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The Effect of Supplementation of Fennel (*Foeniculum Vulgare Mill.)* to the Feed on Egg Production, Slaughter and Carcass Characteristics, Formation of Parasites in the Intestine and Spermatological Quality in Japanese Quail During the Laying Period

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Abstract

This study was carried out to determine the effects of supplementation of ground fennel to quail rations on egg production, slaughter, intestinal parasites, and semen quality. For this purpose, 48 female and 24 male quails were used in the study. The experimental groups consisted of the control group with basal feed + 0% ground fennel, and the GF1, GF2, and GF4 groups with ground fennel-supplemented basal feed by 1%, 2%, and 4% respectively, also each group was designed in pairs. The weekly live weight values were found to be numerically higher in the groups with fennel-supplemented rations than in the control group. In addition, the live weight values of female and male quails were also numerically higher in the groups with fennel-supplemented rations. Egg weight, egg production, and feed intake of female quails were high, especially in the GF2 group. Furthermore, the feed conversion ratio was superior in the GF2 group. Regarding the slaughter and carcass parts, the fennel-supplemented groups were numerically higher than the control group. It was observed that the oviduct weight increased with the growing fennel ratio. In addition, the fennel supplementation increased the semen concentration in male quails. The increasing fennel addition enhanced the abnormal and dead spermatozoa rates and decreased semen motility. As a result of the macroscopic examination of the intestinal lumen of the quails in the control and fennel-supplemented groups, no adult helminths were detected; however, *Giardia* spp.-like cysts were observed. As a result, the usage of ground fennel as a feed additive by 2% had a positive effect on yield characteristics of female quails, and the use by 1% had a positive effect on male quails. Consequently, the usage of ground fennel as a feed additive would be beneficial in quail farming.

Key Words: Dead spermatozoa rates, feed-to-egg ratio, female feed intake, fennel, motility

Japon Bıldırcınlarında Yumurtlama Döneminde Yeme Rezene (*Foeniculum Vulgare* Mill.) İlavesinin Yumurta Verimi, Kesim ve Karkas Özellikleri, Bağırsaklarda Parazit Oluşumu ve Spermatolojik Kalite Üzerine Etkisi

Öz

Bu çalışma bıldırcın rasyonlarına öğütülmüş rezene ilavesinin yumurta verimi, kesim, bağırsak paraziti ve sperma kalitesi üzerine etkilerini belirlemek amacıyla yapılmıştır. Çalışmada 48 adet dişi ve 24 adet erkek bıldırcın kullanılmıştır. Çalışma grupları; bazal yem+%0 öğütülmüş rezene olan kontrol grubu ve bazal yeme %1, %2 ve %4 oranlarda öğütülmüş rezene ilaveli GF1, GF2 ve GF4 gruplarından oluşturulmuş, her grup iki tekrarlı olarak tasarlanmıştır. Haftalık canlı ağırlık değerleri rezene ilaveli gruplarda, kontrol grubundan rakamsal olarak yüksek saptanmıştır. Ayrıca dişi ve erkek bıldırcın canlı ağırlık değerleri de rezene ilaveli gruplarda rakamsal olarak yüksek olmuştur. Dişi bıldırcınların yumurta ağırlığı, yumurta verimi ve yem tüketimi özellikle GF2 grubunda yüksek saptanmıştır. Aynı zamanda yemin yumurtaya dönüşümü en iyi GF2 grubunda gerçekleşmiştir. Kesim ve karkas parçaları bakımından rezene ilaveli gruplarda, kontrol grubundan rakamsal olarak daha yüksek olduğu saptanmıştır. Yumurta kanal ağırlığının artan rezene oranı ile arttığı görülmüştür. Erkek bıldırcınlarda rezene ilavesinin sperma yoğunluğunu artırdığı belirlenmiştir. Aynı zamanda artan rezene ilavesinin anormal ve ölü spermatozoon oranlarını artırdığı, motiliteyi ise azalttığı belirlenmiştir. Kontrol ve rezene ilaveli gruplardaki bıldırcınların bağırsak lümenlerinin makroskobik incelenmesi sonucunda erişkin helmint saptanmamış, ancak dışkıların natif muayenesinde bütün gruplarda *Giardia* spp. benzeri kistlere rastlanmıştır. Sonuç olarak yumurta verim döneminde dişi performansını iyileştirmek için öğütülmüş rezenenin %2 oranının, erkek bıldırcınlar için %1 oranının bitkisel yem katkı maddesi olarak kullanımının olumlu olacağı ifade edilebilir.

Anahtar Kelimeler: Dişi yem alımı, motilite, ölü-canlı spermatozoa oranı, rezene, yem/yumurta oranı

INTRODUCTION

The main effective ingredient of the plant, popularly known as fennel (*Foeniculum vulgare* Mill.), is trans-anethole, and its amount varies depending on different culture conditions (1,2). According to some studies, anethole is an active estro-

genic agent responsible for mammotrophic activity (3), interacts with estrogen receptors, and activates estrogen-dependent progesterone receptors (4). In another study, it was stated that this estrogenic feature increased mammary gland weight, oviduct, and myometrium weights in female rats, and affected the functional integrity of testes and accessory glands in adult male rats (5). Similarly, in humans, it has been noted that fennel causes an increase in the mammary gland and genital organ weight with its estrogenic effect (6). In addition, fennel oil or seed has antimicrobial (7,8) and antioxidant (7) properties and its usage as a feed additive in poultry nutrition have a positive effect on performance (9-11), yield quality (10-12) and animal behavior (12). In a different study, it was reported that the addition of 300 mg/kg of fennel essential oil to quail feed caused a significant increase in egg production and Haugh unit values, and a significant improvement in egg yolk color and eggshell thickness (11). In this context, this study was conducted to determine the effects of adding fennel seeds at different doses to quail feeds on live weight, egg production, egg weight, testicular weight, sperm characteristics, and the parasite load of intestinal contents.

MATERIAL AND METHODS

Hatay Mustafa Kemal University's Scientific Ethical Committee accepted the experimental sets and assessment methodologies, No: 2022/04-03. The study was carried out as a preliminary study to conduct a comprehensive study in the Alternative Poultry Breeding Unit of Hatay Mustafa Kemal University Experimental Research, Applications, and Research Center. In the study, 48 female and 24 male Japanese quails, which were in the laying period and were 50 days old, were used. While each study group had two replications, six female and three male quails were placed in each subgroup. Study groups are as follows; basal feed (control), basal feed + 1% ground fennel (GF1), basal feed + 2% ground fennel (GF2), and basal feed + 4% ground fennel (GF4).

In the formation of the study groups, the sex determination was made through the double control method. For the sex discrimination, while quails with mottled breast feathers and no cloaca glands were defined as female, the quails without spots and cloaca glands were defined as males. After the sex determination, the quails were weighed, their initial live weight values were determined, and then they were randomly distributed to the groups. At the beginning of the study, it was considered that the mean live weight values of the quails in the groups were similar to each other.

The live weight values of the quails in each group were individually weighed on the same day and at the same time each week, and the mean body weights of the groups were determined in the first, first and second weeks.

Feed Properties

In the study, standard feed which is based on corn and soybean, and NRC (13) standards were used (Table 1). Feeds were prepared weekly, drinkers and feeders were checked daily during the study, and fresh water and feed were given to the quail *ad libitum*.

Table 1. Basic nutritional composition of feed (%)

Crude protein	20	Crude ash	4.8	Calcium	0.88
Ether Extract	3	Lysine	1.12	Phosphorus	0.44
Crude Fibre	3	Methionine	0.51	Sodium	0.14

Egg Production Characteristics

Eggs were collected and counted on a daily basis, their weights were determined individually and written on the recording chart of the groups. The daily average egg production (DAEP) and Hen-Housed egg production (HHEP) were determined for each group with the following formulas;

DAEP = Number of eggs collected in 7 days/number of days

HHEP (%) = (DAEP / Number of animals at the beginning of the period) x 100

Feed Utilization Feature

The weekly feed consumption and weekly total egg weight were used to calculate the feed conversion ability, that is, the feed-to-egg ratio.

Weekly feed intake (g) = (The amount of feed given at the beginning of the week – The rest amount of feed at the end of the week)

Daily feed intake (g) = Weekly feed intake / (Number of quails x Number of days)

Weekly feed intake of female quail (g) = (Daily feed intake x Number of female quails x Number of days)

Feed-to-egg ratio = Weekly feed intake of female quail (g) / Total weekly egg weight (g)

Slaughter Traits

To determine the carcass and visceral weights, all female and male quails in the group were sacrificed by the cervical dislocation method when they were 64 days old. Their body hair was removed by skinning. After the feather, head and feet were removed, their hot-filled carcass weights (HFCW) were determined by weighing. Thereafter, edible and non-edible internal organs were removed and hot carcass weight (HHCW) values were recorded without organs. The weights of the heart, liver, gizzard, glandular stomach, oviduct, and intestines were also measured. In addition, the following ratio calculations were made by using (g) which is one of the weight values;

Hot whole carcass yield (%) = (HFCW / Carcass Weight) x 100

Hot carcass yield (%) = (HHCW / Carcass Weight) x 100

Heart ratio (%) = (Heart Weight / HFCW) x 100

Liver ratio (%) = (Liver Weight / HFCW) x 100

Gizzard ratio (%) = (Gizzard Weight / HFCW) x 100

Glandular stomach ratio (%) = (Glandular stomach Weight / HFCW) x 100

Intestine ratio (%) = (Intestine Weight / HFCW) x 100

Oviduct ratio (%) = (Oviduct Weight / HFCW) x 100

The Calculation of Testicular Weight

The testicles were removed by opening the abdominal cavity, and the weight of each testis was measured using an

electronic analytical balance. The relative testis weights were calculated using the formula below (14);

Relative testis weight (%) = (Absolute testis weight (g) / Slaughter Weight (g)) x 100

Spermatological Analysis

The epididymis from both testicles was gently separated and placed in a 60 mm petri dish in PBS (pH 7.4) at 37 °C. The spermatozoa were allowed to pass into the PBS liquid for 5 minutes (Figure 1).

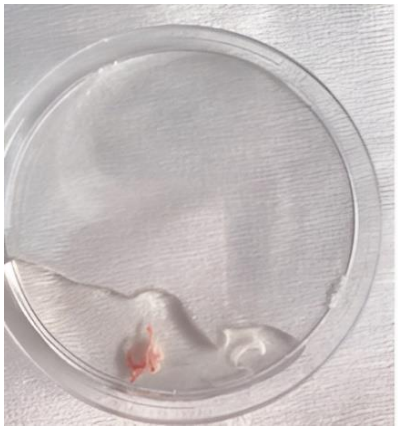

Figure 1. Placing the epididymis in a petri dish

In the determination of sperm concentration, a drop of epididymal homogenate incubated in PBS was taken and counting was completed using the Makler counting chamber.

In the determination of motility, a drop of sperm suspension was placed on a slide on the heating plate under a phase contrast microscope and a coverslip was covered on it. At least 4-5 microscopic fields were observed at 400x magnification of the microscope. The motility of spermatozoa was calculated as a percentage.

While determining the ratio of dead-live spermatozoa, the epididymal sperm were mixed with eosin-nigrosin dye and a smear was drawn on the slide and expressed as % after counting at least 200 cells, by considering that the heads of dead spermatozoa were stained red (dead) and unstained (live) under the microscope at 400x magnification (Figure 2).

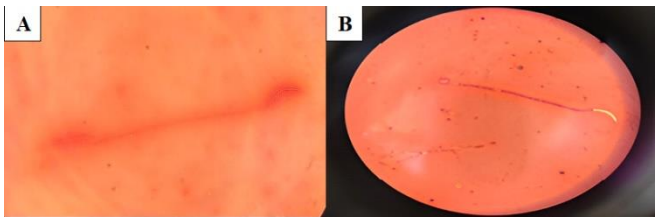

Figure 2. Image of the dead (A) and live (B) spermatozoa

In the determination of abnormal spermatozoa, the sperm suspension taken from the cauda epididymis was counted at least 200 sperm cells and expressed as % by adding immersion oil at 1000x magnification with the eosin-nigrosin staining method under the phase contrast microscopy.

Parasitological Examination of Intestines

After slaughter, the small and large intestines and feces of male and female quails in each group were examined. The intestinal samples of each quail were first examined macroscopically and then carefully opened with scissors to be examined for the presence of adult helminths.

Faeces samples were collected separately for each group in Petri dishes and mixed with a wooden stick. Then, a drop of the mixture was taken on a slide, mixed with a drop of physiological saline, and covered with a coverslip, and then examined under the microscope for the presence of trophozoites, cysts or oocysts of protozoa and helminth eggs. The same procedure was repeated with a drop of Lugol.

Statistical Analysis

The IBM SPSS Statistics 22.0 software was used for the statistical analysis of the obtained data. One-way analysis of variance was used to determine whether there was a difference between the groups regarding the determined parameters. Also, Duncan's test was used to compare multiple groups comparison. The statistical significance level was considered when $P<0.05$.

RESULTS

The live weight values of the quails in the experimental groups during the egg production periods are presented in Table 2. The difference between the groups in terms of body weight values at the base, 57th day, and 64th day was statistically insignificant ($P>0.05$). However, the average live weight value was numerically higher but there are no statistical differences in all fennel-supplemented groups on the 57th day, and higher in the GF2 and GF4 groups on the 64th day compared to the control group. When the study groups were compared in terms of live weight based on gender, it was determined that the weights of female quails in all groups were higher than male quails ($P<0.01$).

Table 2. Live weight values in experimental groups (g)

Groups	50th day (Base)	57th day	64th day
Control	224.61	232.65	240.74
GF1	224.34	235.18	235.88
GF2	227.08	241.06	245.21
GF4	219.46	242.45	247.50
SEM	3.066	3.644	3.253
P value	0.847	0.745	0.602
		Gender-based comparison	
Control – female	238.30^{a}	247.47^{a}	253.75^{a}
Control – male	197.23^{b}	203.01^{b}	214.70^{b}
GF1 – female	235.42^{a}	247.07^{a}	246.41^{a}
GF1 – male	202.18^{b}	211.39^{b}	214.84^{b}
GF2 – female	242.01^{a}	260.08^{a}	261.95^{a}
GF2 - male	197.21^{b}	203.01^{b}	211.75^{b}
GF4 - female	227.79^{a}	255.36^{a}	263.49^{a}
GF4 - male	202.80^{b}	216.63^{b}	215.52^{b}
SEM	2.438	2.838	2.341
P value	0.001	0.001	0.001

a, b: The difference between the groups in the same column and given with different letters is important.

The average daily egg production and Hen-Housed egg production values of the quails in the experimental groups are given in Table 3. The control and GF2 groups were similar to each other (P>0.05) in all determined periods in terms of average daily egg production and Hen housed egg production, yet statistically significant differences were found in the GF1 and GF4 groups (P<0.01).

Table 3. Egg production characteristics of groups

	Number of females	1st Week DAEP (piece)	1st Week HHEP (%)	2nd Week DAEP (piece)	2nd Week HHEP (%)	14 days DAEP (piece)	14 days HHEP (%)
Control	12	4.50^{a}	75.00^{a}	5.36^{a}	89.31^{a}	4.93^{a}	82.15^{a}
GF1	12	3.43^{b}	57.16^{b}	4.29^{b}	71.55^{b}	3.86^{b}	64.27^{b}
GF2	12	4.72^{a}	78.58^{a}	5.72^{a}	95.25^{a}	5.21^{a}	86.83^{a}
GF4	12	3.36^{b}	55.98^{b}	4.29^{b}	71.42^{b}	3.82^{b}	63.68^{b}
	SEM	0.126	2.108	0.118	1.963	0.073	1.214
	P value	0.004	0.004	0.002	0.002	0.001	0.001

a, b: The difference between groups with different letters in the same column is significant (P<0.05); DAEP: Daily average egg production; HHYV: Hen-Housed egg production

(P<0.05); DAEP: Daily average egg production; HHYV: Hen-Housed egg production

The average and weekly total egg weights of the experimental groups, weekly feed intake and Feed-to-egg ratio of female quails are given in Table 4. In terms of the average egg weight which was determined between the 50th and 64th days of the study, the GF1 group was similar to the control group (P>0.05), while the GF2 and GF4 groups differed significantly (P<0.01). However, in terms of weekly total egg weight, control and GF2 were similar (P>0.05), with a higher and significant difference from other fennel-supplemented groups (P<0.01). The differences between the groups in terms of weekly feed intake in female quails are significant (P<0.01, P<0.05, P<0.01 respectively), plus the lowest weekly feed intake in all periods was found in the quails of GF1 and GF4 groups. The feed-to-egg ratio was significantly better in the control and GF2 groups than in the GF1 and GF4 groups between days 50 and 64 (P<0.01).

Table 4. The egg weights, feed intake and feed-to-egg ratio rates of the experimental groups

Groups	First week	Second week	Between day 50-day 64
	Average egg weight (g)		
Control	11.51^{bc}	12.36^{bc}	11.97^{b}
1%	11.31^{c}	12.11^{c}	11.76^{b}
2%	12.03^{ab}	12.72^{ab}	12.41^{a}
4%	12.46^{a}	12.93^{a}	12.72^{a}
SEM	0.103	0.079	0.066
P value	0.001	0.002	0.001
	Weekly total egg weight (g)		
Control	362.54^{a}	463.33^{a}	825.87^{a}
1%	271.39^{b}	363.39^{b}	634.76^{b}
2%	396.93^{a}	508.82^{a}	905.75^{a}
4%	292.87^{b}	387.86^{b}	680.73^{b}
SEM	8.902	10.201	13.254
P value	0.001	0.001	0.001
	Weekly feed intake in female quails (g)		
Control	1346.67^{a}	1406.67^{a}	1376.67^{a}
1%	1233.31^{b}	1273.33^{b}	1253.34^{c}
2%	1366.66^{a}	1413.33^{a}	1390.00^{a}
4%	1326.67^{a}	1313.33^{ab}	1320.00^{b}
SEM	11.659	15.503	9.012
P value	0.008	0.018	0.001
	Feed-to-egg ratio		
Control	3.72^{ab}	3.05	1.67^{b}
1%	4.69^{a}	3.55	1.98^{a}
2%	3.44^{b}	2.80	1.54^{b}
4%	4.60^{a}	3.43	1.94^{a}
SEM	0.157	0.105	0.035
P value	0.035	0.095	0.001

a, b: The difference between the groups in the same column and given with different letters is important

The testis weights and spermatological examination values of the study groups are given in Table 5. The numerical difference between the control and the fennel-supplemented GF1, GF2 and GF4 groups concerning the absolute testis

weight and relative testis weight values was statistically insignificant (P>0.05). In microscopic spermatological evaluations, while the fennel-supplemented experimental groups were similar to each other in terms of spermatozoa concentration, their values were found to be significantly higher than the control group (P<0.05). According to the morphological evaluation, the control and the GF1 groups were similar and had a remarkably lower rate of abnormal spermatozoa when compared to the GF2 and GF4 groups (P<0.01). The GF1, GF2 and GF4 groups were significantly different from the control group in terms of their dead spermatozoa rates, yet the GF1 group had the lowest rate and the GF2 the highest (P<0.01). In addition, the lowest spermatozoon motility values were found to be in the GF4 group and the highest in the GF1 group (P<0.01).

Table 5. The testicular and spermatological parameters in research groups (n=24)

Groups	Absolute Testis Weight (g) (right+left/2)	Relative testis (%) (Absolute testis weight/Slaughter weight)x100	Sperm Concentration (10^6 ml^{-1})	Morphology (Abnormal Spermatozoa Rate) (%)	Dead Spermatozoa Ratio (%)	Motility (%)
Control	2.73±0.349	1.25±0.178	445.83±15.911^{b}	8.00±0.816^{b}	33.50±1.839^{c}	54.17±2.386^{b}
GF1	3.35±0.127	1.54±0.076	505.17±25.878^{a}	7.33±1.145^{b}	22.00±3.162^{d}	70.83±1.536^{a}
GF2	3.13±0.250	1.49±0.126	508.83±14.627^{a}	15.50±0.763^{a}	53.83±3.718^{b}	34.17±4.362^{c}
GF4	3.57±0.351	1.74±0.143	542.83±14.729^{a}	16.33±1.256^{a}	66.50±5.469^{a}	22.50±4.425^{d}
SEM	0.142	0.068	9.198	0.509	1.890	1.708
P value	**0.220**	**0.119**	**0.011**	**0.001**	**0.001**	**0.001**

a, b: The difference between the groups in the same column and given with different letters is important.

The slaughter and carcass characteristics of the groups are given in Table 6. There were no as well as numerical or significant differences found between the groups regarding slaughter characteristics (P>0.05). However, when female quails were compared in terms of carcass yield, there was a remarkable difference between the groups, plus GF2 and GF4 groups showed a significant difference (P<0.01) when compared with the control group. The oviduct weights were numerically higher in the GF2 and GF4 groups than in the control group (P>0.05).

Table 6. The slaughter and carcass parts' weight characteristics of experimental groups

	Gender	Control	FP1	FP2	FP4	SEM	P value
	Female	252.02	258.56	278.03	269.17	3.663	0.075
Slaughter weight (g)	Male	222.99	218.10	211.30	205.16	3.875	0.408
	Both	241.77	243.39	253.01	245.17	4.173	0.786
	Female	205.30	198.29	221.94	212.98	3.342	0.096
Hot filled carcass weight (g)	Male	166.32	166.72	161.14	157.32	2.651	0.554
	Both	191.54	186.45	199.14	192.11	3.739	0.698
	Female	144.59	142.09	150.76	142.16	2.220	0.489
Hot hollow carcass weight (g)	Male	137.11	134.41	133.12	128.72	2.281	0.629
	Both	141.95	139.21	144.14	137.12	1.758	0.522
	Female	1.98	2.02	2.08	1.97	0.051	0.876
Heart weight (g)	Male	1.72	1.95	1.84	1.68	0.049	0.248
	Both	1.89	1.99	1.99	1.86	0.039	0.521
	Female	7.86	8.79	8.82	7.88	0.197	0.151
Liver weight (g)	Male	4.21	3.86	3.90	3.72	0.132	0.624
	Both	6.57	6.94	6.97	6.32	0.304	0.853
	Female	5.11	5.64	6.14	6.07	0.182	0.167
Gizzard weight (g)	Male	4.65	4.57	4.42	4.34	0.119	0.790
	Both	4.95	5.24	5.49	5.42	0.146	0.543
	Female	1.13	1.14	1.18	1.16	0.028	0.891
Glandular stomach weight (g)	Male	0.87	0.79	0.77	0.79	0.025	0.563
	Both	1.03	1.01	1.03	1.02	0.029	0.994
	Female	14.54	16.27	16.49	16.00	0.395	0.292
Intestine weight (g)	Male	9.44	9.85	9.36	8.96	0.288	0.753
	Both	12.78	13.86	13.81	13.36	0.479	0.824
	Female	57.46^{a}	55.07^{ab}	54.23^{b}	52.74^{b}	0.463	0.007
Hollow carcass yield (%)	Male	62.07	61.68	63.01	62.69	0.901	0.953
	Both	59.08	57.55	57.52	56.47	0.639	0.543
Oviduct weight (g)	Female	8.59	8.34	8.95	9.13	0.256	0.711
Oviduct ratio (%)	Female	3.43	3.22	3.21	3.38	0.081	0.705

The intestine images of male and female quails of the study groups and the microscopic analysis photographs of their feces are given in Figure 3. As a result of the macroscopic examination of the intestinal lumen of the quails in the study groups, no adult helminths were found, yet according

to the examination of the stools by native examination, cysts like the *Giardia* spp. were detected, but trophozoite could not.

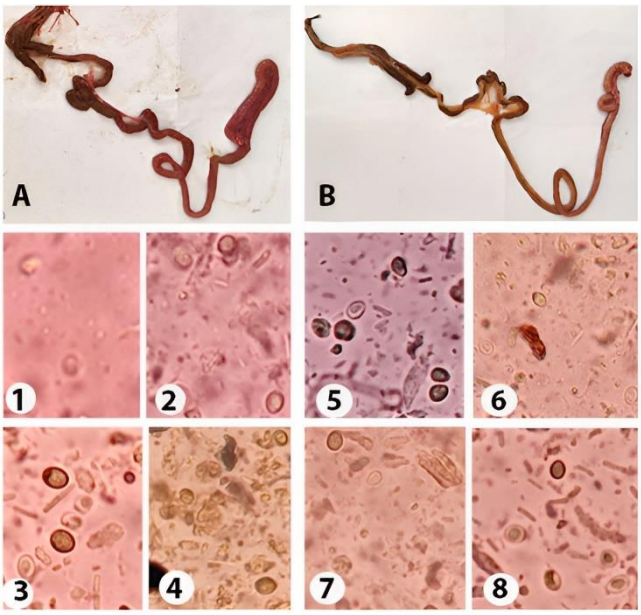

Figure 3. The microscopic images of the faeces were observed by the native-Lugol method and *Giardia* spp. like cysts (400X magnification) A. Intestines of female quails; 1. Control-Female, 2. GF1-Female, 3. GF2-Female, 4. GFP4-Female, B. Intestines of male quails; 5. Control-Male, 6. GF1-Male, 7. GF2-Male, 8. GF4-Male.

DISCUSSION AND CONCLUSION

When the addition of fennel into the feed during the egg-laying period was compared in terms of live weight values, a numerical increase was detected in the GF2 and GF4 groups compared to the control group. Consistent with the study results, the addition of fennel seed (15) and fennel essential oil (11) to quail feed during the egg-laying period had no significant effect on live weight when compared with the control group. According to the study, the female quails had higher body weight than male quails, and the best body weight gain was in the GF2 and GF4 groups in females and the GF4 group in male quails compared to the control group. The fact that female quails have better growth rates than male quails is a predominant factor in breeding female-male quails together in meat production (16-19). In addition, Sarica et al. (20) reported that the live weight of male quails that were left out of breeding increased until the eighth week and then decreased, but it was not considered a significant change.

Hen-Housed egg production was similar and high in the control group and the GF2 group, but significantly lower in the GF1 and GF4 groups. It was stated that the addition of 1.2% fennel seeds (21) and 300 mg/kg fennel essential oil (11) to the feed resulted in a significantly higher egg yield in quails than in the control group. On the other hand, Buğdaycı et al. (15) reported that the egg yield in quails fed with fennel seed added feeds was higher than the control group, especially the 0.6% group had an egg yield rate of 96.64%. Considering the differences in the results, it should be noted that the number of eggs produced per day in the hen house is determined by recording the eggs with shell integrity, therefore, the presence of defective eggs in the groups will cause losses.

When compared with the control group, while the addition of 1% (GF1) and 4% (GF4) ground fennel to the feed resulted in significant decreases in weekly total egg weight and female feed consumption, it resulted in a significant improvement in the feed conversion rates by 2% (GF2). Besides, Yeşilbağ (11) reported that the addition of fennel essential oil decreased feed intake and improved the feed efficiency of quails when compared with the control group. Vakili and Majidzadeh Heravi (22) and Abou-Elkhair et al. (23) reported that the addition of fennel to layer chicken feed improves feed efficiency and increases egg weight. The egg weight and feed consumption rates vary with the live weight values of quails in the egg period, so the use of quails with different weights caused different results.

The fennel-supplemented groups were found to be similar to the control group in terms of all characteristics determined except for the hollow carcass yield. The heart, liver, gizzard, glandular stomach, and intestinal weights were numerically higher in females of the fennel-supplemented groups compared to the control group. In male quails, the weights of the heart, gizzard, and intestinal were higher than in the control group, yet the liver weight was lower. Sarıca et al. (20) reported that edible internal organs (heart, liver, gizzard) weight decreased in non-breeding male quails starting from the 8th week. Accordingly, the oviduct weight of female quails in the fennel-supplemented GF2 and GF4 groups was numerically higher than the control group. The female quail oviduct weight values of the control and fennel-supplemented groups were found to be higher than the 7.06 g value reported by Teixeir et al. (24) for Japanese quails at 48 weeks of age. It is a fact that this difference may be due to the age and live weight difference of the broodstock quail that was used in the study.

In the study, according to the comparisons regarding absolute and relative testis weight, it was determined that the values of the male quails of the fennel-supplemented groups were numerically higher than the ones in the control group. Sarıca et al. (20) found that the testicular weight increased with age in non-breeding male quails, plus it varies between 3-6 g between the 6th and 10th weeks. The male quail values in the fennel-supplemented groups are included in the reported testis weight range. According to the study, the concentration, abnormal and dead spermatozoa rates increased with the rise in fennel rates, but motility decreased. Sperm motility of less than 50% is a sign of reproductive problems. In this sense, it was determined that the GF1 group male quails from the control and other fennel-supplemented groups had a lower rate of abnormal and dead spermatozoa, a lower rate than other fennel-supplemented groups in terms of concentration, but a significantly higher rate than all other groups in terms of motility. The use of fennel, which has an antioxidant effect, is recommended to improve fertility (25). In studies using fennel oil in different animal species, an improvement in testicular histological structure and an increase in spermatological quality have been reported (26-29).

As a result of the macroscopic examination of the intestinal lumen of the quails in the control and fennel-supplemented groups, no adult helminths were found (Figure 3), yet according to the examination of the stools by native examination, cysts like the *Giardia* spp. were detected, but trophozoite could not. In some studies on parasitic diseases of quails; Kurtpınar (30) found that 26 out of 40 quails were infected with various helminths, Tolgay (31) found many cestodes in 2 of 12 quails, Köroğlu (32) found helminth infections in 44 out of 100 quails, and Kalınbacak and Burgu (33) found nematodes such as the *Cyrnea colini* and *Capillaria* sp. in the autopsy of 7 wild quails. In addition, Vasco et al. (34) reported that they could not diagnose *Giardia* spp. cysts in 3 quails, plus Reboredo-Fernandez et al. (35) reported *Giardia duodenalis* assemblage B in a quail in a study examining 433 wild birds. The appearance of *Giardia* spp. similar cysts in control and all experimental groups are generally compatible with the literature. While helminth infection was generally detected in studies conducted with quails in Türkiye, no protozoan infection study was found except for two studies (36,37) in which *Toxoplasma gondii*-specific antibodies were investigated. The number of studies in this area should be increased and molecularly approved.

The weekly live weight gain between the 50th and 64th days of the laying period was determined numerically higher in the fennel-supplemented groups than in the control group in female and male quails. In this sense, the live weight gain was observed in quails of the fennel-supplemented groups at 2% and 4% rates, which made a difference. The average daily number of eggs, hen-housed egg production, egg weight, and feed intake in female quails were highest in the fennel-supplemented group at the rate of 2%. Also, the feed-to-egg ratio in the GF2 group improved positively. Furthermore, the high values regarding slaughter and carcass piece weight values belong to the GF2 group quails. It can be stated that the oviduct weight rises with the increasing fennel ratio, so it differs numerically from the control group. In terms of spermatological quality, while the addition of fennel depending on the dose to the feed had a positive effect on sperm concentration, it increased the rate of dead spermatozoa and decrease the motility rate.

In this sense, the best result was in the male quail of GF1 group. As a result, the use of ground fennel as a natural additive by 2% had a positive effect on yield characteristics of female quails, and the use by 1% had a positive effect on the spermatological quality characteristics in male quails, thus showing that the use of ground fennel would be beneficial. In addition, this study contributes to a small number of studies on the presence and prevalence of parasitic diseases.

CONFLICTS OF INTEREST

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REFERENCES

1. Kan Y, Kartal M, Aslan S, et al. (2006). Farklı Koşullarda Yetiştirilen Rezene Meyvelerinin Uçucu Yağ Bileşenleri. Ankara Ecz Fak Derg. 35(2): 95–101.
2. Kazemi-Fard M, Kermanshahi H, Rezaei M, et al. (2013). Effect of Different Levels of Fennel Extract and Vitamin D3 on Performance, Hatchability and İmmunity in Post Molted Broiler Breeders. Iran J App Anim Sci. 3: 733–745.
3. Al-Yawer MA, Al-Khateeb HM, Al-Khafaji FA, et al. (2007). Herbal Activation of Mammary Gland; A Comparative Morphometrical & Biochemical Analysis. J Fac Med Baghdad. 49(1): 144–146.
4. Haslam S. (1988). Cell to Cell İnteractions and Normal Mammary Gland Function. J Dairy Sci. 71(10): 2843–2854.
5. Malini T, Vanithakumari G, Megala N, et al. (1985). Effect of Foeniculum Vulgare. Mill Seed Extract on The Genital Organs of Male and Female Rats. Indian J Physiol Pharmacol. 29(1): 21–26.
6. Rahimi R, Mohammad Reza SA. (2013). Medicinal Properties of Foeniculum Vulgare Mill. In Traditional Iranian Medicine and Modern Phytotherapy. Chin J Integr Med. 19(1): 73–79.
7. Roby MHH, Sarhan MA, Selim KA, et al. (2013). Antioxidant and Antimicrobial Activities of Essential Oil and Extracts of Fennel (Foeniculum Vulgare L.) and Chamomile (Matricaria Chamomilla L.). Ind Crops Prod. 44: 437–445.
8. Açıkgöz MA, Kara ŞM, Aruç C, et al. (2017). Morphogenetic, Ontogenetic and Diurnal Variability in Antimicrobial Activity of Bitter Fennel (Foeniculum Vulgare Miller Var. Vulgare) Essential Oil. Indian J Pharma Edu Res. 51: 190–193.
9. Ould Sidi Moctar Y, Azeroual E, Kribii A, et al. (2015). Chemical Composition and Zootechnical Effects of Essential Oil of Fennel (Foeniculum vulgare Mill) and Anise (Pimpinellaanisum L.) on Turkey. J. World's Poult Res. 5(4): 90–97.
10. Cengiz ŞŞ. (2018). Effects of Rosemary and Fennel Essential Oil Mix on Performance and Meat Lipid Oxidation in Quails. Van Vet J. 29(1): 39–46.
11. Yeşilbağ D. (2018). Yumurtacı Bıldırcın Rasyonlarına Biberiye ve Rezene Uçucu Yağı İlavesinin Performans ve Yumurta Kalite Parametreleri Üzerine Etkisi. Ankara Üniv Vet Fak Derg. 65: 413–418.
12. Souza AVD, Morais MVM, Rocha MC, et al. (2020). Influence of Fennel in Japanese Quail Diet Over Egg Quality and Behavior Aspects. Bol Ind Anim. 77: 1–13.
13. NRC. (1994). National Research Council, Nutrient Requirements of Poultry. 9t h rev. ed. National Academy Press, Washington, DC.
14. Türk G, Çeribaşı AO, Şimşek ÜG, et al. (2016). Dietary Rosemary Oil Alleviates Heat Stress-İnduced Structural and Functional Damage Through Lipid Peroxidation in The Testes Of Growing Japanese Quail. Anim Reprod Sci. 164: 133–143.
15. Buğdaycı KE, Oğuz FK, Oğuz MN, et al. (2018). Effects of Fennel Seed Supplementation of Ration on Performance, Egg Quality, Serum Cholesterol, and Total Phenol Content of Egg Yolk of Laying Quails. Rev Bras Zootec. 47: 1–7.
16. Çulfacı A, Sezer M, Tarhan S. (2008). Japon Bıldırcınlarında Sınırlı Yemlemenin Büyüme Eğrisi Üzerine Etkileri. Tarım Bil Araş Derg. 1(2): 5–10.
17. Çelik Ş, İnci H, Söğüt B, et al. (2014). Japon Bıldırcınlarında Çeşitli Ağırlık Ölçüleri Arasındaki İlişkinin İncelenmesi. Tr Doğa ve Fen Derg Tr. J. Nature Sci. 3(1): 22–28.
18. Alasahan S, Copur A, Canogullari B. (2016). The İmpact of Eggshell Colour and Spot Area in Japanese Quails: II. Slaughter And Carcass Characteristics. R Bras Zootec. 45(9): 509–517.
19. Abou-Kassem DE, El-Kholy MS, Alagawany M, et al. (2019). Age and Sex-Related Differences in Performance, Carcass Traits, Hemato–Biochemical Parameters, and Meat Quality in Japanese Quails. Poult Sci. 98(4): 1684–1691.

20. Sarıca M, Yamak US, Boz MA. (2014). Bıldırcınlarda Uzun Süreli Beslemenin Kesim ve Bazı Karkas Özellikleri Üzerine Etkileri. Anadolu Tarım Bilim Derg. 29(1): 75–78.
21. Yazarloo M, Sharifi SD, Mallaki M, et al. (2014). Effect of Fennel Seeds on Laying Performance and Egg Quality Traits in Japanese Quails. Anim Prod Res. 3(3): 33–43.
22. Vakili R, Majidzadeh Heravi R. (2016). Performance and Egg Quality of Laying Hens Fed Diets Supplemented with Herbal Extracts and Flaxseed. Poult Sci J. 4(2): 107–116.
23. Abou-Elkhair R, Selim S, Hussein E. (2018). Effect of Supplementing Layer Hen Diet With Phytogenic Feed Additives on Laying Performance, Egg Quality, Egg Lipid Peroxidation and Blood Biochemical Constituents. Anim Nutr. 4(4): 394–400.
24. Teixeira RSC, Cardoso WM, Nogueira GC, et al. (2007). Evaluation of İnduced Molting Methods on The Livability and Reproductive System Regression of Japanese Quails (Coturnix Japonica). Brazil J Poult Sci. 9: 85–89.
25. Pourjafari F, Haghpanah T, Nematollahi-Mahani SN, et al. (2020). Hydroalcoholic Extract and Seed of Foeniculum Vulgare İmprove Folliculogenesis and Total Antioxidant Capacity Level in F1 Female Mice Offspring. BMC Complement Med Ther 20(1): 1–8.
26. Ibrahim AAEM. (2008). Correlation Between Fennel-or Anise-Oil Administration and Damage to The Testis of Adult Rats. Egypt J Bio. 10: 62–76.
27. Sakr SA, Shalab SY, Beder RH. (2017). Protective Effect of Fennel Oil on Cyclophosphamide İnhibited Spermatogenesis and İnduced Oxidative Stress in Albino Rats. J Biotech Biomed Sci. 1(1): 1–18.
28. Karimi A, Besharati M, Nemati Z. (2018). Protective Effects of Fennel (Foeniculum Vulgare) Extract on Frozen-Thawed Sperm of Ghezel Ram. J Anim Envir. 10(4): 83–90.
29. Torkamanpari M, Ghorbani F, Lorian K, et al. (2022). The Effects of Purslane (Portulaca Oleracea) and Fennel (Foeniculum Vulgare Mill) Hydroalcoholic Extracts on The Functional Parameters of Human Spermatozoa After Vitrification. Korean J Fertil Steril. 22: 48–05.
30. Kurtpinar H. (1957). Helminths in Quail (Coturnix Coturnix) in Turkey. J Parasitol. 43(3): 379–381.
31. Tolgay N. (1964). Bıldırcın (Colınus Vırgınıanus) ve Kekliklerde (Perdıx Perdıx) Görülen Helmintler Üzerinde Araştırmalar. Ankara Üniv Vet Fak Derg. 11: 1–2.
32. Köroğlu E. (1993). Elazığ ve Tunceli Yörelerinde Bulunan Av Hayvanlarından Bıldırcın (Coturnix Coturnix) ve Kınalı Keklik (Alectoris Graeca)'lerde Parazitlerin Yayılışı. Doktora tezi, Elazığ, Türkiye.
33. Kalınbacak F, Burgu A. (2004). Türkiye'de Yaban Bıldırcınlarda (Coturnix Coturnix Japonica) Cyrnea Colini Cram, 1927 (Nematoda, Spiruridae) ve Capillaria Sp. (Nematoda, Trichuridae) Olgusu. Turkiye Parazitol Derg. 28: 143–145.
34. Vasco K, Graham JP, Trueba G. (2016). Detection of Zoonotic Enteropathogens in Children and Domestic Animals in A Semirural Community in Ecuador. Appl Environ Microbio. 82(14): 4218–4224.
35. Reboredo-Fernandez A, Ares-Mazas E, Caccio SM, et al. (2015). Occurrence of Giardia and Cryptosporidium in Wild Birds in Galicia (Northwest Spain). Parasitol. 142(7): 917–925.
36. İnci A, Babür C, İşcan KM, et al. (2002). Toxoplasma Gondii (Nicole ve Manceaux, 1908) Spesifik Antikorlarının Sabin-Feldman Boya Testi ile Araştırılması. Türkiye Parazitol Derg. 26: 20–2.
37. Kılıç S, Karatepe M, Karatepe B. (2017). Seroprevalence of Toxoplasma Gondii in Quails (Coturnix Coturnix Japonica) in Niğde Province, Turkey. Kocatepe Vet J. 10(3): 129–133.

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