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Effect of the quail's productive type on the incubation characteristics of domestic quail eggs (*Coturnix japonica domestica*)

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Abstract

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Various factors can affect the hatchability of quail eggs, perhaps the least studied of these is the productive type. The objective of this research was to investigate the incubation characteristics of domestic quail eggs produced from different productive types of quails. Within two days, 460 breeding eggs from three genotypes of quails were collected at 184 days of age. The first breeding group of quails is a typical representative of the European egg laying type (group A), the second group is of the heavy dual-purpose type (meat-egg-laying type, group GG), and the third is a typical meat-producing (group WG). Before loading, the eggs were individually weighed and incubated under the standard incubation parameters for that species, by using industrial hatchery equipment. The following signs were monitored: fertility, embryonic mortality, hatchability from the fertilized eggs, hatchability from the set eggs, and weight at one day of age. The average hatching eggs weight was directly related to the productive type (P<0.001). The highest weight loss of incubated eggs was reported in Group A - 11.43±0.18% (P<0.001), and significantly lower values were observed in the GG and WG groups - 9.24±0.11% and 9.46±0.05%, respectively. Egg fertilization ranged from 93.71% in the GG group to 95.95% in the WG group. Embryonic mortality to transfer was from 4.17% in group A to 5.41% in group WG. The highest hatchability of loaded eggs was reported in the WG group of 79.95% and the lowest in the GG group of 75.43%. The average relative weight of hatched quails was between 67.51±0.12% in group WG and 68.26±0.22% in group A (P<0.005). From the results of this research could be concluded that the productive type of domestic quails has no significant influence on the main incubation characteristics.

Keywords: Japanese quail; egg fertility; embryonic mortality; hatchability; weight at one-day of age

Introduction

Domestic quail (*Coturnix japonica domestica*) is the smallest farm bird originated from the wild Japanese quail (Chang et al., 2007; Lukanov, 2019a). Apart from being a productive animal in industrial and domestic poultry farming for meat and eggs producing, the quail is widely used as a laboratory (Baer et al., 2015), decorative, exhibition (Lukanov et al., 2018), and as a fighting bird (Mills et al., 1997).

In modern intensive hybrid poultry farming breeds are less and less important, as the focus has shifted to highly productive lines of several breeds, from which meat-producing or egg-laying hybrids of birds were obtained (Besbes et al., 2007). Quail farming, as a narrow segment in poultry farming, is still based on highly productive light or heavy populations of domestic quail, from which table eggs or quail meat are produced. Nevertheless, even here the breeds lose their significance, relying on interlinear hybrid forms. As a result of the selection of the quail as a farm bird, which lasts a little more than a century, three productive types have emerged. The lightest type is used for the production of table eggs, and the heaviest - for the production of quail meat. The dual-purpose type is popular in Europe and South America for eggs producing (Lukanov, 2019b). The birds used in exhibition poultry farming are of this type (ESC-P, 2018). There are also intermediate forms: egg-meat and meat-egg. The live weight of the light type quails, widespread in East Asia, is about 100-130 g (Mizutani, 2003; Chang et al., 2009), and for the heavy type - over 300 g (Minvielle, 2004; Tavaniello, 2014). The dual-purpose type in the domestic quail weighs about 250-300 g (EE, 2016).

In Europe, as egg-laying type, slightly heavier representatives are used, weighing about 200-250 g, which also lay larger eggs, than the typical egg strains. (Genchev, 2012). The mentioned main productive types differ not only in live weight, but also in laying capacity, egg weight, meat yield, etc. (Genchev, 2014). In the available literature, information comparing the incubation characteristics of different productive types of domestic quails is difficult to find, which is related to the purpose of the present study. The objective of this research was to investigate the incubation characteristics of eggs produced from different productive types of domestic quails.

Material and Methods

Within two days, 460 breeding eggs were collected from three groups of quails, representatives of egg-laying type reared in Europe (group A), heavy dual-purpose type (group GG) and typical heavy type (group WG). The average live weight of the birds from the three groups was determined after receiving the eggs, by weighing 30 male and 60 female birds from each group, with an electronic scale accurate to 0.1 g (Table 1). The parent flocks were of the same age - 182 -184 days, at a sex ratio of 1:3. The observed light regime was 15 hours of light/9 hours of darkness. Feeding was with compound feed for productive quails with characteristics presented in Table 2.

Table 1. Live body weight of the breeding quails from different groups at 184 days of age, g

Group	A		GG		WG	
gender	male	female	male	female	male	female
n	30	60	30	60	30	60
Mean	183.4	223.3	278.5	328.8	293.5	362.4
SEM	7.55	4.46	5.72	5.09	5.53	4.82
CV, %	15.16	8.24	9.73	11.21	6.32	7.14

Table 2. Chemical composition of the compound feed for breeding quails

Chemical composition	Breeding quails* (>35 days of age)
Metabolizable energy, MJ/kg	11.50
Crude protein, %	19.50
Crude fibre, %	5.00
total Lysine, %	1.00
total Methionine, %	0.40
Calcium, %	2.80
available Phosphorus, %	0.45
Sodium, %	0.18

*Vitamins and trace minerals composition per kg compound feed: Vitamin A – 10000 IU; Vitamin D_3 – 3500 IU; Vitamin E – 50 IU; Vitamin K – 3 IU; Thiamin – 3 mg; Riboflavin – 10 mg; Pyridoxine – 3 mg; Pantothenic acid – 18 mg; Folic acid – 2 mg; Biotin – 250 µg; Niacin – 60 mg; Choline – 600 mg; Vitamin B_{12} – 20 µg; Manganese – 80 mg; Iron – 30 mg; Copper – 10 mg; Zinc – 80 mg; Iodine – 0.5 mg; Selenium – 0.3 mg

The eggs were incubated in a standard for the species technological mode on Single-stage incubation (Table 3),

Table 3. Technological parameters used for hatching of Quail eggs (T – temperature, ^oC; RH – Relative Humidity, %)

Incubation, days	T, ^oC	RH,%	Fresh air supply, m^3/h /1000 eggs
Setter*			
Full load – single-stage setter			
1-7	37.7-37.8	65	0.25-0.3
8-15	37.5-37.6	50-55	1-1.4
Hatcher			
Till mass pipping	37.4	50-55	1.5-1.9
Till mass hatching	37.2	70-75	2.0-2.2
Quail chicks drying	37-37.2	55	2.5-4.0

*45° egg turning on every one hour from 1st day of incubation until egg transfer on 15th day. Vertical egg position with point end down

The following parameters were studied:

- Hatching egg weight, % - by individual weighing of all eggs in groups, before incubation, by means of a calibrated electronic CB 2000 balance with precision of 0.01 g.
- Fertility (%) – as a percentage of fertilized from all eggs loaded. The fertilized eggs are counted during the first examination - day 7, by ovoscopy and subsequent breaking to differentiate the unfertilized from those with a dead embryo.
- Embryonic mortality (%) – it was measured at the end of the first week and at the transfer of the eggs on the 15th day, by ovoscopy and subsequent internal analysis of the separated eggs. After hatching, the unhatched eggs were separated for analysis and determination of embryonic mortality during the last stage.
- Egg weight loss at transfer (%) – as a percentage of weight loss of eggs until their transfer on the 15th day. The measurement of the mass before incubation and during the transfer was by means of a calibrated electronic CB 2000 balance with precision of 0.01 g.
- Hatchability from the fertilized eggs (%) – it was defined as the percentage of hatched quails from fertilized eggs.
- Hatchability from the set eggs (%) – it was calculated as the percentage of hatched quails from all loaded eggs.
- Weight at one day of age (g) – the mass of all quality day-old quails was recorded using a calibrated electronic balance CB 2000 with precision of 0.01 g.
- Relative weight at one day of age (%) – as a percentage of the weight of the hatched quails in relation to the weight of the eggs before loading.

Statistical analysis

All data were processed with statistical software Statistica 13.0 (Statistica for Windows; Stat–Soft, 2015). Mean (m) and standard error of mean (SEM) values were calculated for each group. The differences considered statistically significant at $P<0.05$, using Student's t-test, if the data were normally distributed.

Results and Discussion

The mass of the hatched quails is directly related to the mass of hatching eggs (Traldi et al., 2011). The weight of the eggs at loading was different for the three groups, in a positive correlation with the live weight (Fig. 1), which is also characteristic for domestic quails (Genchev, 2014). The lowest egg weight (13.46±0.08 g) was measured in group A, and the heaviest was in group WG (14.73±0.05 g). The differences between the groups are statistically proven ($P<0.001$). Group GG showed almost identical average weight of hatching eggs to group WG – 14.68±0.09 g. Group A expressed a relatively high egg mass for the respective productive age in this productive type, approaching the average for the Estonian breed (Lamber & Laan, 2013). The excellent results in terms of this productive trait are related to the applied selection for a number of generations, both on this population and on the other two used in the experiment. (Lukanov et al., 2018, 2019). The higher mean values on the basis of the trait can also be explained by the age of the quails, which were in the fifth productive month. Usually with the age of quails, the mass of their eggs increases (Yannakopoulos & Tserveni-Gousi, 1986). The difference between the egg weight in the light type compared to the two heavier ones used in the study was 9.06% and 9.44%, respectively.

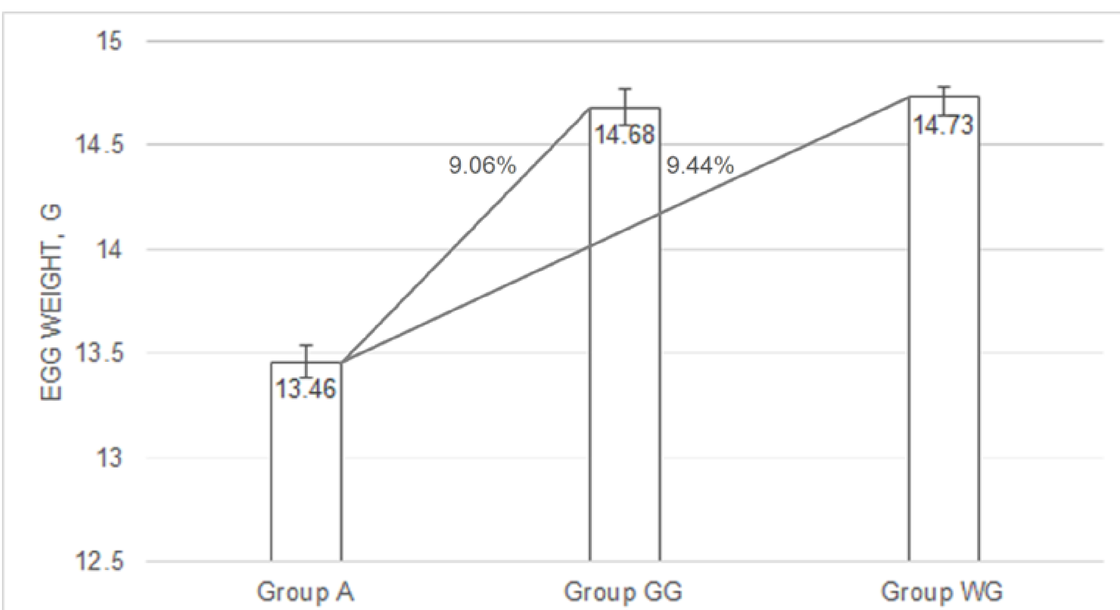

Figure 1. Average hatching egg weight, g

The weight loss during incubation is directly related to the area of the shell, its porosity, microclimatic parameters during incubation and some other factors (Bramwell, 2019) and is due to the diffusion of water through the shell (Tona et al., 2001). For most poultry species, it is between 10.2 and 14% (Burtov et al., 1990), and in single-stage incubation the ideal weight loss is lower than in multi-stage incubation (Bramwell, 2019). If the loss of mass or water during incubation is too low or too high, the hatchability is negatively affected (Meir et al., 1984). In group A the highest weight loss was reported - 11.43%, while in groups GG and WG it was 9.24% and 9.46%, respectively (Fig. 2). Our results on the trait are in line with those presented for the Japanese quail by Genchev (2009), and in accordance with those of low-mass eggs of *Alectoris graeca* (Çağlayan et al., 2009), eggs of *Rhynchotus rufescens* (Nakage et al., 2003), and in fertilized Japanese quail eggs (Soliman et al., 1994). Saylam (1999) and Saylam & Sarıca (1999) reported weight loss in incubated quail eggs over 20%. Between 16.32% and 23.40% weight loss by day 15th were reported by El-Samahy et al. (2017) when incubating quail eggs, depending on their weight and storage period. Hegab & Hanafy (2019) revealed greater weight loss in small quail eggs (12.62±0.06 g) compared to large (14.84±0.06 g), 16.08±1.33% and 12.36±0.78%, respectively. We found a similar relationship in the present study. Lower weight loss in eggs from light (9.31%) and heavy (8.27%) Japanese quails stored for a short period until incubation was reported by Romao et al. (2008), as with the increase of the storage period, the values decrease even more.

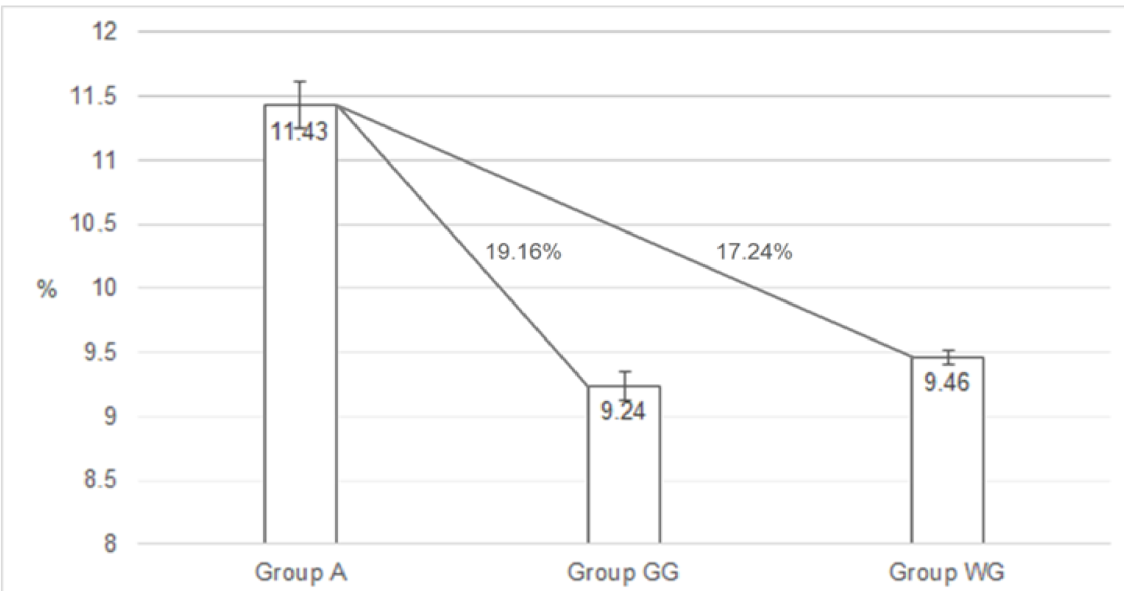

Figure 2. Hatching egg weight loss at the transfer, g

Fertilization of eggs is influenced by a number of factors, some of the most important of them are age, sex ratio, live weight of parents used, genotype, parental nutrition, diseases, duration and conditions of hatching eggs storage, their weight, and others (Narahari et al., 1988; King'ori, 2011). The measured fertilization of eggs in all three groups was high - from 93.71% in group GG to 95.95% in group WG, without any influence of productive type on the trait. Comparable results with respect to the trait, were reported by Santos et al. (2015) in a study on breeding quails of different ages, and by Narahari et al. (1988) for a sex ratio of 1:2 to 1:4. Very high values of egg fertilization, both in egg-laying and in meat-producing quails, were reported by Santos et al. (2011), also without noticeable influence of productive type on the fertilization. Hegab & Hanafy (2019) reported significantly lower fertilization of quail eggs with small and large sizes, respectively, 83.20% and 80.53%. Similar lower results on this parameter were reported by Taha (2011) during the incubation of eggs obtained from quails with different plumage color. In the present study, no relationship was found between egg size and fertilization. In the two heavier groups, higher embryonic mortality until transfer was observed, mainly due to higher values of the second week of incubation (Table 4). A significantly higher percentage of dead embryos and unhatched quails was reported in group GG. After summarizing the results, it can be seen that the lowest embryonic mortality was reported in group A, and the highest in group GG, 13.89% and 16.57% respectively. In the available literature, the results in terms of embryonic mortality in quails vary considerably, from high (Taha, 2011; El-Samahy et al., 2017) to low (Santos et al., 2015). This is due to the influence of a number of factors, which are related to the factors influencing the hatchability (King'ori, 2011). The results obtained in the present study with regard to embryonic mortality are in line with the usual practice of domestic quail eggs incubation (Genchev, 2009), approaching the optimal values.

Table 4. Fertilization rate and embryonic mortality of the different productive type of quails, %

Parameter	Group		
	A	GG	WG
Hatching eggs, n	460	460	460
Fertilization, %	94.44	93.71	95.95
Embryonic mortality first week, %	3.47	3.43	4.05
Embryonic mortality second week, %	0.69	1.14	1.35
Embryonic mortality and unhatched 15-18 day, %	9.72	12.00	9.91
Embryonic mortality total, %	13.89	16.57	15.32

The main factors that affect hatching are hereditary, nutrition, health status and age of the parent stock, size and quality of eggs, duration and storage conditions of hatching eggs (King'ori, 2011). The hatchability of set eggs varied between 75.43% in group GG to 79.95% in group WG (Fig. 3). The values on this parameter in the European egg laying type quails (group A) were very close to those of group WG. From the obtained results, no influence of the productive type on the two features concerning hatchability was noticed. Santos et al. (2011) observed higher values for hatchability from the fertilized eggs due to higher fertilization of eggs. The authors reported higher hatchability in the egg-laying type compared to the meat type, 87.57% and 85.34%, respectively. A similar relationship has been reported by Romao et al. (2008). Hegab & Hanafy revealed lower hatchability rate from the fertilized eggs, especially for the small ones (2019).

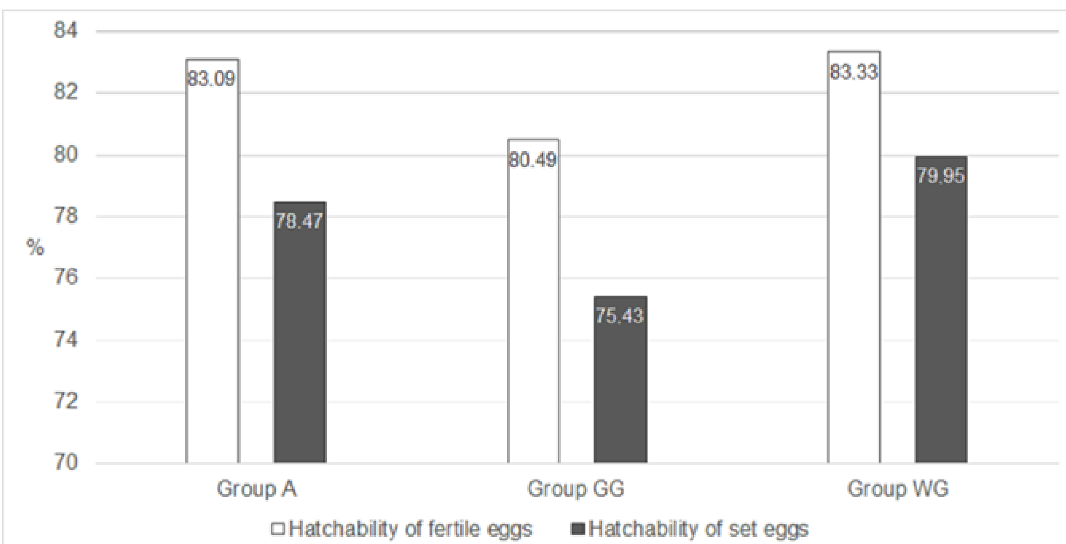

Figure 3. Hatchability rate, %

The weight after hatching is directly related to the hatching egg weight, varying between 62% and 76% of the hatching egg weight (Traldi et al., 2011) and the optimal for the chickens is about 67% (Foote, 2019). In addition to the weight of the egg, the weight of the newly hatched bird is also affected by the loss of weight during incubation, the weight of the shell and the residues of hatching (Tullett & Burton, 1982). The relative weight of hatched quails was in close intergroup limits, between 67.51±0.12% in the heavy type (group WG) and 68.26±0.22% in the light type (Group A), which are statistically significant ($P<0.005$) (Fig. 4). The obtained results are in accordance with the norms and are an indicator of the normal course of the incubation process. Genchev (2009) reported slightly higher values of this parameter - from 70.23±0.60% to 72.14±0.61%. Lower values (about 65.4%) were presented by Soliman et al. (2011). These variations could be explained not only by a different technological regime of incubation, but also by the residence time of the hatched quails in the incubator (Nir & Levanon, 1993).

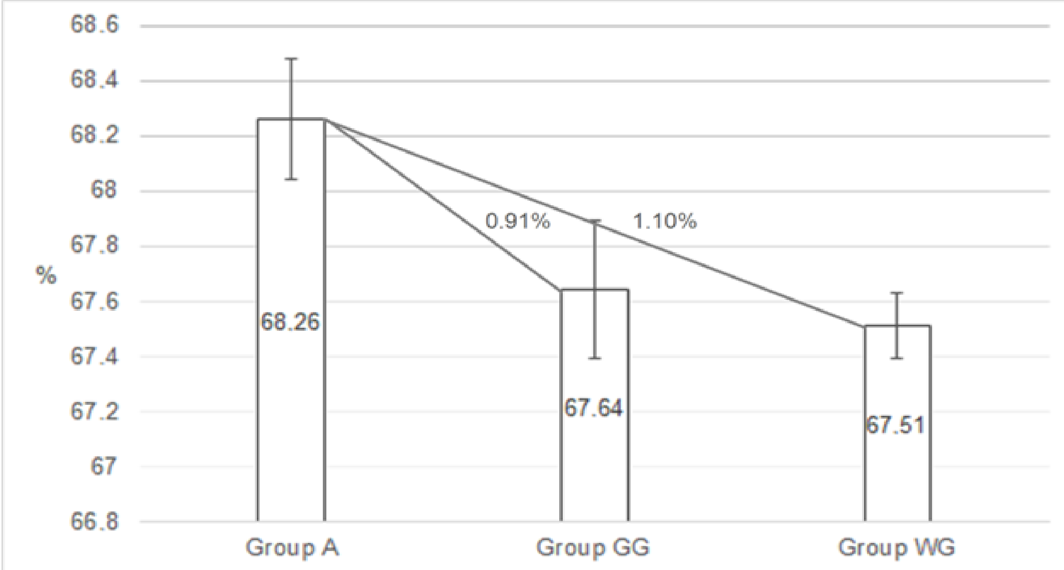

Figure 4. Average relative weight of the hatched quails, %

Conclusions

All of the research results are within the standards of domestic quail hatching practice, which does not lead to the conclusion that the productive type has a significant influence on the main incubation characteristics of this species. Optimal weight loss in incubated eggs from domestic quail is lower than that in larger poultry species.

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