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The Effect of Hatching System and Egg Weight on Hatching Traits in Turkish Geese: Hatch time, Hatchability and Gosling Quality Traits

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ABSTRACT

This study was performed to determine the effect of hatching system (house and hatcher) and egg weight (heavy and light) on pip-hatch time, hatchability and some gosling quality traits. A total of 389 eggs (fertile of candling) from 2-year-old Turkish Native Goose were used in the study. Before the incubation process, all eggs were individually numbered and weighed. Eggs were divided into heavy (≥160 g) and light (<160 g) eggs according to average weight (160 g), and these eggs were placed in similar numbers in two hatching system. Pip time was delayed for about 7 h and 5 h in heavy and house eggs compared to light and hatcher, respectively. With regard to hatch time, it was calculated approximately 12 h and 8 h delay for the eggs in the heavy and house compared to the light and hatcher, respectively. Weight and length of goslings that hatched from heavy eggs were higher than those that hatched from light eggs. The activity and navel score of goslings in the house and hatcher systems were 3.38, 5.59 and 9.54, 11.06, respectively, at 32 d. The study results showed that the pip and hatch-time was delayed in heavy and house system eggs. It has been determined that the goslings hatched from heavy eggs were heavier and longer. House hatching system also negatively affected the activity and navel score of goslings.

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Introduction

Waterfowls have considerably lower reproduction potential than chickens, in general. Because the number of eggs during one laying cycle is relatively low laid by each goose and high mortality of embryos is particularly disadvantageous. Paper reports on this issue indicate that embryonic mortality in poultry is dependent on some factors such as environmental conditions, incubation techniques, breeder genotype, breeder age, nutrition, male:female ratio and egg weight (Rosinski and Bednarczyk 1997; Bednarczyk and Rosinski 1999; Boz 2015; Uçar and Sarıca 2018; Uçar et al., 2020).

New hatchling quality traits are affected by maternal age, egg size, incubation conditions, feed access time and embryo physiology. Well hatchling quality is profoundly significant in poultry rearing for maximizing post-hatch performance and minimizing mortality (Bruggeman et al., 2009; Özlü et al., 2020). The assessment of hatchling quality is done by taking into account qualitative characteristics depend on some ascertained traits, and quantitative measurable parameters like hatchling length and hatchling weight. The hatchling weight at hatch time is mainly affected by egg weight before incubation (Deeming and Birchard 2007). It might be said that heavier eggs obtain from the studied goose population, in order to guarantee maximum gosling weight (Saatci et al., 2005). There was close correlation between egg weight and hatchling weight (Abiola et al. 2008).

Generally, hatch goslings in the hatchery, they are transported to the house and placed as day-old, where they receive their first water and feed (Boz et al. 2017; de Jong et al. 2020). In a commercial broiler or layer hatchery, the chicks start to hatch after 19 d of incubation and hatch window (generally 468-504 h) takes process between 24 and 36 h (Careghi et al., 2005; Almeida et al. 2008; van de Ven et al., 2009; Tong et al., 2011). It has been reported that the performance of hatchlings is negatively affected after 28 h following hatch time (Özlü et al., 2020). While the post-hatch feed-water deprivation period may last up to 72 h for chicks (Careghi et al., 2005; Willemsen et al., 2010; Boz et al., 2017), especially early hatch goslings can wait even longer. Previous studies showed that post-hatch feed and water deprivation longer than 36 h for chicks may impair intestinal and other organ development, immunity system development and capacity to cope with poorly environmental conditions especially in the first days of rearing (Bigot et al., 2003; van den Brand et al. 2010; Lamot et al., 2014; Panda et al., 2015; de Jong et al., 2017). Information on hatch window in geese is very limited. To avoid negative effects of feed and water deprivation on hatchling development and quality, alternative hatching systems such as house hatching and hatchery fed have been developed, which allow free access to water and feed (Hollemans et al., 2018).

In comparison with other poultry species, egg yield of geese is quite low, generally about 35 eggs per year while the egg numbers are about 20 in Turkish native genotype. Since only about 10-15 goslings per year result, it is evident that fertility and hatchability are very poor. Thus, it is significant to examine what affects hatchability and gosling quality (Gillette 1977; Rosinski and Bednarczyk 1997; Boz et al., 2014; Boz 2015). The aim of the current study was to determine the effects of hatching system and egg weight on pip-hatch time, hatchability and gosling quality traits.

Material and Methods

Hatching Eggs and Incubation

A total of 389 eggs (fertile of candling) from 2-year-old Turkish Native Goose were used in the study. The eggs were collected throughout a week and were stored as 18°C temperature and %75 relative humidity. The eggs were weighed individually by bascule with a sensitivity of up to 0.001 g and the average weight was determined (160 g). Eggs were divided into heavy (≥160 g) and light (<160 g) eggs according to average weight. The same conditions were applied to the eggs placed in the one setter until the 27 d. In the setter process temperature and relative humidity set as 37.5°C and 60%, respectively. After the 8 d of incubation, additional humidification was performed by cooling and spraying every day at the same time. At 27 d of incubation, eggs from heavy and light categories were further divided into 2 sub-groups and transferred to either of the hatching systems (house or hatcher) for the hatch period of incubation. This resulted to 4 treatment groups; House-Heavy, House-Light, Hatcher-Heavy and Hatcher-Light (Table 1).

In each group, an equal number of eggs were placed to 3 trays and each tray was considered as a replicate. Depending on hatching system; in the hatcher temperature and relative humidity as 36.9 ° C and 70%, respectively and in the house temperature and relative humidity as 35.5 ° C and 70% at egg level in the house system because of 33°C had been set at litter level for brooding, respectively. House system was 450×900×250 cm in size and had a window and ceiling fan. Radiant heaters and humidifier system were operated depending on automation. In the house, the trays were placed 30 cm above the litter.

Pip and Hatch Time

Eggshell temperature was determined during hatching period. While the goslings in the house reached the feed and water freely until the hatch is over, those that came out of the hatcher waited for hatch to be completed. Figure 1 shows the eggshell temperatures of treatment groups. During the hatch period the pip and hatch times were checked and recorded every 6 hours, and the pip, hatch and hatch – pip times of all groups were determined. Hatch times were determined as Early: 682-708 h; Middle: 708-734 h; and Late: 734-760 h periods proportionally.

Embryonic Mortality and Hatchability

The candling was made during the transfer of the eggs to hatching system at 27 d of incubation. Unfertile eggs and embryonic deaths between 0-27 days of incubation were determined by candled and removed. The incubation was ended at the 768 h of incubation, then late and pipped embryonic mortality, cull gosling and hatchability of fertile eggs (HoF) were calculated with macroscopic examination. HoF was calculated by ratio of hatched goslings according to transferred eggs thought to have live embryos on day 28.

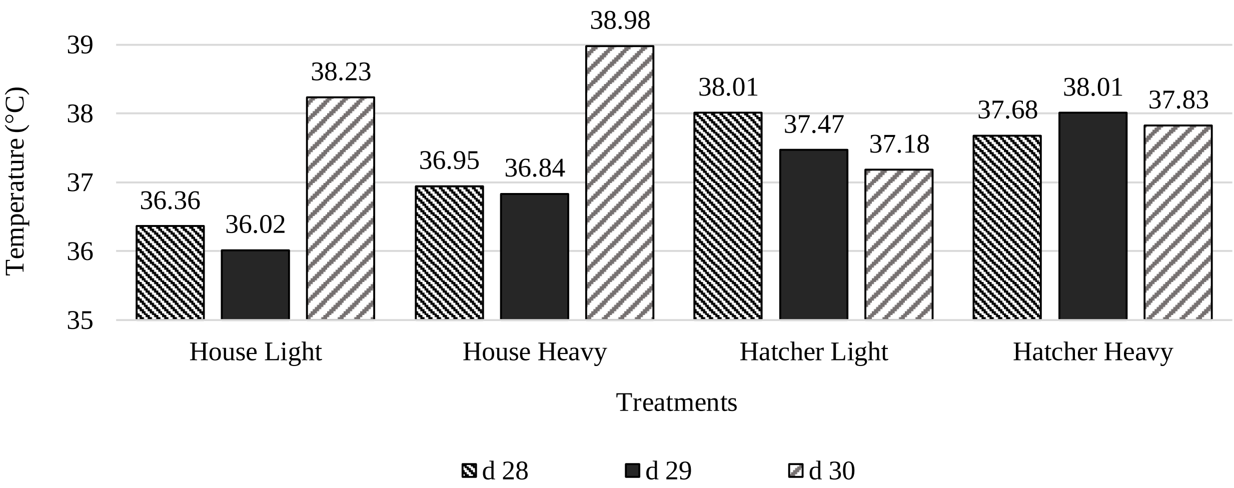

Figure 1. Eggshell temperature of treatments

Table 1. Descriptive statistics of hatching system and egg weight groups according to transferred fertile eggs

Hatching System / Egg Weight		n	Mean	Standard Deviation	Minimum	Maximum
			g			
House	Heavy	102	172.93	8.153	160.50	199.20
	Light	93	149.49	9.621	132.20	159.80
Hatcher	Heavy	103	171.87	7.741	160.10	193.70
	Light	91	151.24	6.801	132.37	159.80
House		195	162.78	14.06	132.20	199.20
Hatcher		194	163.32	12.56	132.37	193.70
Heavy		205	172.41	8.012	160.10	199.20
Light		184	150.31	7.089	132.20	159.80
Total		389	163.03	13.33	132.20	199.20

Table 2. Hatching results and eggshell temperatures of hatching system and egg weight groups

HS[1]	EW[2]	HoF[3]	Embryonic Mortality / Cull			Eggshell Temperature
			Late	Pipped	Cull[4]	
			%			°C
House	Heavy	92.10	3.52	2.18	2.18	37.21
	Light	95.52	2.18	1.28	1.00	36.19
Hatcher	Heavy	93.45	2.18	2.18	2.18	37.86
	Light	95.31	2.08	0.55	2.08	37.59
SEM		1.734	1.190	0.907	1.021	0.132
	House	93.81	2.84	1.72	1.60	36.70^{b}
	Hatcher	94.45	2.08	1.36	2.10	37.73^{a}
	SEM	0.461	0.579	0.432	0.535	0.094
	Heavy	92.85^{b}	2.84	2.18	2.08	37.53^{a}
	Light	95.41^{a}	2.08	0.90	1.60	36.89^{b}
	SEM	0.501	0.579	0.432	0.535	0.094
P-value						
HS		0.349	0.940	0.946	0.952	0.001
EW		0.004	0.346	0.195	0.355	0.001
HS x EW		0.225	0.265	0.955	0.812	0.065

^{a,b}: According to the Duncan test results, the differences between means by different letters are remarkable in same column (P<0.05). [1] Hatching System: The eggs were hatched in hatcher or house.[2] Egg Weight: Heavy ≥ 160 g, Light < 160 g. [3] Hatchability of Fertile Eggs: Ratio of hatched goslings according to transferred eggs thought to have live embryos on day 28. [4] Cull is the second-grade chick percentage.

Table 3. Pip and hatch times of hatching system, egg weight and gender groups

HS[1]	EW[2]	G[3]	Hatch Time[3]			Pip Time h	Hatch Time h	Hatch – Pip Time[4] h
			Early %	Middle%	Late %			
House	Heavy	F[5]	8.82	29.41	61.76	707.24	734.12	26.06
		M[6]	11.76	41.18	47.06	706.73	730.00	24.75
	Light	F	11.76	70.59	17.65	697.52	719.53	20.00
		M	13.33	80.00	6.67	699.60	718.67	19.07
Hatcher	Heavy	F	10.53	78.95	10.53	699.35	718.74	20.38
		M	15.38	57.69	26.92	699.04	723.77	22.75
	Light	F	33.33	54.17	12.50	694.25	714.42	18.61
		M	30.00	65.00	5.00	694.00	710.90	18.32
SEM						0.984	1.123	0.816
	House		11.00^{y}	48.00^{b}	41.00^{a}	704.24^{a}	727.92^{a}	23.52^{a}
	Hatcher		20.37^{x}	65.74^{a}	13.89^{b}	697.11^{b}	717.53^{b}	20.15^{b}
	SEM					0.984	1.128	0.815
	Heavy		11.36^{b}	52.27^{y}	36.36^{a}	703.26^{a}	726.59^{a}	23.43^{a}
	Light		23.68^{a}	65.79^{x}	10.53^{b}	695.97^{b}	715.47^{b}	18.93^{b}
	SEM					0.984	1.123	0.815
	Female		15.04	57.52	27.43	700.38	722.57	21.67
	Male		16.84	56.84	26.32	700.77	722.48	21.91
	SEM					0.984	1.122	0.816
P-value								
HS			0.087	0.012	<0.001	<0.001	<0.001	0.039
EW			0.029	0.061	<0.001	<0.001	<0.001	0.008
G			0.849	1.000	0.877	0.841	0.971	0.883

^{a,b}.: According to the Duncan test and Fisher's exact test for two proportions results, the differences between means by different letters are remarkable in same column (P<0.05; ^{x,y}: P<0.10). [1] Hatching System: The eggs were hatched in hatcher or house. [2] Egg Weight: Heavy ≥ 160 g, Light < 160 g. [3] Hatch time: Early=682-708 h ; Middle=708-734 h; Late=734-760 h. [4] Time from pip time to hatch time. [5] Female; [6] Male

Table 4. Some gosling quality traits of hatching system, egg weight and gender groups

HS[1]	EW[2]	G[3]	Gosling Yield %	Gosling Weight g	Gosling Length mm	Shank Length mm	Shank Width mm	Activity Score	Navel Score
House	Heavy	F[4]	65.99	113.68	267.43	34.14	6.33	3.30	10.15
		M[5]	65.35	111.57	266.81	28.50	6.24	4.62	9.75
	Light	F	65.90	99.95	260.29	27.04	7.75	3.14	10.09
		M	66.07	99.54	258.88	27.86	5.80	2.45	8.18
Hatcher	Heavy	F	66.08	113.48	268.08	28.48	6.23	5.45	10.42
		M	64.29	110.72	264.08	28.19	5.87	5.50	10.88
	Light	F	65.95	99.31	259.97	27.83	5.85	5.57	11.29
		M	65.58	101.05	265.60	27.30	5.85	5.82	11.65
SEM			0.795	2.032	2.040	5.219	0.895	0.744	0.834
	House		65.83	106.19	263.33	29.39	6.53	3.38[b]	9.54[b]
	Hatcher		65.48	106.14	264.41	27.95	5.95	5.59[a]	11.06[a]
	SEM		0.407	1.039	0.104	2.668	0.458	0.390	0.438
	Heavy		65.73	112.36[a]	266.60[a]	29.83	6.17	4.72	10.30
	Light		65.88	99.96[b]	261.25[b]	27.51	6.31	4.25	10.30
	SEM		0.407	1.039	0.104	2.668	0.458	0.386	0.433
	Female		65.98	106.61	263.91	29.37	6.54	4.36	10.49
	Male		65.32	105.72	263.84	27.96	5.94	4.60	10.11
	SEM		0.406	1.037	0.104	2.662	0.457	0.389	0.437
P-value									
HS			0.541	0.978	0.463	0.704	0.374	0.001	0.016
EW			0.437	0.001	0.001	0.540	0.624	0.397	0.997
G			0.254	0.548	0.845	0.709	0.360	0.671	0.651

[a,b]: According to the Duncan test results, the differences between means by different letters are remarkable in same column ($P<0.05$). [1] Hatch System: The eggs were hatched in machine or house. [2] Egg Weight: Heavy ≥ 160 g, Light < 160 g. [3] Gender: [4]Female; [5]Male

Gosling Quality Measurements

Hatching weight of goslings were determined by scale with a sensitivity of up to 0.001 g, which individual numbered by wing tag obtained from individually marked eggs, and gosling yield (gosling weight/initial egg weight) was calculated. Post-hatch activity (if the reversed gosling returns within 2 seconds score 6 if not returned score 0) and navel (score 12: completely closed and clear; score 6: not covered and dark colored; score 0: light colored and distorted) score means in goslings were calculated as gosling quality traits according to the trial groups (Tona et al., 2003). In addition, the gosling length, shank length and shank diameter were determined via digital caliper with 0.01 cm accuracy.

Statistical Analyses

The present study was a 2 × 2 × 2 factorial design with 2 hatching system, 2 egg weight and 2 gender treatments (at hatch, gender was determined by looking at the cloaca). Data were analyzed via a factorial ANOVA using the GLM procedure in SPSS software program (Version 20.0, licensed by Ondokuz Mayis University). Data on activity and navel score were evaluated using Kruskal-Wallis and Mann-Whitney U tests. The data on hatch time ratio was evaluated with Fisher's exact test for two proportions (Özdamar 2002). The model used for the statistical analyses of embryonic mortalities, cull goslings and HoF was $Y_{ij} = \mu + H_i + W_j + (HW)_{ij} + e_{ij}$, where Y_{ij} is the dependent variable, μ is the overall mean, H_i is the hatching system (i = house or hatcher), W_j is the egg weight (j = heavy or light), HW_{ij} is the interaction between the hatching system and egg weight, and e_{ij} is the error term. The model used for the statistical analyses of gosling weight, gosling yield, gosling length, shank length and diameter was $Y_{ijk} = \mu + H_i + W_j + G_k + (HW)_{ij} + (HG)_{ik} + (WG)_{jk} + (HWG)_{ijk} + e_{ijk}$, where Y_{ij} is the dependent variable, μ is the overall mean, H_i is the hatching system (i = house or hatcher), W_j is the egg weight (j = heavy or light), HW_{ij} is the interaction between the hatching system and egg weight, HG_{ik} is the interaction between the hatching system and gender, WG_{jk} is the interaction between the egg weight and gender, HWG_{ijk} is the interaction between the hatching system, egg weight and gender, and e_{ijk} is the error term.

Results and Discussion

The effect of hatching system and egg weight groups on hatching results and eggshell temperature are shown in Table 2. There were no differences between hatching systems in terms of hatchability of fertile eggs. However, hatchability of light eggs was found to be approximately 3% higher than the heavy eggs ($P<0.05$). There were no differences both hatch system and egg weight groups with regards to late and pipped embryonic mortality and also cull (second grade gosling) rates ($P>0.05$).

Eggshell temperature was significantly higher in hatcher system and heavy egg groups than house system and light egg ($P<0.05$).

The effect of hatching system, egg weight and gender groups on pip and hatch times are shown in Table 3. Goslings in the hatcher system were nearly 7 h and 10 h earlier compared to the house for average pip and hatch time, respectively ($P<0.01$). However, it was determined that in the hatcher system only 3 h earlier in terms of hatch-pip time ($P<0.05$). Considering the hatch time rates, most of the goslings hatched in the house were in late period, while most of the goslings in the hatcher were in the earlier period ($P<0.05$).

Pip and hatch time of goslings that hatched from the heavy eggs were approximately 8 h and 11 h later, respectively, compared to light eggs ($p<0.01$). There was a nearly 5 h difference between egg weight treatment groups for hatch-pipping time difference ($p<0.01$). Similar to house system, it was determined that most of the hatched goslings from the heavy and light eggs were in the late and early period, respectively ($p<0.05$).

There were no differences between female and male goslings in terms of pip and hatch times ($P>0.05$).

The effect of hatching system, egg weight and gender groups on some gosling quality traits are shown in Table 4. Goslings hatched from heavy eggs were found to be both heavier and longer than those hatched from light eggs ($P<0.01$). There were no differences between hatching system or gender with regards to gosling weight and gosling length ($P>0.05$).

The quality of goslings, hatched in the house was adversely affected compared to hatched in the hatcher in terms of activity and navel score ($P<0.05$). There were no differences between egg weights or genders with regards to these scores ($P>0.05$). There were no differences between treatment groups in terms of shank length and shank width ($P>0.05$).

Studies on different hatching systems in chickens are a well-documented up-to-date field of study. However, this topic about geese is largely unknown. While the hatch window lasts 36-48 h in chicks (Decuypere et al., 2001; Almeida et al. 2008), this period lasted as long as 78 h of goslings in our study. Therefore, brooding practices during the hatch window become more important in geese. Since hatchability is relatively low in geese, even small details such as egg weight are valuable in terms of hatchability.

Kucharska-Gaca et al. (2017) reported that the highest hatchability was obtained from the lightest eggs of geese hatching eggs. Duman and Şekeroğlu (2017) and Abiola et al. (2008) reported that the highest hatchability was in medium-weight eggs of broiler hatching eggs. While Çağlayan et al. (2009) and De Witt and Schwalbach (2004) reported that they obtained the highest hatchability from the heaviest eggs in partridges and chickens (New Hampshire and Rhode Island Red), and the lowest hatchability was obtained in the lightest eggs from indigenous chicken genotype (Abudabos et al., 2017). Elibol and Brake (2008) and Iqbal et al. (2016) reported that lighter eggs were better in terms of hatchability in broiler hatching eggs. In the current study, light eggs were better hatchability than heavy eggs. Also hatching system did not affect hatchability, similar to results of da Silva et al. (2021). However, van de Ven et al. (2009) reported that patio (type of house hatching system) had better hatchability than commercial hatcher.

As a factor in the decrease in hatchability in heavy eggs, the eggshell temperature may be higher than the light eggs (Ipek et al., 2014). Eggshell temperature can also affect both hatchling weight and hatchling length (Lourens et al., 2005). The low eggshell temperature may be a factor in delay hatching in the house system (Bergoug et al., 2013), but hatching was earlier for the light eggs with low eggshell temperature.

Similar to our results, Bagliacca et al. (2005) reported that the incubation period of Pekin and Muscovy ducks increased as egg weight increased. Some researchers reported that in a indigenous chicken genotype (Abudabos et al., 2017), rock partridge (Çağlayan et al., 2009) hatchling weight increased as egg weight increased. In accordance with the results of our study, it is seen that the hatchability decreases even though heavy eggs are used to obtain heavy goslings (Gillette 1977). Kucharska-Gaca et al. (2017) reported the gosling weight and gosling yield was as 89 g and 59.00%; 102 g and 60.00%; 115 g and 61.17%; 132 g and 63.76%, according to initial egg weight groups such as 151 g; 170 g; 188 g; 207 g, respectively. It has been reported that there was no difference in poult yield in turkey eggs among different weight groups (Applegate and Lilburn 1996). Shanawany (1987) reported the relationship between egg weight and hatchling weight in poultry species such as chicken, turkey, duck, goose, pheasant and quail, the highest correlation was observed in geese, however gosling yield was only about %59. In our results, while there was no difference in gosling weight between hatching systems, van de Ven et al. (2009) reported that the hatchlings hatched in the house were heavier.

Similar to current study results, according to references reported that the hatchlings hatched from heavy eggs were longer (Nangsuay et al., 2011; Mukhtar et al., 2013; Iqbal et al., 2016; Iqbal et al., 2017). In addition, da Silva et al. (2021) reported that the hatchlings hatched in the hatcher were longer than house in terms of hatchling length. However, there was no difference between hatching systems in the current study.

Elibol and Brake (2008) and Iqbal et al. (2016) reported that lighter eggs were better in terms of chick quality in broiler hatching eggs. In our study, egg weight appeared to be an advantage in terms of heavy goslings. While hatchling weight is highly correlated with egg weight, hatchling weight as a quality trait does not correlate so highly with subsequent performance (Meijerhof 2009). New hatched goslings should be active and the navel should be completely closed and in clear appearance (Tona et al. 2005). When viewed from this point in our study, it is seen that the goslings hatched in the house were adversely affected in terms of quality.

Conclusion

In conclusion, the pip and hatch-time was delayed in heavy and house system eggs. It was determined that the goslings hatched from heavy eggs were heavier and longer. House hatching system also negatively affected the activity and navel score of goslings.

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