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Effects of Combined Use of Canola and Sunflower Meals in Quail Diet on Performance and Some Carcass Quality Traits

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Abstract.- This study was conducted to determine the effects of using canola meal (CM) and sunflower meal (SM) in combination (CS) in quail diets on performance and some carcass quality traits. A total of 300 three-day-old Japanese quails (*Coturnix coturnix japonica*), including both males and females were divided into one control group and four treatment groups containing 60 quails in each. Each group was divided into five replicate groups each containing 12 quails. The control group was fed corn-soybean meal based diet without CS. The CS was used at level of 10% (CS10), 20% (CS20), 30% (CS30), and 40% (CS40) in treatment diets (in each treatment C and S ratio is 1:1). The experimental period was lasted for 5 weeks. The results of the study showed that there were no changes in terms of body weight, body weight gain and feed intake as well as carcass weights and yields, relative weight of liver, heart, spleen, gizzard, proventriculus and abdominal fat in all experimental groups with CS supplementation (P>0.05). Feed conversion ratio improved in the CS10 and CS20 groups compared with the control and the other groups (P<0.001). As a result, it may be stated that the combined dietary supplementation of up to 40% of canola-sunflower meal had no any adverse effect on the performance and some carcass quality traits in quails

Key words: Canola meal, sunflower meal, performance, carcass quality, quail.

INTRODUCTION

Protein occupies an important place in poultry feeding since it provides the highest body weight gain in the shortest time by consuming the lowest amount of feed and limiting the feed cost at optimal level (NRC, 1994; Firman and Boling, 1998). The protein requirement in the growth period is very high (24%) for highly efficient, young and fast-growing quails (NRC, 1994). In order to meet these protein requirements, vegetable protein resources with rich protein contents are used in diets (Ravindran and Blair, 1992). Of those, the soybean meal is one of the most preferred vegetable protein resources due to its high protein level, balanced amino acid content and high digestibility (Leeson and Summers, 2001). However, very few countries can produce soybeans sufficient to meet their own demand (Vieira *et al.*, 1992; Mushtaq *et al.*, 2006). Besides, the soybean meal contains some antinutritional factors which must be eliminated by proper heating during the production process (Kucukersan *et al.*, 2001; Juskiewicz *et al.*, 2009). The use of other protein resources thus becomes imperative in the quail diets that can replace the soybean meal (Akinci and Bayram, 2003; Erener *et al.*, 2003; Yalcin *et al.*, 2005; Bulbul and Ulutas, 2014).

Canola meal (CM) (Bell, 1993; Newkirk and Classen, 2002; Newkirk, 2009) and sunflower meal (SM) (Rama Rao *et al.*, 2006; Senkoylu and Dale, 2006) are easily available and have good potential to be used as feed ingredient in poultry diets/feeds for their high protein content, balanced amount of amino acids, vitamins and minerals. Crude fiber level in the meals is variable depending upon the dehulling status of seed and crude fat level which varies with the processing technique used (Villamide and San Juan, 1998; Kocher *et al.*, 2000; Senkoylu and Dale, 2006).

In some studies, the effect of the canola and sunflower meals in the diets has been described on the performance (Kocher *et al.*, 2000; Newkirk and Classen, 2002; Pinheiro *et al.*, 2002; Sarıcicek *et al.*, 2005; Rama Rao *et al.*, 2006; Senkoylu and Dale, 2006; Mushtaq *et al.*, 2006, 2007, 2009; Ahmadauli *et al.*, 2008; Khajali *et al.*, 2011; Min *et al.*, 2011; Jankowski *et al.*, 2011) and carcass quality (Newkirk and Classen, 2002; Pinheiro *et al.*, 2002;

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Sarıcicek *et al.,* 2005; Rama Rao *et al.,* 2006; Senkoylu and Dale, 2006; Mushtaq *et al.,* 2007; Ahmadauli *et al.,* 2008; Mushtaq *et al.,* 2009; Khajali *et al.,* 2011) traits of the poultry during growth period. The present study determines the effect of combined use of dietary canola and sunflower meals on the performance and carcass quality traits at different levels in quails.

MATERIALS AND METHODS

Animals and experimental protocol

The study was carried out at the Animal Research Center of Afyon Kocatepe University, Turkey, following approval by the ethics committee (AKÜHADYEK-224-13). A total of 300 three-day-old Japanese quail chicks (*Coturnix coturnix japonica*) of both sexes were used. They were divided into five, one control and four treatment groups, each containing 60 quails. Each group was divided into five replicate groups with 12 quails each. The quails were housed into California-type cages. Feed and water were provided *ad libitum* and quails were exposed to light for 24 h throughout the experimental period. During the experiment, 24 h of lightening, with fluorescent lamps during the night and daylight during the day time, was applied to the quail. Ventilation was made with windows and fans, and the initial ambient temperature of 32-35ºC was adjusted and kept at 22-24ºC during the study. The experimental period lasted for 35 days.

Diets

The CM, SM and other raw feed materials were obtained from Tinaztepe Flour and Feed Factory, Afyonkarahisar and analyzed for the nutrient contents. The diets with corn, wheat, boncalite, corn gluten meal, soybean meal (except from the last trial ration), CM, SM, meat-bone meal and vegetable oil were formulated to be isocaloric and isonitrogenous in order for them to include approximately 24% of crude protein and 2900 kcal/kg of metabolizable energy in accordance with the animals' NRC (1994) requirements. These diets were prepared with feed grinding and mixing machine in AKU Animal Research Center.

The control group was fed with the soybean meal based ration which was not supplemented with canola and sunflower meals, while the experimental groups were formed as 5% canola meal + 5% sunflower meal (CS10), 10% canola meal + 10% sunflower meal (CS20), 15% canola meal + 15 % sunflower meal (CS30) and 20% canola meal + 20% Sunflower meal (CS40), respectively.

The nutrient composition of the CM, SM and diets was determined according to the AOAC (2000). The meals were also analyzed to determine the neutral detergent fiber and acid detergent fiber content, as described by Van Soest *et al.* (1991). The metabolizable energy (ME) levels were estimated using the following equation devised by Carpenter and Clegg (Leeson and Summers, 2001). The content of CM, SM and diets is presented in Table I and II, respectively.

Table I.- Chemical composition of canola and sunflower meals (%)

Chemical composition (analyzed)	Canola meal	Sunflower meal
Dry matter	91.06	90.51
Crude protein	37.15	37.12
Crude fat	0.68	0.92
Crude fiber	11.10	19.10
Crude ash	6.74	6.17
Nitrogen free extract	35.39	27.20
Neutral detergent fiber	37.33	31.73
Acid detergent fiber	24.77	22.74
Metabolizable energy[1] (kcal/kg)	1682.4	1835.1

[1]Metabolizable energy content of diets was estimated using the equation of Carpenter ve Clegg (Leeson and Summers, 2001).

Performance traits

The quails were weighed individually at the beginning of the experiment. Body weight and body weight gain were recorded weekly throughout the study. Mortality rate was also recorded when it was occurred. Feed intake (g/quail) was recorded biweekly as the group average. Feed conversion ratio (FCR) was calculated as kg feed/kg body weight gain.

Carcass quality traits

At the end of the experimental period, 5 males and 5 females from each subgroup were randomly chosen and slaughtered. After the slaughter, the feathers, internal organs, heads and feet of every single animal were set aside and hot

Table II.- Composition of the experimental diets (%).

Ingredients	Control	Treatment groups			
		CS5	CS10	CS15	CS20
Corn	37	38	35	30	28.3
Wheat	12	4.9	3.4	3.45	3
Boncalite	9	10.8	10.8	10	9
Corn gluten meal (58%)	9.6	10.2	10.2	9.3	8.5
Soybean meal (48%)	25	17.6	10.7	6.4	-
Canola meal	0	5	10	15	20
Sunflower meal	0	5	10	15	20
Meat-bone meal (38%)	3	2.3	2.2	2	2
Vegetable oil	2	3.4	4.9	6.2	6.5
Limestone	1	1.2	1.2	1.2	1.2
Salt	0.25	0.20	0.20	0.20	0.20
Dicalcium phosphate	0.6	0.8	0.7	0.6	0.6
L-lysine	0.25	0.25	0.35	0.3	0.35
$NaHCO_3$	0.05	0.10	0.10	0.10	0.10
Vitamin-mineral premix[1]	0.25	0.25	0.25	0.25	0.25
Chemical composition (analyzed)					
Dry matter (%)	90.92	91.33	91.62	91.93	92.11
Crude protein (%)	23.92	23.71	23.68	24.13	24.05
Crude fat (%)	4.83	6.15	7.26	8.28	8.48
Crude fiber (%)	3.01	4.11	5.19	6.32	7.40
Calcium (%)	0.79	0.85	0.85	0.84	0.87
Total phosphorus (%)	0.32	0.32	0.32	0.31	0.33
Metabolizable energy[2] (kcal/kg)	2997	2996	2989	2954	2922

[1]Composition per 2.5 kg of product: vitamin A, 12.000.000 IU; vitamin D3, 2.400.000 IU; vitamin E, 30 g; vitamin K3, 2.5 g; vitamin B1, 2.5 g; vitamin B2, 6 g; vitamin B6, 4 g; vitamin B12, 20 mg; niacin, 25 g; calcium-D-panthotenate, 8 g; folic acid, 1 g; vitamin C, 50 g; D-biotin, 50 mg; choline chloride, 400 g; canthaxanthin, 1.5 g; Mn, 80 g; Zn, 60 g; Fe, 60 g; Cu, 5 g; I, 1 g; Co, 0.5 g; Se, 0.15 g.
[2]Metabolizable energy content of diets was estimated using the equation of Carpenter ve Clegg (Leeson and Summers, 2001).

carcass weight was calculated for each animal. Hot carcass yield was calculated by dividing hot carcass weight by pre-slaughter weight. The liver, heart, spleen, gizzard, proventriculus and abdominal fat were weighed. The weights of these organs were divided by pre-slaughter body weights; the ratios were calculated. Cold carcass weight was determined by keeping the carcasses at +4°C for 18 hours. Cold carcass yield was calculated by dividing cold carcass weights by pre-slaughter weights. Hot and cold carcass yields were calculated according to the following formulas:

$$\text{Hot carcass yield, \%} = \frac{\text{Hot carcass weight (g)}}{\text{Body weight (g)}} \times 100$$

$$\text{Cold carcass yield, \%} = \frac{\text{Cold carcass weight (g)}}{\text{Body weight (g)}} \times 100$$

Statistical analyses

The significance of differences between the mean values of the groups for body weight, body weight gain, feed intake, FCR and carcass quality traits were determined using the Variance Analysis Method. The Tukey Test was applied to control the significant difference between groups (SPSS 13.00, Inc., Chicago, IL, USA). A value of $p<0.05$ was considered the limit for statistical significance.

RESULTS

The chemical compositions of CM, SM and diets used in quail feeding are shown in Tables I, II, respectively.

The effect of CM and SM dietary supplementation on quail performance traits are presented in Table III. There were no changes in any of the experimental groups compared with the

Table III.- Effects of supplementation canola meal and sunflower meal in combination to diets on performance traits in quails.

Item	Control	Treatment groups				SEM	P
		CS5	CS10	CS15	CS20		
Initial body weight (g)	9.24	9.40	9.34	9.42	9.43	0.091	0.974
Final body weight (g)	180.55	184.89	182.51	185.47	183.10	1.249	0.771
Body weight gain (g)	171.37	175.49	173.16	176.05	173.67	2.022	0.793
Feed intake (g)	555.22	551.50	548.56	572.78	570.49	4.062	0.193
Feed conversion ratio (g feed/g)	3.24[a]	3.14[b]	3.16[b]	3.25[a]	3.28[a]	0.013	0.000***

[a, b]: Different letters in the same line are statistically significant (***): P<0.001, n=5.

Table IV.- Effects of supplementation canola meal and sunflower meal in combination to diets on carcass weights (g), carcass yields (%), relative inert organ and abdomen fat weights (%) in quails.

Item	Control	Treatment groups				SEM	P
		CS5	CS10	CS15	CS20		
Hot carcass weight	123.55	119.84	11640	127.52	124.97	1.729	0.279
Cold carcas weight	118.93	112.87	11168	120.48	118.52	2.781	0.192
Hot carcass yield	66.36	65.60	66.26	67.39	65.31	0.515	0.761
Cold carcas yield	64.03	62.33	64.84	66.85	63.72	1.28	0.364
Liver	2.40	2.65	2.29	2.65	2.12	0.088	0.252
Heart	0.88	0.89	0.87	0.91	0.86	0.019	0.942
Spleen	0.08	0.05	0.04	0.09	0.06	0.006	0.081
Gizzard	1.68	1.65	1.79	1.95	1.81	0.037	0.074
Proventriculus	0.44	0.42	0.37	0.44	0.36	0.009	0.105
Abdominal fat	1.77	1.71	1.89	1.74	1.83	0.080	0.961

Differences among the groups were not statistically significant. (P>0.05), n=5.

control group in terms of initial and final body weights, body weight gain and feed intake (P>0.05). Feed conversion ratio improved in the CS10 and CS20 groups compared with the control and the other groups (P<0.001).

Hot and cold carcass weights and yields as well as relative weight of liver, heart, spleen, gizzard, proventriculus and abdominal fat were not affected by dietary CS supplementation (P>0.05, Table IV).

DISCUSSION

In the study which was conducted to determine the effect of combined use of canola and sunflower meals at graded levels in quail diets on the performance and some carcass quality traits, the crude protein levels of the dietary canola and sunflower meals were high (37.15% and 37.12%). Crude fiber levels depending on the amount of hulls were 11.1% and 19.1%, respectively whereas other fractions of the cellulose (neutral detergent fiber and acid detergent fiber) were at high levels (Table I). Although some researchers (Rama Rao *et al.*, 2006; Senkoylu and Dale, 2006) reported lower crude protein and crude cellulose levels for the SM than in this study, there are several other studies that report similar results for canola (Khajali and Slominski, 2012) and sunflower (Villamide and San Juan, 1998; Jankowski *et al.*, 2011) meals. Crude fat level of the meals was determined to be quite low (0.68% and 0.92%) (Table I). Nonetheless, low crude protein levels but high crude oil contents for the canola and sunflower meals were reported by Kocher *et al.* (2000). Nutrient contents of the canola (Bell, 1993; Dale, 1996; Newkirk, 2009) and sunflower (Zhang and Parsons, 1994; Senkoylu and Dale, 1999, 2006) meals may vary according to the kind and physical characteristics of the seed used, and environmental conditions such as meal acquiring method and processing technique. In present study, the main nutrient components of canola and sunflower meals may be associated with these factors.

The examination of the chemical compounds of the diets used in the study proved that the diets were prepared isonitrogenic and isocaloric to meet the protein and energy requirements of the quails. It was determined that crude fat and crude cellulose contents of diets escalated depending on the graded levels of the meals. The calcium and phosphorus levels of diets were at sufficient levels to meet the requirements of the quail (Table II).

In the present study, the supplementation of canola and sunflower meals to the quail diets resulted in no differences between the groups in terms of initial and final body weights, body weight gain and feed intake (P>0.05, Table III). The studies on the separate use of canola and sunflower meals in the poultry revealed similar findings to this study. In this context, the supplementary use of the CM at 5-25% (Min *et al.,* 2011), 20% and 30% (Mushtaq *et al.,* 2007) did not change body weight gain and feed intake in broilers; it did not affect the feed intake at 6.27%-36.91% for broilers (Newkirk and Classen, 2002) and at 12.15% and 24.3% for the quail (Sarıcicek *et al.,* 2005). It has also been reported that SM supplementation did not affect body weight gain in broilers at 14.82-56.01% (Rama Rao *et al.*, 2006), feed intake in turkeys at 7-21% (Jankowski *et al.,* 2011) and in broilers at 65.6% (Rama Rao *et al.,* 2006), as well as body weight gain and feed intake in broilers at 4-12% (Pinheiro *et al.,* 2002), 8% and 16% (Homayouni and Shivazad, 2003), 20% and 30% (Mushtaq *et al.,* 2006, 2009).

However, some studies reported that the supplementation of CM at 12.48% (Newkirk and Classen, 2002), 30% (Mushtaq *et al.,* 2007) and 35% (Kocher *et al.,* 2000) in broilers, at 24.3% in the quail (Sarıcicek *et al.,* 2005) had adverse effects on body weight. It has also been reported that body weight gain and feed intake reduced in broilers with CM supplementation at levels of 8.85% and 11.8% (Ahmadauli *et al.,* 2008) and at high levels (46%) (Khajali *et al.,* 2011). The studies where the SM was used reported that body weight decreased at 14% and 21% in turkeys (Jankowski *et al.,* 2011), and at high level in broilers (Rama Rao *et al.,* 2006). There are also some other studies reported that the CM at low level (6.27%) (Newkirk and Classen, 2002) and the SM at 34.5% (Rama Rao *et al.,* 2006) and 35% (Kocher *et al.,* 2000) enhanced body weight gain, and the use of SM at 17.3% and 34.5% (Rama Rao *et al.,* 2006) and 35% (Kocher *et al.,* 2000) levels increased feed intake in broilers. The decrease in the body weight or the feed intake despite the graded levels of the meals used in the researches were associated to cellulose fractions and antinutritional factors such as glucosinolates, phytic acid, sinapine and tannin for the CM (Liang, 2000; Khajali and Slominski, 2012), and were related to higher amounts of cellulose in diet for the SM (Janssen and Carre, 1985; Villamide and San Juan, 1998). In present study the combined dietary supplementation of canola and sunflower meals did not change the feed intake which might have been because of similar protein and energy contents in diets. The body weight and body weight gain does not change in this study is considered to occur. It can also be expressed that a change in body weight and body weight gain did not occur due to no change in feed intake.

In this study, the combined supplementation of canola and sunflower meals to diet at levels of 10% and 20% improved feed conversion ratio (P<0.001, Table III). Similarly, SM supplementation has positive effect on the feed conversion ratio at 35% (Kocher *et al.,* 2000), 29.64% and 56.01% (Rama Rao *et al.,* 2006) in broilers. However, high supplementary levels of CM in broilers (Kocher *et al.,* 2000; Mushtaq *et al.,* 2007; Ahmadauli *et al.,* 2008; Khajali *et al.,* 2011) and SM in broiler (Homayouni and Shivazad, 2003; Senkoylu and Dale, 2006) and quail (Sarıcicek *et al.,* 2005) diets were reported to negatively affect feed conversion ratio. Some studies reported that the supplementations of CM at 5-25% (Min *et al.,* 2011), 20% and 30% (Mushtaq *et al.,* 2007), 6.27-36.91% (Newkirk and Classen, 2002) for broilers, and SM at 7-21% for turkeys (Jankowski *et al.*, 2011) and at 20% and 30% for broilers (Mushtaq *et al.,* 2009) did not change feed conversion ratio. In this study, feed conversion ratio was positively affected as the amount of dietary canola and sunflower meals decreased. As the amount of dietary canola (Choct, 2002) and sunflower (Kocher *et al.,* 2000; Jankowski *et al.,* 2011) meals increase, fibrous fractions and antinutritional factors containing of their inhibit digestive enzymes, reduce the utilization and bioavailability of the nutrients in the poultry. In this study, the improved feed conversion ratio in the groups where low levels of canola and sunflower meals might have resulted from fibrous fractions' and antinutritional factors in the content of the meals inefficiency at used levels as well as quails' high ability in using them.

It was determined that the carcass weights and yields, relative weight of liver, heart, spleen, gizzard, proventriculus and abdominal fat were not affected by the graded levels of the canola and sunflower meals in the diets (*P*>0.05, Table IV). Similarly, Sarıcicek *et al.* (2005) observed that CM used at levels of 12.15% and 24.3% in quail diets did not change liver, heart and gizzard weights. Some studies using CM reported that high supplementation level (46%) of CM did not change liver weight (Khajali *et al.,* 2011). In other studies there was also no effect observed by graded levels of CM on liver and heart weight (Newkirk and Classen, 2002; Ahmadauli *et al.,* 2008), and 20% and 30% inclusion level has also shown no effect on abdominal fat weight (Mushtaq *et al.*, 2007). Moreover, it was reported that the supplementation of SM in broilers did not effect on liver, gizzard and proventriculus weights at high level (46.4%) (Senkoylu and Dale, 2006), and on liver and abdominal fat weights at 14.83-56.01% (Rama Rao *et al.,* 2006). However, CM supplementation at high levels to broiler diets has been reported to increase gizzard (Ahmadauli *et al.,* 2008) and heart (Khajali *et al.*, 2011) weight while reducing carcass weight (Ahmadauli *et al.*, 2008) and carcass yield (Khajali *et al.,* 2011). The SM was reported to have increased gizzard weight at 16% of supplementation level (Homayouni and Shivaza, 2003).

CONCLUSIONS

It was concluded that the combined supplementation of canola and sunflower meals at different levels to quail diets did not affect on body weight, body weight gain, feed intake and feed conversion ratio as well as some carcass traits. The supplementation of up to 40% of canola-sunflower meal (C:S, 1:1) in combination to diets used for quails as long as economic conditions allow.

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