Scientific Works. Series C. Veterinary Medicine. Vol. LXII (1)
ISSN 2065-1295; ISSN 2343-9394 (CD-ROM); ISSN 2067-3663 (Online); ISSN-L 2065-1295

THE EFFECT OF DIETARY SUPPLEMENTATION OF LEMON GRASS (*Cymbopogon citratus*) ON PERFORMANCE, CARCASS QUALITY, AND MARKETING OF QUAIL (*Coturnix coturnix japonica*)

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Abstract

This study was conducted to determine the effects of supplementation of lemon grass (Cymbopogon citratus) leaf meal on performance, carcass quality traits, and marketing of quail (Coturnix coturnix japonica). A total of 150, four-day-old quail were distributed into three groups with five replicates and 10 quail each. Quail were fed either basal diet (Control group) or 1.5% and 3% lemon grass leaf meal supplemented to basal diets for 5 weeks period. Live weight, live weight gain and feed consumption were recorded and feed efficiency was calculated at the 7th, 21st, and 35th days of the study. At the end of the experiment, carcass traits were also determined. Lemon grass supplementation ratio did not affect live weight and live weight gain (P>0.05) at 1.5% level however, 3% supplementation decreased live weight (P<0.05). Feed consumption and feed conversion ratio were not affected by lemon grass supplementation. In 3% supplemented group, intestine weight and ratio decreased (P<0.05). Lemon grass supplementation did not affect slaughter weight, carcass weight, dressing percentage, liver and gizzard weight and ratio (p>0.05). Also, meat pH, cooking loss, thawing loss, dry matter, ash and protein ratio were not affected by lemon grass supplementation (P>0.05). According to economic evaluation, supplementation of lemon grass did not improve the performance and carcass quality of quail and so, revenue from the lemon grass supplemented groups were lower than those of the control group. In conclusion, higher level supplementation of lemon grass (3%) to quail diet negatively affected the performance; however the lower level (1.5%) had no negative effect on performance and carcass quality.

Key words: *Carcass, Lemon grass, performance, quail, Revenue.*

INTRODUCTION

Due to increases in population, income and living standards, consumers' demand shifts to higher quality, various, and more poultry meat consumption. The poultry industry is presently studying on alternatives to meet these consumers' demands. Also, scientists are trying much more efforts to respond to these expectations. On the other hand, they want to make sure this does not decrease the quality of the end product or ignore animal welfare. Nowadays, increasing of consumer awareness for safety poultry products and from stable to table approach tended the consumers' preferences towards to healthy animals' products. Performance enhancers until recently called growth promoters are used to improve animal growth rate and/or feed conversion ratio. One of the feed additives used to increase the performance of poultry are herbs. Herbs are the dried leaves of aromatic plants, usually found without stems (Peter, 2012). In particular, with the ban on the use of antibiotics to increase growth, studies on plant-based alternatives have increased.

Lemon grass *(Cymbopogon citratus, LG*) contains flavonoids, phenolic compounds, terpenoids (Burkill, 1996) and essential oils (such as citral α, citral β, nerol geraniol, citronellal, terpinolene, geranyl acetate, myrecene and terpinol methylheptenone) which

may be responsible for its different biological activities such as antibacterial, antidiarrheal, antifungal, antioxidants, and as a growth promoter (Shah et al., 2011). There are few scientific studies on the use of LG or its secondary metabolites for performance-enhancing purposes in poultry, especially in broilers (Mmereole, 2010; Mukhtar et al, 2012; Thayalini et al., 2011), pigs (Tartrakoon et al., 2002) and rabbits (Omer et al., 2010). Mmereole (2010) and Mukhtar et al. (2012) reported that lemon grass could be an alternative to antibiotics. In contrast to others, Thayalini et al. (2011) reported that lemon grass did not improve the performance, but even decreased.

According to the authors' knowledge, no study has been conducted on lemon grass supplementation to quails' diet. Therefore, the aim of the present study was to investigate the effect of LG on performance, carcass quality traits, and marketing of quails.

MATERIALS AND METHODS

Animals and Diets

A total of 150 unsexed four-day-old Japanese quail (*Coturnix coturnix japonica*) were distributed three groups of 50 quails each, following four day adaptation period. The quails were housed in wire cages with dimensions of 50×90×20 cm (width, length, height). They were allowed free access to food and water. The heater temperature was set at 33ºC at the beginning of the study and decreased by 3 degrees every week for 3 weeks and they were kept at 24^{o}C for the rest of the study. The lighting schedule was 24 hours during the experiment. The quail were fed for 5 weeks with iso-caloric and iso-nitrogenic diet containing 0% (control group), 1.5% and 3% lemon grass leaf meal (treatment groups).

The lemon grass (*Cymbopogon citratus*) was collected from the Antalya province of Turkey (located in Mediterranean region), dried in the shade and kept in dry conditions for 2 weeks and then ground into fine particles before being added to the diets.

The composition of basal diet and lemon grass leaf meal used in this study is given in Table 1 and 2.

Table 1. The composition of basal diet

Ingredients	Ratio, %
Corn	30.00
Soy bean meal 46%	15.00
Corn bran	14.40
Wheat	11.18
Sunflower meal 36%	10.00
Corn Protein	8.00
Vegetable oil	6.00
Meat-bone meal	3.50
Limestone	0.60
Lysine	0.51
Methionine	0.18
Vitamin and mineral premix*	0.25
Salt	0.25
Phytase	0.075
Enzyme	0.05
Calculated composition	
Crude protein, %	24.00
Crude fiber, %	5.00
Crude fat, %	8.30
Crude ash, %	6.30
Lysine, %	1.30
Methionine, %	0.60
Calcium , %	0.90
Total phosphorous, %	0.75
Metabolizable energy, kcal/kg	3200

*Vitamin-mineral premix per kilogram of the diet, retinol asetat, 4500 mcg; cholecalciferol, 50 mg; tocopheryl acetate, 40.0 mg; menadione, 5.0 mg; thiamine, 3.0 mg; riboflavin, 6.0 mg; pyridoxine, 5.0 mg; cobalamin, 0.03 mg; nicotinic acid, 30.0 mg; biotin, 0.1 mg; calcium d-pantothenate, 12 mg; folic acid, 1.0 mg, choline chloride, 400 mg, manganese, 80.0 mg; iron, 35.0 mg; zinc, 50.0 mg; copper, 5.0 mg; iodine, 2.0 mg; cobalt, 0.4 mg; selenium, 0.15 mg assured.

Table 2. Composition of lemon grass leaf meal

Nutrient	%
Dry matter	92.95
Crude ash	9.19
Crude protein	13.90
Crude fat	2.96
Crude cellulose	28.78
ADF	36.45
NDF	54.44

Performance traits

Quail were weighed at the beginning of the study (4th day of life) and separated into groups with similar live weight ($p>0.05$). The individual live weight of quails and feed consumption were recorded at the 7th, 21st and 35th days of the study. Mortality rates were recorded on a daily basis and were taken into account when calculating feed consumption.

For the evaluation of carcass and internal organ traits, 20 quail (10 male and 10 female) in each group were slaughtered by cervical dislocation at the 36th days of the experiment. The quail

feathers were plucked, and the carcasses were eviscerated by hand. The carcass, liver, empty gizzard, and intestine (large+ small intestine) weights were recorded. Individual part yields were obtained as; (part weight / carcass weight) × 100. The breast muscle was separated for determining the chemical composition, pH, cooking and thawing losses.

Meat Properties

pH

In breast meat samples (20 birds per group) the pH values were measured by using a pH meter (Thermo Scientific Orion Star A111) at 1 h (pH1) and 24 h (pH24) after slaughter. To determine pH, the probe was inserted into the center of the breast muscle (*pectoralis major*), 0.5 to 1 cm below the surface of the muscle and then the pH value was read.

Cooking loss

Cooking loss was determined in 1.5 cm-thick breast meat samples of similar geometry, individually placed inside polyethylene bags in a water bath at 75°C for 30 min until the temperature of 70 °C was achieved and then cooled for 30 min. The samples were removed from the bags, dried with paper and weighed (Önenc and Kaya, 2004). The weight loss, expressed as a percentage of initial weight, was determined as the cooking loss.

Thawing loss

Meat samples of about 10 g were frozen at -20 ºC overnight and thawed. The free water was discarded and then the samples were reweighed and the difference between the first and last weight was calculated as thawing loss percentage (Honikel, 1998).

Analytic procedures

The dry matter, crude protein, fat, cellulose and ash content of lemon grass and meat samples were determined according to AOAC (2001). The lemon grass crude fiber (CF), acid-detergent fiber (ADF) and neutral-detergent fiber (NDF) levels were determined with ANKOM Technology Method 2008 (Ankom15, ANKOM Technology, New York, USA). The feed's metabolizable energy contents were calculated by using the TSE (1991) equation.

Statistical and economic analysis

The current data were analyzed using the General Linear Models (GLM) procedure of the SPSS (version 15.0). The models included control, 1.5%, and 3% lemon grass level. Means were separated using Duncan's multiple range test and a 5% level of probability was used. To calculate the effect of sex ratio, the X^2 (chi-square) test was performed. The results of statistical analysis were shown as mean values and standard error of the means (SEM) in the tables. In economic evaluation; the total income, total cost and net income increase/decrease were calculated as follows;

Total income = [total carcass weight (g) × carcass price (TL)]

Total cost = [feed consumption (kg) × feed cost (TL)] + [the amount of lemon grass added in feed (g) × lemon grass cost (TL)]

Net income increase/decrease = total income – total cost

In the study, accepted quail feed cost was 1.00 TL/kg, carcass price was 15 TL/kg, and lemon grass cost was 50 TL/kg.

RESULTS

Live weight, live weight gain, feed consumption and feed conversion ratio were not affected in 1.5% LG supplemented group ($P>0.05$); however, in 3% LG supplemented group decreased body weight at the 7th, 21st and 35th days ($P<0.05$) compared to the control group (Table 3).

Additionally, first 7 days results in the 3% LG supplemented group live weight gain was significantly lower than those of other groups, but after the 7th day, live weight gain was not affected by LG supplementation. Both levels of LG used in this study had no effect on feed consumption and feed conversion ratio. In the 3% LG supplemented groups' intestinal weight and proportion were decreased ($P<0.05$). However, LG did not affect slaughter and carcass weight, dressing percentage, intestine, liver and gizzard weight and their ratios ($p>0.05$; Table 4).

Also, some carcass quality characteristics such as pH, cooking loss, thawing loss, dry matter, ash, and protein content were not affected by LG supplementation ($p>0.05$; Table 5).

Table 3. The effect of supplementation of lemon grass on performance traits

Parameter	Control	1.5% LG	3% LG	P
Live weight (g)				
Initial	13.04±0.16	13.20±0.16	13.16±0.16	NS
7th day	40.60±0.80[a]	40.84±0.63[a]	37.52±0.68[b]	**
21st day	125.67±1.89[a]	127.88±1.17[a]	120.92±1.46[b]	**
35th day	192.16±3.96[a]	188.37±3.86[ab]	178.32±3.60[bc]	*
Live weight gain (g)				
0-7th days	27.56±0.19[a]	27.64±0.51[a]	24.36±1.00[b]	**
8-21st days	85.00±1.74	87.04±2.17	83.40±1.97	NS
22-34th days	66.27±6.15	60.87±5.72	57.40±3.99	NS
0-35th days	178.84±7.20	175.63±7.24	165.16±5.23	NS
Feed consumption (g)				
0-7th days	56.40±3.24	54.76±2.87	57.08±2.24	NS
8-21st days	232.28±3,38	232.60±4.07	219.48±5.07	NS
22-34th days	293.62±13,13	297.41±20.78	278.16±11.46	NS
0-35th days	594.71±12,57	600.14±17.65	576.12±15.11	NS
FCR (g/g)				
0-7th days	2.04±0.10	1.98±0.09	2.36±0.15	NS
8-21st days	2.74±0.09	2.67±0.04	2.63±0.09	NS
22-34th days	4.50±0.21	4.93±0.13	4.92±0.30	NS
0-35th days	3.33±0.07	3.42±0.05	3.49±0.12	NS

[a,b,c:] Values with different superscript in a line differ significantly P:probability, *:p<0.05, **:p<0.01,. LG: lemon grass, NS: non-significant, FCR: feed conversion ratio.

Table 4. The effect of supplementation of lemon grass on carcass traits

Carcass trait	Control	1.5% LG	3% LG	P
Slaughter weight, g	192.84±6.05	188.00±5.30	176.53±6.29	NS
Hot carcass weight, g	128.86±3.41	128.35±3.12	119.69±3.84	NS
Dressing percentage, %	67.13±0.96	68.46±0.74	67.99±0.55	NS
Intestine weight, g	7.76±0.44[a]	6.97±0.32[a]	5.87±0.33[b]	**
Intestine percentage, %	5.97±0.23[a]	5.41±0.20[a]	4.86±0.19[b]	**
Liver weight, g	4.95±0.46	4.52±0.44	3.69±0.32	NS
Liver percentage, %	3.76±0.27	3.44±0.26	3.02±0.20	NS
Gizzard weight, g	4.49±0.21	4.15±0.13	3.93±0.14	NS
Gizzard percentage, %	3.47±0.10	3.24±0.78	3.29±0.96	NS

[a,b:] Values with different superscript in a line differ significantly **:p<0.01,. LG: lemon grass, NS: non-significant.

Table 5. The effect of supplementation of lemon grass on meat quality

Quality trait	Control	1.5% LG	3% LG	P
pH1	5.95±0.03	5.98±0.03	6.06±0.03	NS
pH24	5.95±0.06	5.91±0.06	5.83±0.05	NS
Cooking loss, %	35.77±1.39	33.98±1.43	35.45±0.37	NS
Thawing loss, %	3.53±0.40	3.60±0.61	3.35±0.33	NS
Dry matter, %	26.77±0.60	28.22±0.60	26.74±0.60	NS
Ash, %	5.90±0.14	5.92±0.14	6.06±0.14	NS
Protein, %	28.14±2.34	26.80±2.28	26.03±2.34	NS

P: probability, LG: lemon grass, NS: non-significant.

In the economic assessment, LG supplementation did not provide any advantage either in feed consumption and live weight gain or in carcass values and quality, it even decreased the revenue (Table 6). The distribution of quails' sex (female, male) in each group were not significant (p>0.05).

DISCUSSIONS

The quail diet supplemented with 3% LG leaf meal showed a significantly lower final body weight compared to the control (p<0.05). This finding was similar with Thayalini et al. (2011) who reported that reduced body weight in broilers fed with 2% LG leaf supplemented

diet. However, this result was contrary to those of Mmereole (2010) and Mukhtar et al. (2012) who reported that supplementation of LG leaf meal or oil resulted in a significantly higher body weight in broilers. During the first week of the study, there was a significant difference in the 3% LG group in body weight gain. However, body weight gain was not significant among groups during the last four weeks and overall. These findings were different from some previous studies (Mukhtar et al., 2012; Mmereloe, 2010; Thayalini et al., 2011).

Table 6. The effect of supplementation of lemon grass on revenue*

Revenue/Cost Item	Control	1.5% LG	3% LG
1. Total revenue, TL	94.71	94.34	89.77
2. Total cost, TL	29.28	51.60	72.01
2.a. Feed, TL	29.28	29.49	28.80
2.b. Lemon grass, TL	-	22.11	43.21
3. Net revenue, TL	65.44	42.74	17.76

*Data were given for groups (50 quail). LG: lemon grass.

The expected effects of herbs on feed consumption could be related with improvement in feed taste, palatability, enhanced appetite of poultry in addition to faster passage and digestion of nutrients through the digestive effects of herbs (Mmereloe 2010; Mukhtar et al., 2012).

Mukhtar et al. (2012) reported that 50, 100 and 150 mg/kg supplementation of LG oil in broiler diets caused an increase in the feed consumption. Similar to present results, Mmereloe (2010) reported that the supplementation of 1% LG leaf to broiler diets did not affected feed consumption. There was no statistical difference among the groups in terms of feed consumption in weeks and overall period. Differences between the results in the literature on feed consumption could be related with the form of LG used (leaf or oil).

Mukhtar et al. (2012) reported that supplementation of 0.5%, 1% and 1.5% LG oil and Thayalini et al. (2011) supplementation of 2% LG leaf to diet did not affect the feed conversion ratio in broilers. Similarly, supplementation of 1.5% and 3% LG leaf did not affect the feed conversion ratio of quail; whereas Mmereole (2010) reported that 1% LG leaf supplementation to broiler diet improved the feed conversion ratio.

Results revealed that there were no significant differences ($P>0.05$) among groups regarding carcass yield, liver and gizzard ratio, and meat chemical composition such as crude protein, ash and dry matter. These results are consistent with the findings of Mukhtar et al. (2012), they did not find significant effect of LG addition to diet on carcass and meat traits in broilers.

In contrast to Mukhtar et al. (2012), economic evaluation of this study showed that the supplementation of LG leaf meal to quail diet did not improve performance and revenue compared to the control group. This was probably due to the cost of LG leaf meal and the supplemented level.

The controversial results between studies could be related with plant origin, harvest time, processing, extraction method, storage conditions and period, dietary inclusion levels and form of herbs.

In conclusion, it is necessary to determine the optimum dietary inclusion levels and used form/type (leaf, oil, dried and fresh) of LG and their effect on revenue in future studies.

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