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RESEARCH ARTICLE

Effects of dietary supplementation of combined safflower meal and sunflower meal on fattening performance and carcass quality characteristics in quails

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Öz

Bulbul T, Ulutas E, Ozdemir V, Bulbul A, Evcimen M. Bıldırcın rasyonlarına aspir ve ayçiçeği küspelerinin birlikte ilavesinin besi performansı ve karkas kalite özellikleri üzerine etkisi.

Amaç: Bu araştırma bıldırcın rasyonlarına aspir-ayçiçeği küspesinin birlikte (AAK) ilavesinin besi performansı ve bazı karkas kalite özellikleri üzerine etkisini belirlemek amacıyla yapıldı.

Gereç ve Yöntem: Araştırmada toplam 300 adet üç günlük Japon bıldırcını (*Coturnix coturnix japonica*) erkek ve dişi karışık olacak şekilde her biri 60 bıldırcından oluşan 1 kontrol ve 4 deneme grubuna ayrıldı. Her bir grup da 12 bıldırcından oluşan 5 alt gruba ayrıldı. Kontrol grubu aspir ve ayçiçeği küspesi içermeyen mısır-soya fasulyesi küspesi temeline dayanan rasyonla beslendi. Deneme gruplarının rasyonlarında aspir ve ayçiçeği küspeleri birlikte %10 (AAK10), 20 (AAK20), 30 (AAK30) ve 40 (AAK40) düzeylerinde (AK ve AÇK oranı 1:1) kullanıldı. Araştırma 5 haftada tamamlandı.

Bulgular: Araştırmada AAK ilaveli tüm deneme grupları arasında canlı ağırlık, canlı ağırlık artışı, yem tüketimi, karkas ağırlıkları ve randımanları ile karaciğer, kalp, dalak, taşlık, bezli mide ve abdominal yağ ağırlıklarının canlı ağırlığa oranlarının değişmediği belirlendi (P>0.05). Yemden yararlanma oranının AAK40 grubunda kontrol ve diğer deneme gruplarına göre olumsuz etkilendiği tespit edildi (P<0.001).

Öneri: Bıldırcın rasyonlarına eşit miktarlarda aspir ve ayçiçeği küspelerinin birlikte ilavesinin bazı performans ve karkas kalite özelliklerini etkilemediği, bu küspelerin %30'a kadar birlikte ilavesinin yemden yararlanma oranı üzerinde daha olumlu etkiler oluşturduğu ifade edilebilir.

Anahtar kelimeler: Aspir küspesi, ayçiçeği küspesi, performans, karkas kalitesi, bıldırcın

Abstract

Bulbul T, Ulutas E, Ozdemir V, Bulbul A, Evcimen M. Effects of dietary supplementation of combined safflower meal and sunflower meal on fattening performance and carcass quality characteristics in quails.

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Aim: This study was carried out to determine the effects of combined safflower-sunflower meal (SSM) supplementation in quail diets on fattening performance and some carcass quality parameters.

Materials and Methods: 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 sub-divided into five replicates each containing 12 quails. The control group was fed corn-soybean meal based diet without SSM. The SSM was used at level of 10% (SSM10), 20% (SSM20), 30% (SSM30) and 40% (SSM40) in treatment diets (in each treatment S and SF ratio is 1:1). The experimental period was lasted for 5 weeks.

Results: There were no changes in terms of body weights, body weight gain and feed intake as well as carcass weights, relative weight of liver, heart, spleen, gizzard, proventriculus and abdominal fat in all experimental groups with SSM supplementation (P>0.05). Feed conversion ratio impaired in the SSM40 group compared with the control and the other groups (P<0.001).

Conclusions: It may be stated that the supplementation of safflower-sunflower meal (C:S, 1:1) in combination to diets has no any adverse effect on the some performance and carcass quality characteristics, and as well as the supplementation of up to 30% of these might be more effective on feed conversion ratio in quails.

Keywords: Safflower meal, sunflower meal, performance, carcass quality, quail

Introduction

Oilseed meals are vegetable origin protein resources which form the second most important component of poultry diets after grain feeds (Ravindran and Blair 1992, Brookes 2001). Soybean meal, particularly, is one of the mostly used vegetable protein sources in efficient and fast growing quails owing to its high protein and balanced amino acid content (NRC 1994, Leeson ve Summers 2001). However, the production of soybean is insufficient in some countries therefore feed sector has to import soybean or processed soybean products to meet the needs (Vieira et al 1992, Mushtaq et al 2006). Therefore, the use of alternative protein sources which may reduce the cost of poultry products and increase the performance has been brought up recently due to the high demand for soybean meal in poultry diets (Sarıcicek et al 2005, Yalcin et al 2005, Ryhanen et al 2007, Jankowski et al 2011, Khajali et al 2011, Bulbul and Ulutas 2015, Karayagiz and Bulbul, 2015a).

Safflower (*Carthamus tinctorius L.*) which is compatible with terrestrial climate, resistant to drought, arable in winter time, non-selective with the type of soil and can grow in arid conditions (Karakas Oguz and Oguz 2006, Gilbert 2008). It is reported that safflower seed can be used successfully in broiler without causing any adverse effect with supplementation of some exogenous enzymes up to 20% (Daffa alla et al 2015). As safflower meal (SM) obtained from the seeds con-

Table 1. Experimental protocol used in the study.

Groups	Diets
Control	Basal diet without SSM
SSM10	5% Safflower meal + 5% Sunflower meal
SSM20	10% Safflower meal + 10% Sunflower meal
SSM30	15% Safflower meal + 15% Sunflower meal
SSM40	20% Safflower meal + 20% Sunflower meal

Table 2.Ingredients and chemical compositions of the diets (%).

	Treatment groups				
Ingredients	Control	SSM10	SSM20	SSM30	SSM40
Corn	48.95	41.4	34.13	30	25.85
Wheat	10.5	10	9.8	6.92	1
Soybean meal (48%)	33.2	23.15	19	15.35	-
Safflower meal (19.5%)	-	5	10	15	20
Sunflower meal (36.18%)	-	5	10	15	20
Full fat soybean	2	9	8.5	6.6	22
Meat-bone meal (38%)	2.55	2	1.5	1.5	1
Vegetable oil	-	1.6	4.2	6.7	7.2
Limestone	1.2	1.2	1.2	1.2	1.2
Salt	0.3	0.25	0.25	0.25	0.25
Dicalcium phosphate	1	1	1	1	1
L-lysine	0.05	0.15	0.17	0.23	0.25
Vitamin-mineral premix[1]	0.25	0.25	0.25	0.25	0.25
Chemical composition (analyzed)					
Dry matter (%)	90.82	91.14	91.32	91.75	91.81
Crude protein (%)	22.83	22.44	22.29	22.06	21.85
Crude oil (%)	3.45	5.76	7.88	9.79	12.43
Crude fiber (%)	2.87	5.43	7.83	10.18	12.90
Calcium (%)	0.86	0.85	0.80	0.82	0.78
Total phosphorus (%)	0.34	0.31	0.29	0.30	0.28
Metabolizable energy[2] (kcal/kg)	2853	2838	2846	2820	2804

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

tain high amount of hull approximately 33-60% which result in higher fiber contents and reduced its usability and inclusion in poultry diets (Kohler et al 1965) but it can be used in poultry by taking care in adjusting the energy value with some essential amino acids (Daffa alla et al 2015). Sunflower (Helianthus annus L.) is adoptive to harsh conditions and can grow well in all climatic zones (Grompone 2005). It is mainly harvested to produce oil and its by product sunflower meal (SFM) is a price worthy to be used in broiler feeding (Kalmendal et al 2011). The energy content of SFM is negatively correlated with crude fiber and hull amount (Villamide and San Juan 1998, Senkoylu and Dale 2006).

It has been reported that SM (Petersen et al 1957, Kuzmicky and Kohler 1968, Thomas et al 1983, Mohan et al 1984, Rehman and Yaqoob Malik 1986) and SFM (Kocher et al 2000, Pinheiro et al 2002, Rama Rao et al 2006, Senkoylu and Dale 2006, Mushtaq et al 2006, 2009, Karayagiz and Bulbul 2015b) could be successfully used in the poultry in the growth period. However, no data on how the combined use of safflower and sunflower meals in quail diets affect the performance and carcass quality characteristics was revealed. Therefore, the objective of the current study was to evaluate the effects of combined use of safflower and sunflower meals at different levels in diets on fattening performance and some carcass quality characteristics in quails.

Table 3. Chemical composition of safflower and sunflower meals (%).

Chemical composition (analyzed)	Safflower meal	Sunflower meal
Dry matter	86.37	89.57
Moisture	13.63	10.43
Crude protein	19.5	36.18
Crude fat	0.6	0.97
Crude fiber	36.1	19.8
Crude ash	3.15	7.07
Nitrogen free extract	27.02	25.55
Neutral detergent fiber	49.42	37.48
Acid detergent fiber	38.59	22.75
Acid detergent lignin	10.78	7.66
Metabolizable energy[1] (kcal/kg)	906.2	1803.7

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

Materials and Methods

Animals

The protocol for this study was approved by the Ethics Commission (AKÜHADYEK-225-13) of Afyon Kocatepe University, Turkey, under Project number 13.VF.05. A total of 300 three-day-old Japanese quail chicks (*Coturnix coturnix japonica*) of both sexes were housed in California-type cages. In 1st week of age plate-type feeders and child-cup drinkers were placed while in the rest period of experiment metal gutter feeders and automatic nipples drinkers were used in each cage. By applying group feeding to quails, feed and water were given as ad libitum. During the experiment, 24 hours of lightening, with fluorescent lamps during the night and daylight during the day time, was provided to the quail. Ventilation was made with windows and fans. The experimental period was lasted for 35 days.

Experimental protocol and diets

The quails were divided into one control group and four treatment groups, each consisting of 60 quails. Each group was further sub-divided into five replicates consisting of 12 quails. The SM, SFM and other raw feed materials were obtained from a commercial company and they were analyzed for the nutrient contents (AOAC 2000). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) content of the meals were determined by following the procedures described by Van Soest et al (1991). The diets with corn, wheat, soybean meal, SM, SFM, full fat soybean, meat-bone meal and vegetable oil were formulated to meet the nutritional requirements according to the recommendations of NRC (1994). These diets were prepared

Table 4. The effects of combined dietary supplementation of safflower and sunflower meals on fattening performance in quails.

	Treatment groups						
	Control	SSM10	SSM20	SSM30	SSM40	SEM	P
Initial body weight (g)	9.19	9.19	8.80	8.98	8.97	0.07	0.385
Final body weight (g)	177.6	174.5	173.9	176.3	172.1	0.87	0.321
Body weight gain (g)	168.4	165.3	165.1	167.3	163.1	0.84	0.325
Feed intake (g)	641.8	624.0	635.7	647.0	654.3	4.11	0.177
Feed conversion ratio (g feed/g)	3.81[b]	3.77[b]	3.84[b]	3.86[b]	4.01[a]	0.02	0.000***

[a, b]: Means within a row followed by the different superscripts differ significantly (***): P<0.001, n=5.

Table 5. The effects of combined dietary supplementation of safflower and sunflower meals on carcas quality in quails.

	Treatment groups						
	Control	SSM10	SSM20	SSM30	SSM40	SEM	P
Body weight at slaughter (g)	179.9	174.1	171.0	171.7	177.3	3.01	0.882
Hot carcass weight (g)	122.5	121.6	114.9	117.6	121.5	1.78	0.643
Hot carcass yield (%)	68.18	69.95	67.71	68.68	68.82	0.55	0.780
Cold carcass weight (g)	120.14	120.51	114.49	116.62	122.17	1.74	0.645
Cold carcass yield (%)	67.01	69.31	67.44	68.06	69.09	0.54	0.617
Liver (%)	2.58	2.67	2.39	2.24	2.40	0.06	0.251
Heart (%)	0.90	0.88	0.95	0.92	0.95	0.01	0.566
Spleen (%)	0.08	0.09	0.09	0.08	0.09	0.01	0.660
Gizzard (%)	2.05	1.89	1.93	1.86	2.08	0.06	0.728
Proventriculus (%)	0.39	0.39	0.44	0.37	0.38	0.01	0.466
Abdominal fat (%)	1.33	1.27	1.17	1.28	1.25	0.02	0.378

with grinding and mixing machines at AKU Animal Research Center. All diets were isonitrogenic and isocaloric. The metabolizable energy (ME) levels were estimated using the equation of Carpenter and Clegg (Leeson and Summers 2001). Experimental diets consisted of a control group fed with the soybean meal based diet which was not supplemented with safflower and sunflower meals and four levels of combined safflower and sunflower meals formulated as 5% Safflower meal + 5% Sunflower meal (SSM10), 10% Safflower meal + 10% Sunflower meal (SSM20), 15% Safflower meal + 15% Sunflower meal (SSM30) and 20% Safflower meal + 20% Sunflower meal (SSM40), respectively (Table 1). The chemical composition of the diets and meals is presented in Table 2 and 3, respectively.

Fattening performance

The chicks were individually weighed at the beginning of the experiment. After this, birds were weighed weekly to calculate body weight and body weight gain. Mortality was recorded daily when it occurred. Feed consumption was recorded weekly as the group average. Feed conversion ratio was calculated weekly as kg feed/kg body weight gain.
Carcass quality

At the end of experimental period (35 days), ten quails (5 males and 5 females) from each subgroup were randomly selected and slaughtered to determine the carcass characteristics. The percent hot carcass yield, which was determined after the removal of the feathers, internal organs, heads and was calculated by dividing the hot carcass weight by pre-slaughter weight and multiplying with 100. The internal organs (liver, heart, spleen, gizzard, proventriculus and abdominal fat) were weighed. The cold carcass yield determined by keeping the carcasses at +4oC for 18 hours was calculated by dividing cold carcass weights by pre-slaughter weights. Hot and cold carcass yields as well as relative organ weights and abdominal fat percentage were calculated according to the following formulas: Hot carcass weight/body weight at slaughterx100, and cold carcass weight/body weight at slaughterx100 as well as organ weight/body weight at slaughterx100 and abdominal fat/body weight at slaughterx100, respectively.

Statistical analyses

The significance of differences between the mean values of the groups for body weight, body weight gain, feed intake, feed conversion ratio and carcass quality characteristics were determined using the One-Way ANOVA. 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 ingredients and chemical compositions of the diets are presented in Table 2. The chemical compositions of SM, SFM are shown in Table 3. The main chemical compositions of SM were dry matter (86.37%), crude protein (19.5%), crude oil (0.6%), crude fiber (36.1%), ash (3.15%), nitrogen free extract (27.02%), NDF (49.42%), ADF (38.59%), ADL (10.78%) and, ME (906.2 kcal/kg), whereas SFM contained crude protein (36.18%), crude oil (0.97%), crude fiber (19.8%), ash (7.07%), nitrogen free extract (25.55%), NDF (37.48%), ADF (22.75%), ADL (7.66%) and ME (1803.7 kcal/kg). The diets were analysed as isocaloric and isonitrogenous.

The effects of SM and SFM dietary supplementation on quail performance characteristics are presented in Table 4. There

were no changes in any experimental groups compared with the control group in terms of initial and final body weights, body weight gain and feed intake($P>0.05$). Feed conversion ratio increased in SSM40 group 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 SSM supplementation ($P>0.05$, Table 5).

Discussion

The aim of this study was to determine the effects of graded levels of combined safflower and sunflower meals on fattening performance and some carcass quality characteristics of quails.

The level range selected was between 10% and 40% on the basis of other meal studies (Rama Rao et al 2006, Bulbul et al 2015, Karayagiz and Bulbul 2015a) because there was no available data about combined use of safflower and sunflower meals supplementation of diets.

In this study, protein and energy levels were similar between the groups. The dry matter, crude oil and crude fiber contents of the diets were found to have increasing trend depending on the increasing levels of the these meals. Calcium and phosphorus levels in the diets met the needs of the quails (Table 3).

SM contains 19.5% crude protein, 0.6% crude oil, 49.42% NDF, and 38.59% ADF, so the composition of SM is roughly comparable to SFM, being lower in crude protein and higher in crude fiber and fibrous fractions (NDF, ADF and ADL). The energy value of SM was lower than the SFM due to its higher crude fiber and lower oil and protein contents (Table 3). Although the ME value of the meals were detected lower in safflower compared to the some researchers (Farran et al 2008, 2010), similar results were reported for SFM (Rama Rao et al 2006). On average for growing period, an increase in the SM and SFM contents of diets was accompanied by an increase in crude fiber concentrations, from 2.87% in diets without soybean meal to 12.90% in diets containing 30% of SSM. An increase was also noted in the content of dry matter, from 90.82% to 91.81%, and crude oil 3.45% to 12.43%. Diets containing SSM were supplemented with vegetable oil to balance their energy content. These variations might have resulted from the properties of the seeds used in both meals and different processing methods applied to the meals (Senkoylu and Dale 2006, Farran et al 2010). In current study, the nutrient compositions of safflower and sunflower meals may be associated with these differences.

In the present study, it was determined that combined use of safflower and sunflower meals in quail diets did not differ in terms of body weights, body weight gain and feed intake among the treatment groups ($P>0.05$, Table 4). The results were similar with studies where safflower and sunflower meals were used individually in the poultry. In this context, the supplementation of the SM at the levels of 3.6-16% (Petersen et al 1957) and 5-12.5% (Kuzmicky and Kohler 1968) did not change body weight and body weight gain, and also SFM at the levels of 4-12% (Pinheiro et al 2002), 5-20% (Karayagiz and Bulbul 2015a), 20-30% (Mushtaq et al 2006, 2009) did not change body weight gain and feed intake. Also, it was determined in this study that dietary supplementation of SSM at 40% reversely affected feed conversion ratio. In this study, the increasing level of safflower and sunflower meals (40%) caused a negative effect in feed conversion ratio ($P<0.001$, Table 4). It has also been reported that SFM meal supplementation did not affect feed conversion ratio at 15% and 20% (Karayagiz and Bulbul 2015a), and 20 % and 30% (Mushtaq et al 2009). Some studies which used other meals reported that supplementation of false flax (Aziza et al 2010, Bulbul et al 2015) and canola (Mushtaq et al 2007, Karayagiz and Bulbul 2015a) meals to the diets did not change body weight gain and feed intake. However, increasing SM levels (Mohan et al 1984, Rehman and Yaqoob Malik 1986) and high SFM levels (Rama Rao et al 2006) in broiler diets were reported to have had adverse effects on body weight. Some studies reported that the supplementations of SFM at 35% increased body weight gain and feed intake (Kocher et al 2000, Rama Rao et al 2006). On the other hand, some studies reported that the use of SFM at 5% and 10% (Kocher et al 2000, Rama Rao et al 2006, Karayagiz and Bulbul 2015a), and SM at 12.5% (Kuzmicky and Kohler 1968) levels positively affected feed conversion ratio.

In the current study, the combined dietary supplementation of safflower and sunflower meals did not change the feed intake which might have been because of similar protein and energy contents in diets. It may be stated that because feed intake remained the same so no change occurred in body weight and body weight gain. SM contains antinutritional factors such as cyanide, oxalate and trypsin inhibitor (Ingale and Shrivastava 2011), while SFM contains phytic acid and polyphenolic compounds like tannin (Gandhi et al 2008). These factors (Kocher et al 2000) and high fiber levels of the meals (Villamide and San Juan 1998, Farran et al 2010) reduce the bioavailability of the nutrients in the poultry. In this study, the impaired feed conversion ratio in the group with high level of safflower and sunflower meals might have resulted from high fiber, high fibrous fractions and antinutritional factors in the content of the meals as well as quails' poor 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

safflower and sunflower meals in the diets (P>0.05, Table 5). Similarly, Karayagiz and Bulbul (2015a) demonstrated that supplementation at 5-20% of SFM to quail diets did not change carcass weights and yields as well as liver, heart, spleen, gizzard and proventriculus weights.

Moreover, it was reported that the supplementation of SM did not affect liver, gizzard and proventriculus weights at high level (46.4%) (Senkoylu and Dale 2006), and liver weight at 14.83-56.01% (Rama Rao et al 2006). Studies on the use of other meals reported that false flax meal at 5-20% did not change carcass weight and body weight ratios of liver, heart, spleen, gizzard and proventriculus (Bulbul et al 2015), as well as canola meal at 12.5% and 24.3% did not change liver, heart and gizzard weights (Saricicek et al 2005) in quails. Morever, some studies have been reported that the supplementation of canola meal at high level (46%) (Khajali et al 2011) and increasing levels (Newkirk and Classen 2002, Ahmadauli et al 2008) in broilers did not effect on liver and heart weights. However, SFM supplementation to broiler diets at level of 16% has been reported to increase gizzard weight (Homayouni and Shivazad 2003). No differences were noticed regarding the carcass and relative organ weights in the groups in this study which might be because of no effect on body weight within these groups.

Conclusions

It may be concluded that the combined supplementation of safflower and sunflower meals at different levels to quail diets do not affect body weight, body weight gain and feed intake as well as some carcass traits, whereas the supplementation of SSM up to 30% to diets might be more effective on feed conversion ratio and it could be recommended that the supplementation of up to 30% of safflower-sunflower meal (S:SF,1:1) in combination to diets can be used as an alternative protein source for fattening quails. Further research is needed to increase the usage of safflower and sunflower meals in quail diets by adding exogenous enzyme which can enhance the utilization of fibrous fraction by breaking the bonds and minimizing the effects of antinutritional factors.

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