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INCREASING OF STORAGE PERIOD ALTERS EMBRYO DEVELOPMENT AND HATCHING CHARACTERISTICS OF PEKIN DUCK EGGS

SUMMARY

This research was performed to determine the effects of storage period on embryo development and hatching characteristics in Pekin ducks. A total of 360 Pekin duck eggs was divided into four groups as 5-7 d, 8-10 d, 11-13 d and 14-16 d storage period and each group were stored at 15-18 ºC. Eggs were incubated at 37,5°C and a relative humidity of 55 to 60% during the first 24 days of incubation. These eggs were transferred into hatching machine for the last four days. A hatcher temperature of 37.0°C and a relative humidity of 72% were provided during hatching period.

The effects of storage period on embryo development, embryonic mortality, hatchability of fertile eggs, hatchability of total eggs and chick hatching weight were significant ($P<0.01$). Results showed that a longer storage period caused a decline in yolk absorption and therefore decline of embryo growth parameters including body weight and length during incubation period. Hatchability declined with increasing of storage duration, and a storage period less than 7 d appeared to be the best for maximum hatchability. Egg weight loss increased with increased storage length ($P<0.01$), and the chick weight tended to decline in relation with storage period longer than 5-7 days.

Keywords: Pekin duck, egg storage, embryo development, hatching characteristics.

INTRODUCTION

Recently, meat-type duck production, which has a huge economical value in Asian countries, has gained increasingly importance in other countries as an alternative poultry species for animal protein requirement. Due to the rapid growth in the world population, there is a growing trend in meat-type duck production (Ipek and Sözcü, 2017).

At that point, white Pekin duck is one of the most popular meat-type duck strains and is widely produced in most countries, for example China, Korea, England, and France (Heo et al., 2015; Wen et al., 2015).

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In commercial practices, hatching eggs are stored for short or long time until the setting time to obtain sufficient number for maximum capacity of incubator. It is known that prolonged of storage period has detrimental effects for embryo growth, embryonic mortalities, hatchability and in fact chick quality at hatching (Tona et al., 2003, 2004; Reijrink et al., 2009).

This research was performed to determine the effects of four storage periods (5-7 d, 8-10 d, 11-13 d and 14-16 d) on embryo development and hatching characteristics in Pekin ducks.

MATERIAL AND METHODS

The research was performed at the Research and Experimental Farm of the Department of Animal Science in Uludağ University in Turkey. A total of 360 hatching eggs were collected from a breeder flock at 36 to 38 wk of age. The breeder flock was kept according to the standard industry practices in the experimental farm of the faculty. All eggs were numbered and weighted with ± 0.1g precision before storage period. The eggs were stored for 5-7 d (S-I), 8-10 d (S-II), 11-13 d (S-III) and 14-16 d (S-IV, n=90 eggs/storage period). During storage period, eggs were kept at a temperature of 17.0°C and a relative humidity of 75%.

After the storage period, all eggs were weighted again and incubated in a fully automated, ventilated, programmable incubator at 37.5ºC and a RH of 55 to 60% during the first 24 d of incubation. The eggs from each storage period group were randomly placed into incubator trays consisting of 30 eggs (n = 3 trays/storage period group). On d 25 of incubation, eggs were weighed to determine the weight loss during incubation, and all eggs were transferred to a hatcher. The hatcher was operated at 37.0ºC and 72% relative humidity.

A total of 10 eggs per each group were randomly sampled for measurement of embryo development on d 25 of incubation. The eggs were carefully cracked, and embryos were killed by cervical dislocation. The embryos were separated from the yolk sac. Excessive embryonic fluid was dried off, and the embryos were weighed for embryo weight and yolk sac weight to calculate the yolk free body weight, relative embryo and yolk sac weights (Willemsen *et al.*, 2010; Ipek *et al.*, 2014). The embryo length was measured from the tip of the beak to the tip of the middle toe by placing the embryo face down on a flat surface and straightening the right leg (Hill, 2001; Nangsuay *et al.*, 2011). The shank length was measured from right knee joint to the tip of the middle toe (Willemsen *et al.*, 2008).

After the completing of hatching process, all of the hatched chicks were pulled out according to standard hatchery procedures, and were weighed with ±0.1 precision to determine the chick hatching weight. Then, the chicks were classified into two categories as saleable and cull chicks. The percentages of saleable and cull chick were determined as a percentage of fertile eggs. Unhatched eggs were opened to macroscopically determine fertility and embryonic mortality (early-term, mid-term and late-term embryonic mortalities).

Mortality and fertility were calculated as the percentage of total eggs at set to fertile eggs.

The data were subjected to analysis of variance (SAS, 1998) utilizing ANOVA procedures for balanced data. The parameters were analyzed using the general linear model (GLM) procedure. In the study, 3 replicate trays (30 eggs per tray) were used for each treatment group, and the trays were considered an experimental unit. Analyses for the percentage data were conducted after square root of the arc sine transformation of the data. Significant differences among treatment means were determined by Duncan's multiple range test. Data are presented as means ± SE. Differences were considered significant at $P < 0.05$.

RESULTS AND DISCUSSION

The effects of different storage periods on embryo development and yolk absorption on day 25 of incubation period are presented in Table 1. Embryos in S-I and S-II groups were found to be heavier compared to embryos in S-III and S-IV groups (36.1 g and 35.4 g vs. 33.2 g and 31.2 g, respectively). Similar difference was also observed for relative embryo weight. A higher yolk sac weight and relative yolk sac weight (respectively 18.7 g and 23.9%) were found in embryos of S-IV group. On the other hand, yolk free body weight, embryo body and shank length were found to be higher in S-I and S-II groups compared to other groups. Results showed that prolonged storage periods retarded embryo growth during incubation.

This could be related with some changes in the embryo growth and egg characteristics during storage period (Lapão *et al.*, 1999), for example an increment in albumen pH (Lapão *et al.*, 1999), a decline in albumen height (Burley and Vadehra, 1989), and strength of the vitelline membrane (Fromm, 1966). Also a retarded of embryo growth could be associated with a higher egg weight loss during storage in S-IV group, compared to the other groups. This finding is supported by Reijrink et al. (2010).

Table 1. The effect of different storage periods on embryo development and yolk absorption on day 25 of incubation period

Parameters	**Storage periods**			
	S-I	**S-II**	**S-III**	**S-IV**
Egg sampling weight (g)	77.2±1.6	78.4±1.4	77.7±1.5	78.1±1.5
Embryo weight (g)	36.1±1.4^{a}	35.4±1.7^{a}	33.2±1.1^{b}	31.2±1.1^{c}
Relative embryo weight (%)	46.8±1.8^{a}	45.1±1.9^{a}	42.7±1.5^{b}	39.9±1.4^{c}
Yolk sac weight (g)	14.6±1.1^{c}	15.3±1.2^{c}	17.5±1.2^{b}	18.7±1.1^{a}
Relative yolk sac weight (%)	18.9±1.4^{c}	20.2±1.3^{c}	22.5±1.2^{b}	23.9±1.3^{a}
Yolk free body weight	21.5±2.3^{a}	20.1±2.0^{a}	15.7±1.4^{b}	12.5±1.6^{c}
Body length (mm)	187.1±4.1^{a}	184.6±5.3^{a}	177.2±4.5^{b}	166.9±4.3^{c}
Shank length (mm)	45.0±1.0^{a}	44.7±1.1^{a}	43.6±1.1^{b}	42.1±1.2^{b}

$^{a-c}$ Means in the rows with different letters significantly ($P<0.05$)

S-I: 5-7 d, S-II: 8-10 d, S-III: 11-13 d, S-IV: 14-16 d

n: 10 eggs/storage period

The effects of different storage periods on incubation results are presented in Table 2. Initial egg weight was 77.4 g in S-I, 78.1 g in S-II, 78.0 g in S-III, 77.9 g in S-IV group. Egg weight loss until transfer was found to be the highest with a value 18.4% in S-IV group compared to other groups. Hatchability of fertile and total eggs was higher in S-I (84.8% and 74.4%, respectively) and S-II (83.1% and 71.1%, respectively) groups.

The highest percentages for early and late term embryonic mortalities were observed in S-IV group, whereas mid-term embryonic mortalities were higher in S-III and S-IV groups. The percentage of cull chick was the lowest with a value of 1.4% in S-I group. On the other hand, chick hatching weight and relative chick weight were the highest in S-I (48.4 g and 62.5%) and S-II (47.7 g and 61.2%) groups.

Table 2. The effect of different storage periods on incubation results

Parameters	**Storage periods**			
	5-7 d	**8-10 d**	**11-13 d**	**14-16**
Number of eggs	90	90	90	90
Average egg weight (g)	77.4±1.2	78.1±1.3	78.0±1.0	77.9±1.2
Egg weight at transfer (g)	69.5±1.4^{a}	68.1±1.3^{b}	65.3±1.2^{c}	63.5±1.1^{d}
Egg weight loss (%)	10.2±1.5^{d}	12.8±1.6^{c}	16.2±2.1^{b}	18.4±2.2^{a}
Fertility (%)	87.8±2.8	85.6±2.4	86.7±2.1	85.6±2.6
Hatchability of fertile eggs (%)	84.8±2.5^{a}	83.1±2.6^{a}	78.2±2.7^{b}	74.0±2.7^{c}
Hatchability of total eggs (%)	74.4±3.6^{a}	71.1±3.4^{a}	67.8±3.1^{b}	63.3±2.9^{c}
Early term TEM* (%)	6.3±0.9^{c}	6.5±1.1^{c}	7.7±1.0^{b}	9.1±1.4^{a}
Mid TEM* (%)	1.3±0.9^{b}	1.3±0.8^{b}	2.6±0.8^{a}	2.5±0.7^{a}
Late TEM* (%)	7.6±1.3^{c}	9.1±1.8^{c}	11.5±2.2^{b}	14.3±2.7^{a}
Contaminate egg ratio (%)	0.0±0.0	1.6±1.2	1.6±1.3	1.8±1.3
Cull chick (%)	1.4±0.7^{c}	1.7±0.6^{c}	3.3±1.1^{b}	7.1±1.4^{a}
Chick hatching weight (g)	48.4±1.9^{a}	47.8±1.7^{a}	45.4±1.4^{b}	43.5±1.6^{c}
Chick/egg weight ratio (%)	62.5±2.1^{a}	61.2±1.8^{a}	58.2±1.5^{b}	55.8±2.0^{c}

$^{a-d}$ Means in the rows with different letters significantly ($P<0.05$)
*TEM: term embryonic mortalities n: 3 trays per each egg weight group

Observed higher egg weight loss and embryonic mortalities and a decline in hatchability in prolonged storage period (S-III and S-IV) are consist with previous findings by Wilson (1991), Renema *et al.* (2006), Reijrink *et al.* (2010).

Similarly, the negative effects of prolonged storage in S-III and S-IV on chick quality parameters are also reported by Tona *et al.* (2003) for chick weight and chick quality parameters, by Wolanski *et al.* (2004), Lourens *et al.* (2005) for yolk-free body weight, and by Hill (2001), Wolanski *et al.* (2004), Molenaar *et al.* (2008) for body length.

CONCLUSIONS

In conclusion, it seems to the storage length had negative effects for egg weight loss, embryo development, embryonic mortalities, hatchability and chick quality in Pekin duck eggs.

Therefore, during storage period, some environmental factor associated with storage (storage temperature and humidity) and storage length could be considered to minimise the negative effects of storage.

REFERENCES

Burley R.W., Vadehra D.V. (1989). The avian egg, chemistry and biology. John Wiley and Sons, New York, USA.

Fromm D. (1966). The influence of ambient pH on moisture content and yolk index of the hen's yolk. Poultry Science, 45: 374-379.

Heo K.N., Hong E.C., Kim C.D., Kim H.K., Lee M.J., Choo H.J., Choi H.C., Mushtaq M.M.H., Parvin R., Kim J.H. (2015). Growth performance, carcass yield and quality and chemical traits of meat from commercial Korean native ducks with 2-way crossbreeding. Asian-Australaian Journal of Animal Science, 28: 382-390.

Hill D. (2001). Chick length uniformity profiles as a field measurement of chick quality? Avian Poultry Biology Reviews, 12: 188.

Ipek A., Sozcu A. (2017). Comparison of hatching egg characteristics, embryo development, yolk absorption, hatch window, and hatchability of Pekin Duck eggs of different weights. Poultry Science, 96(10): 3593-3599.

Ipek A., Sahan U., Baycan S.C, Sozcu A. (2014). The effects of different eggshell temperatures on embryonic development, hatchability, chick quality and first-week broiler performance. Poultry Science, 93: 464-472.

Lapão C., Gama L.T., Chaveiro Soares M. (1999). Effects of broiler breeder age and length of egg storage on albumen characteristics and hatchability. Poultry Science, 78: 640-645.

Lourens A., van den Brand H., Meijerhof R., Kemp B. (2005). Effect of eggshell temperature during incubation on embryonic development, hatchability and posthatch development. Poultry Science, 84: 914-920.

Molenaar R., Reijrink I.A.M., Meijerhof R., van den Brand H. (2008). Relationship between hatchling length and weight on later productive performance in broilers. World's Poultry Science Journal, 64: 599-603.

Nangsuay A., Ruangpanit Y., Meijerhof R., Attamangkune S. (2011). Yolk absorption and embryo development of small and large eggs originating from young and old breeder hens. Poultry Science, 90: 2648-2655.

Reijrink, I.A.M., Meijerhof R., Kemp B., Graat E.A.M., van den Brand H. (2009). Influence of prestorage incubation on embryonic development, hatchability, and chick quality. Poultry Science, 88: 2649-2660.

Reijrink I.A.M., Berghmans D., Meijerhof R., Kemp B., van den Brand H. (2010). Influence of egg storage time and preincubation warming profile on embryonic development, hatchability, and chick quality. Poultry Science, 89: 1225-1238.

Renema R.A., Feddes J.J.R., Schmid K.L., Ford M.A., Kolk, A.R. (2006). Internal egg temperature in response to preincubation warming in broiler breeder and turkey eggs. Journal of Applied Poultry Research, 15: 1-8.

SAS Institute. (1998). SAS user's guide: A user's guide to SAS. SAS Institute Inc: Cary (NC).

Tona K., Bamelis F., De Ketelaere B., Bruggeman V., Moreas V.M.B., Buyse J., Onagbesan O., Decuypere E. (2003). Effects of egg storage time on spread of hatch, chick quality, and chick juvenile growth. Poultry Science, 82: 736-741.

Tona K., Onagbesan O., De Ketelaere B., Decuypere E., Bruggeman V. (2004). Effects of age of broiler breeders and egg storage on egg quality, hatchability, chick quality, chick weight, and posthatch growth to forty-two days. Journal of Applied Poultry Research, 13: 10-18.

Wen Z.G., Xie M., Fouad A.M., Tang J., Maqbool U., Huang W., Hou S.S. (2015). The effect of feed consumption levels on growth performance and apparent digestibility of nutrients in White Pekin ducks. Journal of Applied Animal Research, 43: 112–117.

Willemsen H., Everaert N., Witters A., De Dmit L., Debonne M., Verschuere F., Garain P., Berckmans D., Decuypere E., Bruggeman V. (2008). Critical assessment of chick quality measurements as an indicator of posthatch performance. Poultry Science, 87: 2358-2366.

Willemsen H., Kamers B., Dahlke F., Han H., Song Z., Ansari P.Z., Tona K., Decuypere E., Everaert N. (2010). High and low temperature manipulation during late incubation: Effects on embryonic development, the hatching process, and metabolism in broilers. Poultry Science, 89: 2678-2690.

Wilson H.R. (1991). Interrelationships of egg size, chick size, posthatching growth and hatchability.World's Poultry Science Journal, 47: 5-20.

Wolanski N.J., Luiten E.J., Meijerhof R., Vereijken A.L.J. (2004). Yolk utilisation and chick length as parameters for embryo development. Avian Poultry Biology Reviews, 15: 233-234.