its use.

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