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Egg Production and Traits and Hatching Traits of Geese in the First and Next Laying Seasons

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ABSTRACT

Background: This study aimed to determine the yield traits of geese reared under enterprise conditions.

Methods: The study examined egg production and hatching traits of young and adult breeder geese across two laying seasons. A total of 425 geese in the first year and 445 geese in the second year were used as breeders.

Result: Conducted on a private goose farm, the study found that the laying season for the young flock was 122 days, with an average egg production of 13.49 eggs per goose, an average egg weight of 152.50 g. For the adult flock, the laying season was 90 days, with an average egg production of 25.52 eggs per goose, an average egg weight of 159.40 g. The effects of breeding age and egg weight on hatching traits were also investigated. The breeder age significantly affected fertility rate, hatchability of total eggs and early embryonic death efficiency (P<0.001). The egg weight groups effect on hatchability was also statistically significant (P<0.001).

Key words: Age, Egg production, Egg traits, Goose breeder, Hatching traits.

INTRODUCTION

Geese were the first domesticated poultry species and were reported to have been domesticated at least 7000 years ago in China (Eda *et al*., 2022). Geese are highly adaptable to diverse environmental conditions and are widely bred for their ability to graze on pasture and their resistance to disease (Salamon, 2020; Rayan *et al.,* 2022). Geese have slightly lower yield traits than other poultry, with a shorter, seasonal laying period, so nearly all eggs are used for hatching rather than are not consumed as table eggs. Flock egg production peaks 5-6 weeks after laying starts; in geese, the maximum rate is 50%, compared to 90% in other poultry (Kırmızıbayrak *et al*., 2016; Rath *et al.,* 2019).

Genotype, age, nutrition and environmental conditions affect geese's egg production and hatching traits (Salamon, 2020; Monika *et al.,* 2021). Breeding age significantly affects geese's egg production and fertility, with a positive relationship between age and egg weight. Eggs from geese over two years old are heavier than those from one-year-old geese (Drzazga *et al*., 2016). Geese used as breeders should not be older than five years (Kucharska *et al*., 2022). Geese reach peak egg production at four to five years, declining after five (Kuzniacka *et al*., 2019; Salamon, 2020). First-season egg production in geese is lower than in later seasons and breeder age impacts egg quality, hatching performance and chick quality (Drzazga *et al*., 2016; Kucharska *et al.,* 2022).

This study aimed to assess the effects of breeding age on egg production and hatchability traits in geese, as well as to investigate the influence of goose egg weight groups on hatchability, ultimately providing detailed information for goose farmers.

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MATERIALS AND METHODS

This study was carried out at Kafkas University, Health Sciences Institute, Department of Animal Breeding and Husbandry, between December 2021 and June 2023. This study was carried out in a private goose farm in the province of Kars in Türkiye. The breeding geese were housed in a total of four building with access to outdoor area. They had free access to the buildings and a spacious grazing area, which included an easily accessible water pond. In the private goose farm where the research was conducted, two to four year-old adult geese consisting of Gray Hungarian and German Mast goose crossbreeds were reared as a single flock in the first year of the research. The goslings of these adult geese, in their first laying period, were used as young breeders. The flock size of the adult geese was determined as 241 males and 184 females (total 425 heads) and the young flock as 135 males and 310 females (total 445 heads). The male-to-female ratio of

the adult flock was calculated as 1:1 and the male-to-female ratio of the young breeding flock was calculated as 1:2.3.

Barley, oats, corn, corn silage and concentrate feeds were provided to the breeding geese during both laying seasons (Table 1). Before laying, each goose received 250 g of feed daily, increasing to 350 g during the laying season and the feeding program continued until the end of the laying period. Daily egg production of geese was recorded during both laying seasons. Eggs to be incubated were stored for a maximum of 7-12 days. After storage, the eggs were disinfected. Before being placed in the incubator egg weight was measured with a digital balance of 0.01 g. Egg fertility was checked on the 10th day of incubation by observing vascularization under strong light. The eggs were soaked and cooled during hatching. Oxygen supply and carbon dioxide removal are vital for healthy embryonic development from the the beginning of the incubation. Therefore, the circulation of air inside the incubator is important and particularly, ventilation becomes even more critical from the 15th day, when the embryo begins to produce heat. Cooling began on the eighth day for 5 minutes, extending to 35 minutes on subsequent days, followed by spraying the eggs with room temperature water.

In this study, the weekly egg production of the breeder flocks and its ratio to the overall season, daily laying rate, egg production per goose (weekly, monthly and seasonal), laying period length and mean egg weights (weekly and for the laying season) were determined. The egg production of the flock during the first laying period was calculated using hen-day egg production. The laying season was analyzed in three periods: the beginning of the season (from the first egg-laying date to the week of peak production), mid-season (from the week of peak egg production to the last three weeks of the laying period) and end of the season (the last three weeks of the season). The hatching traits were determined for each breeder age group with respect to the laying season and six egg weight groups.

Statistical analysis

Arithmetic means, standard error, minimum-maximum values and coefficient of variation were calculated in the study. The Shapiro-Wilk test checked data normality and the Levene test assessed variance homogeneity among groups. The t-test for two independent groups, one-way analysis of variance (One-way ANOVA) for more than two groups and the Duncan test were used to evaluate the significance of differences between groups. The Chi-Square test was used to assess the significance of frequencies in categorical data. Statistical analysis was performed using SPSS version 26.

RESULTS AND DISCUSSION

Egg yield and traits

In the first year of the study, the adult breeder flock began the laying period toward the end of February. The flock began the laying period with a laying rate of 9% on the first day. Egg production and laying rate increased throughout the season, peaking at 53% on the 23rd day (Fig 1). The laying period lasted a total of 90 days. The average egg production per goose at the end of the laying season was 25.52 eggs/goose.

Table 1: Nutrient content of the growth feed used in the study.

CP (%)	CS (%)	CY (%)	CA (%)	ME (Kcal/kg)	Ca (%)	Na (%)	P (%)	Lys (%)	M (%)
17.00	3.40	4.90	13.40	2.850	4.00	0.20	0.70	0.80	0.40

CP: Crude protein, CC: Crude cellulose, RO: Raw oil, CA: Crude ash, ME: Metabolic energy, Ca: Calcium, Na: Sodium, P: Phosphorus, Lys: Lysine, M: Methionine.

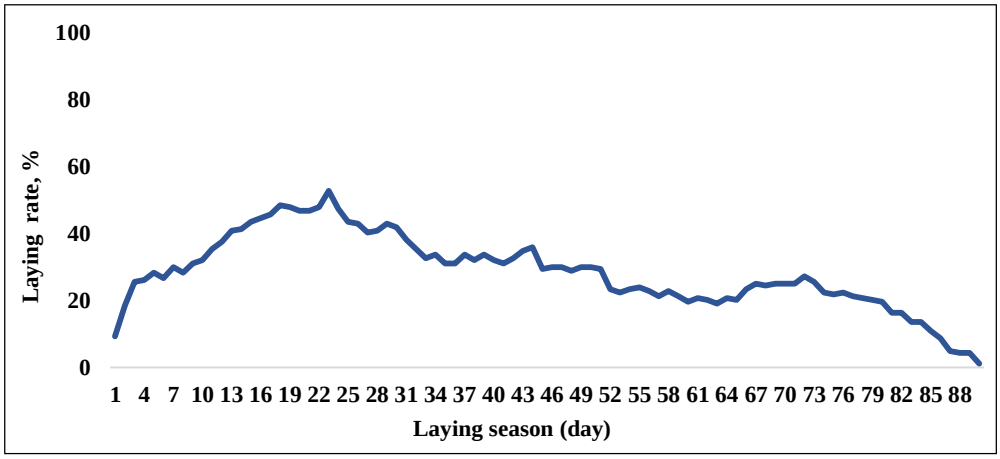


Fig 1: Daily laying rates of adult breeder flock during the laying season.

The adult breeder flock at the beginning of the laying season were produced 755 eggs and the egg yield per goose was 4.10 eggs/goose. In the middle of the season, 3352 eggs were laid and the egg yield per goose was 18.22 eggs/goose. At the end of the season, 588 eggs were produced and the egg yield per goose was 3.20 eggs/goose. The ratio of the eggs obtained from the adult breeder flock to the overall season was determined to be 44.43% in the first month, which was the highest month (Table 2). According to the periods of the laying season, the average egg weight was 164.64 g at the beginning of the season, 158.41 g in the middle and 155.50 g at the end (Table 3). The differences in average egg weight between weeks of the season and between periods were found to be statistically significant (P<0.001).

Table 2: Weekly and monthly hen-day egg production in the adult breeder flock (n: 184) and their share in the laying season.

Laying season periods	Weeks	Egg yield (eggs)	Season-wide rate (%)	Egg production in the period (eggs/goose)
Begining	1st	302	6.43	1.64
	2nd	453	9.65	2.46
	Total	755	16.08	4.10
Middle	3rd	595	12.67	3.23
	4th	580	12.35	3.15
	5th	470	10.01	2.55
	6th	416	8.86	2.26
	7th	402	8.56	2.18
	8th	322	6.86	1.75
	9th	266	5.67	1.45
	10th	301	6.41	1.64
	Total	3.352	71.40	18.22
End	11th	304	6.47	1.65
	12th	221	4.71	1.20
	13th	63	1.34	0.34
	Total	588	12.52	3.20
Laying of month				
1st		2.086	44.43	11.34
2nd		1.610	34.29	8.75
3rd		999	21.28	5.43
Overall season		4.695	100.00	25.52

Table 3: Egg weight in adult breeder flock according to weekly and laying season periods.

Laying season (Week)	n	Min-Max	CV (%)	$\bar{x} \pm S\bar{x}$
1st	401	105.7-207.1	9.93	163.89±0.81^{ab}
2nd	607	111.2-206.3	9.56	165.13±0.64^{a}
3rd	545	108.2-207.8	10.04	163.90±0.70^{ab}
4th	426	97.7-202.3	10.03	161.71±0.78^{b}
5th	395	91.8-205.4	9.90	158.56±0.79^{c}
6th	377	105.1-199.5	9.56	154.97±0.76^{de}
7th	290	115.5-195.2	9.96	152.98±0.88^{ef}
8th	257	110.0-200.2	8.83	152.22±0.83^{f}
9th	316	95.4-208.0	9.79	154.93±0.85^{de}
10th	278	121.3-226.4	8.86	157.16±0.83^{cd}
11th	180	119.7-192.2	9.57	153.93±1.09^{ef}
Laying season periods				
Begining	1.008	105.7-207.1	9.71	164.64±0.50^{a}
Middle	2.290	91.8-207.8	10.18	158.41±0.33^{b}
End	774	95.4-226.4	9.43	155.50±0.52^{c}
Overall season	4.072	91.8-226.4	10.13	159.40±0.25

a-f: Differences between means with different letters in the same column are statistically significant (P<0.001).

In the second year of the study, the laying period of the young breeder flock started in mid-February. The flock began laying with a 1% rate, which increased over time, peaking at 23% on the 29th day of the season (Fig 2). The laying period for the young breeder flock lasted 122 days, with an average egg production of 13.49 eggs per goose.

The young breeder flock at the beginning of the laying season were produced 406 eggs and the egg yield per goose was 1.31 eggs/goose. In the middle of the season, 3354 eggs were laid and the egg yield per goose was 11.67 eggs/goose. At the end of the season, 138 eggs produced and, egg yield per goose at the end of the season was 0.51

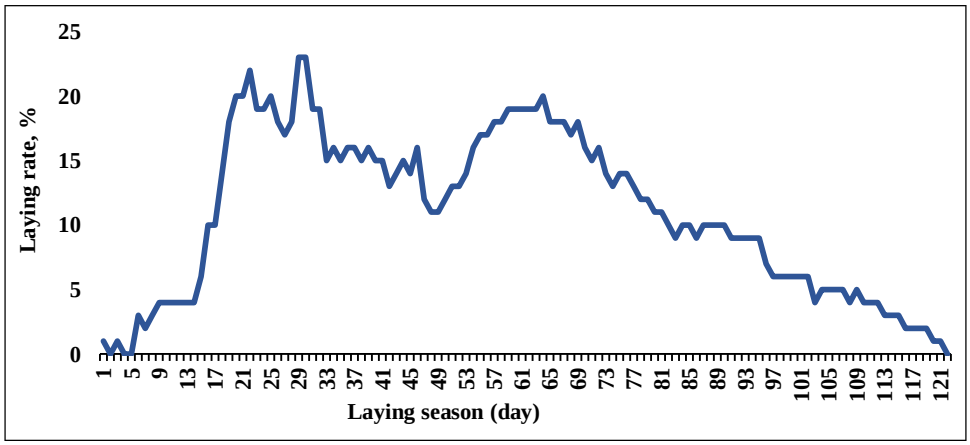


Fig 2: Daily laying rates of young breeder flock during the laying season.

Table 4: Weekly and monthly hen-day egg production in the young breeder flock and their shares in the season.

Laying season periods	Weeks	n	Egg yield (eggs)	Season-wide rate (%)	Egg production in the period (eggs/goose)
Begining	1st	310	21	0.54	0.07
	2nd	310	81	2.08	0.26
	3rd	310	304	7.80	0.98
	Total	310	406	10.42	1.31
Middle	4th	310	412	10.57	1.33
	5th	310	406	10.42	1.31
	6th	309	329	8.44	1.06
	7th	308	289	7.41	0.93
	8th	299	305	7.82	1.03
	9th	284	370	9.49	1.31
	10th	271	343	8.80	1.27
	11th	270	264	6.77	0.98
	12th	270	204	5.23	0.76
	13th	270	183	4.69	0.68
	14th	270	148	3.80	0.55
	15th	270	101	2.59	0.37
	Total	287	3.354	86.04	11.67
End	16th	270	83	2.13	0.31
	17th	270	49	1.26	0.18
	18th	270	6	0.15	0.02
	Total	270	138	3.54	0.51
Laying of month					
1st		310	962	24.68	3.10
2nd		301	1.397	35.84	4.64
3rd		271	1.127	28.91	4.16
4th		270	412	10.57	1.52
Overall season		289	3.898	100.00	13.49

eggs/goose. The ratio of the eggs obtained from the young breeder flock to the overall season was determined to be 35.84% in the second month, which was the highest month (Table 4). According to the periods of the laying season, the average egg weight was 155.20 g at the beginning of the season, 150.82 g at the middle and 154.34 g at the end of the season (Table 5). The differences between seasonal weeks and periods in terms of average egg weight were found to be statistically significant (P<0.001).

Hatching traits

The laying season for both the adult and young breeder flocks was divided into three periods: the beginning, middle and end of the season. Hatching averages were examined according to these periods and the statistical differences between the periods were analyzed. The average fertility rates of adult breeder flock eggs were 86.31% at the beginning, 69.74% at the middle and 44.44% at the end of the laying season. The average hatchability of total eggs rate was 74.90% at the beginning of the season, 59.48% at the middle and 36.43% at the end (Table 6). The differences among the means of fertility rates and on hatchability of total eggs were found to be statistically significant by period (P<0.001).

The average fertility rates for the young breeder flock eggs were determined by the laying periods as 79.85% at the beginning, 51.61% in the middle and 26.42% at the end of the laying season. The differences among these periods were found to be statistically significant (P<0.001). The average hatchability of total egg efficiency was 70.20% at the beginning, 41.70% in the middle and 20.17% at the end of the season (Table 7).

In this study, a total of 7630 eggs were hatched in the private goose farm over two laying seasons. The hatching traits of all eggs hatched in both years were evaluated across six weight groups. It was observed that the weights of the hatched eggs were intensive between 120.00 and 179.99 g. The lowest fertility rate in these egg-weight groups

Table 5: Egg weight in young breeder flock according to weekly and laying season periods.

Laying season (Week)	n	Min-Max	CV (%)	$\bar{x} \pm S\bar{x}$
1st	101	106.6-212.9	15.77	149.07±2.33^{de}
2nd	546	107.4-251.4	14.28	155.32±0.94^{ab}
3rd	420	100.9-214.7	12.30	156.52±0.94^{a}
4th	340	93.7-263.6	13.56	156.77±1.15^{a}
5th	311	107.0-206.0	12.84	152.01±1.10^{bcd}
6th	209	96.2-211.7	12.42	148.83±1.27^{de}
7th	357	97.4-238.2	12.39	148.69±0.97^{de}
8th	302	97.5-200.3	12.75	147.44±1.09^{e}
9th	260	103.9-190.6	11.07	149.14±1.02^{de}
10th	228	92.8-190.1	11.16	150.67±1.11^{cde}
11th	132	114.2-193.2	9.80	152.81±1.30^{abcd}
12th	140	114.2-203.3	9.60	154.09±1.25^{abc}
13th	112	120.1-195.6	8.69	154.66±1.27^{abc}
14th	100	110.7-188.7	10.11	154.35±1.56^{abc}
Laying season periods				
Begining	1.067	100.9-251.4	13.72	155.20±0.65^{a}
Middle	2.139	92.9-263.6	12.46	150.82±0.40^{b}
End	352	110.7-203.3	9.44	154.34±0.77^{a}
Overall season	3.558	92.8-263.6	12.68	152.50±0.32

a-e: Differences between means with different letters in the same column are statistically significant (P<0.001).

Table 6: Hatching traits of adult breeder flock based on laying season periods.

Laying season periods	Fertility (%)	Total embryonal death (%)	Hatchability of fertile eggs (%)	Hatchability of total eggs (%)
Begining	86.31^{a}	13.22	86.78	74.90^{a}
Middle	69.74^{b}	14.72	85.28	59.48^{b}
End	44.44^{c}	18.02	81.98	36.43^{c}
P value	0.001	0.188	0.83	0.001
Overall	69.03	14.66	85.34	58.91

a-c: The difference between means with different letters in the same column is statistically significant (P<0.001).

was 39.88% in eggs weighing less than 120.00 g. Fertility rates were significantly higher for eggs weighing 160.00 g and above. Among the traits examined for the hatchability of total eggs, the lowest hatching efficiency rate of 28.90% was determined in the egg weight group of less than 120.00 g (Table 8). The best hatchability rate was determined in the egg weight group between 160.00 and 199.99 g (P<0.001).

The laying season length for adult geese is shorter in comparison to that observed for two- and four-year-old White Koluda geese by Drzazga *et al.* (2016) and for Legarth and Great Grey geese older than two years by Petriv *et al.* (2019). The laying season length for young breeder geese was found to be shorter than previously reported for White Italian geese by Kuzniacka *et al*. (2019) and Landes geese by Cüneydioğlu *et al.* (2022). The shorter laying season observed may be due to differences in genotype and feeding conditions.

In this study, the average egg production at the end of the laying season for adult breeder geese was found to be higher than the reported values for two-year-old Kars province local geese by Arslan and Saatcı (2003) and for adult Kars province local geese by Önk and Kırmızıbayrak (2019). However, it is lower than the values reported for Legarth and Great Gray geese older than two years by Petriv *et al*. (2019). For young breeder geese, the average egg production at the end of the season was determined to lower than the reported values for Italian geese by Kuzniacka *et al*. (2019) and for Landes geese by Cüneydioğlu *et al*. (2022). The lower end-of-season egg yield in this study may be due to differences in genotype, care and feeding conditions.

In this study, the mean egg weight of adult breeder geese was determined to be higher than the values reported for three-year-old Linda geese by Sarı *et al*. (2019) and for three- and four-year-old Kars province local geese by Saatcı *et al.* (2005). However, it was lower than the values reported for the W_{33} line, developed from White Koluda geese older than two years by Wolc *et al*. (2008) and for two- and three-year-old geese of the Lithuanian Vishtines genotype by Juodka *et al.* (2012). For young breeder geese, the mean egg weight was determined to be higher than the reported values for Afyonkarahisar province local geese by Peşmen and Yönetken (2020) and for Eskildsen Schwer crossbreed geese by Eroğlu and Erişir (2022). It is similar to the value reported for White Koluda geese by Kucharska *et al*. (2022) and lower than reported for Landes geese by Cüneydioğlu *et al*. (2022). The lower mean egg weight may be due to differences in care, feeding conditions and genotype.

In this study, the average fertility rate for adult breeder geese was determined to be higher than the reported for two-year-old Kars province local geese by Arslan and Saatcı (2003). However, it is lower than the reported values for two- and three-year-old Eskildsen Schwer crossbreed geese by Eroğlu and Erişir (2022) and for adult breeder geese in the Fayoumy region by Abdel-Kafy *et al*. (2023). For young breeder geese, the average fertility rate was determined to be is lower than the reported values for Afyonkarahisar province local geese by Peşmen and Yönetken (2020) and

Table 7: Hatching traits of young breeder flock based on laying season periods.

Laying season periods	Fertility (%)	Total embryonal death (%)	Hatchability of fertile eggs (%)	Hatchability of total eggs (%)
Begining	79.85^{a}	12.09^{b}	87.91	70.20^{a}
Middle	51.61^{b}	19.20^{a}	80.80	41.70^{b}
End	26.42^{c}	23.66^{a}	76.34	20.17^{c}
P value	0.001	0.001	0.384	0.001
Overall	57.59	16.45	83.55	48.12

a-c: The difference between means with different letters in the same column is statistically significant (P<0.001).

Table 8: Hatching traits of all incubated eggs examined according to weight groups, egg weight (g).

Traits	<120.00	120.00 -139.99	140.00 -159.99	160.00 -179.99	180.00 -199.99	≥200.00	P value
Total number of eggs incubated	173	1.214	2.954	2.643	579	67	-
Number of fertilized eggs	69	650	1.765	1.890	441	45	-
Fertility (%)	39.88^{c}	53.54^{b}	59.75^{b}	71.51^{a}	76.17^{a}	67.16^{a}	0.001
Number of chicks hatched	50	526	1.500	1.639	363	33	-
Hatchability of fertile eggs, (%)	72.46	80.92	84.99	86.72	82.31	73.33	0.79
Hatchability of total eggs, (%)	28.90^{e}	43.33^{cd}	50.78^{b}	62.01^{a}	62.69^{a}	49.25^{bc}	0.001
Total number of embryonal deaths	19	123	273	248	73	13	-
Total embryonal mortality rate, (%)	27.54^{a}	18.92^{b}	15.47^{bc}	13.12^{c}	16.55^{bc}	28.89^{a}	0.002

a-e: The difference between means with different letters in the same column is statistically significant (P <0.001).

for Egyptian geese in their first laying season by El-Hanoun *et al*. (2012). The lower fertility rates observed may be attributed to genotype, care and feeding differences, as well as a higher number of inexperienced males among young breeder geese.

In this study, the average hatchability of total eggs for adult breeder geese was found to be higher than the reported values for two-year-old Kars province local geese by Arslan and Saatcı (2003) and for adult geese in the Fayoumy region of Egypt by Abdel-Kafy *et al*. (2023). However, it is lower than the reported values for two-year-old Eskildsen Schwer crossbreed geese by Eroğlu and Erişir (2022) and for adult geese in the Saiddy region of Egypt by Abdel-Kafy *et al*. (2023). For young breeder geese, the average hatchability of total eggs was determined to be higher than the reported value for Kars province local geese by Arslan and Saatcı (2003), but lower than the reported values for Eskildsen Schwer crossbreed geese by Eroğlu and Erişir (2022) and for Afyonkarahisar domestic geese by Peşmen and Yönetken (2020). The lower hatchability of total eggs observed may be due to differences in feeding conditions and genotype.

CONCLUSION

As a result of the study, found that young breeder geese had a longer laying season, reaching peak egg production in the fifth week, while adults peaked in the fourth. Adult geese had higher average egg weights, which decreased throughout the season, whereas young geese showed an increasing trend. Egg weight significantly impacted hatching traits, with the best results in the 160.00-199.99 g range. Egg production, egg traits and hatching traits were high level in adult breeder geese compared to young breeders.

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Note

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Disclaimers

The authors assume full responsibility for the findings and conclusions presented in this article. They do not accept any liability for any direct or indirect loss resulting from the use of this content.

Informed consent

The study was approved by Kafkas University Animal Experiments Local Ethics Committee (KAÜ-HADYEK) dated 23.09.2021 and numbered 2021-145 and was conducted in accordance with the principles of the ethics committee.

Conflict of Interest

There is no conflict of interest between the authors.

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