



## A Comparative Study on the Effects of Use Hemp Seed Oil Substitute to Soybean Oil in Growing Quail Diets

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### ABSTRACT

This study was conducted to investigate the effects of hemp seed oil replaced soybean oil as an energy supply on growth performance parameters, carcass yield, liver weight, breast meat pH, and meat color values in quails. A total of 100 one-day old quail chicks were reared in two treatment groups for 5 weeks. The experimental diets were formulated as to contain 4.4% crude soybean(control) and hemp seed oils. According to the results of the present study, crude hemp seed oil replaced soybean oil in the diet was effective on finishing body weight, feed intake, feed conversion ratio, weight gain and carcass yield. All of these parameters were lower than the soybean oil (control) group. Liver weight, and breast meat color values ( $L^*$ ,  $a^*$ , and  $b^*$ ) have shown similarities between experimental groups. The breast meat pH value decreased significantly in the hemp seed oil treatment group compared to soybean oil group. Using hemp seed oil instead of soybean oil used in quail diets negatively affects performance parameters (except for feed conversion ratio).

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## Introduction

Modern poultry production has common practice to use fat and oil for raising the energy density in poultry diets (Khatun et al., 2018; Parmar et al., 2019). Oils, besides of being energy source have important structural and metabolic functions such as, isolation of the body against environmental temperature alterations, transportation and the absorption of fat-soluble vitamins and providing of linoleic acid which is essential for poultry (Şenköylü, 2001). Although many types of vegetable and animal sources oils and fat used in poultry diets, crude soybean oil is one of the most preferred in the commercial context. However, due to a shortage of common vegetable oil sources such as soybean oil (SO), finding alternative oil sources has become an urgent requirement for poultry nutrition (Yang et al., 2019). Hemp seed oil is a by-product produced from hemp seeds and Hemp (*Cannabis sativa L.*) is an annual herbaceous plant which has been grown agriculturally for many centuries for its fiber and oil (Oomah et al., 2002). Hemp seed contains a high amount of protein (20–25%), carbohydrate (20–30%), oil (25–35%) and insoluble fiber (10–15%), and also it is a rich source of minerals (Deferne and Pate, 1996; Pate, 1999; Oomah et al., 2002). Hemp seed also contain antinutritional factors such as phytic acid, trypsin

inhibitors, condensed tannins, cyanogenic glycosides, and saponins (Russo and Reggiani, 2013, 2015; Galasso et al., 2016). Hemp seed oil is a valuable by-product that can extract by solvent or by screw press as virgin from seeds and crude oil can purification by refining (Matthäus and Brühl, 2008), and it is seen functional edible oil due to balanced fatty acid and high tocopherol content. Hemp seed oil has high level unsaturated fatty acids and the predominant fatty acids are linoleic and linolenic acids and its saturated fatty acid content is low. Tocopherol content amount of hemp seed oil is between 77-80 mg for each 100 g (Matthäus and Brühl, 2008) and this amount may change depending on the year, location, or variety. Hemp seed oil also contains approximately 4% gamma-linolenic acid (GLA), a unique n-6 fatty acid that serves as an intermediate for the formation of anti-inflammatory eicosanoids, which may have similar anti-inflammatory and anti-proliferative properties as EPA and DHA (Fan and Chapkin, 1998; Leizer et al., 2000; Kapoor and Huang, 2006). In some countries (Russia) hemp seed oil takes place as an alternative fat source in the human diet (Callaway, 2004). However, hemp seed oil can contain trace amounts THC (tetrahydrocannabinols) and the other cannabinoids which are lipophilic antioxidants that have

the therapeutic potential (Callaway, 2004). Moreover, due to high polyunsaturated fatty acid composition of hemp seed oil is very susceptible to oxidative deterioration during long time storage or preparing food by heat processing (Matthäus and Brühl, 2008). Despite nutritional potential, due to consideration regarding THC content and rancidity probabilities hemp seed oil is less preferred worldwide for human nutrition compared to the other oils. Currently, hemp seed and its meal have been subject to animal nutrition researches, partially in poultry nutrition and various reports can be found on the effect of hemp on growth and laying performance in poultry (Khan et al., 2010; Ondrej et al., 2015; Raza et al., 2016) but, studies regarding the effect of hemp seed oil in poultry nutrition are quite limited. It is well known that the source and type of dietary fat and influences on carcass quality of poultry meat (Khatun et al., 2018). The favorable composition of hemp seed oil provides evidence that it may represent a potentially valuable feed ingredient for poultry (Jing et al., 2017). Therefore, this study was conducted to determine the effects of using hemp seed oil obtained by pressing method instead of soybean oil in the quail rations on growth performance, meat color, carcass yield, liver weight and meat pH.

## Materials and Methods

The animal experiment was conducted at the application farm facility of Selçuk University Agriculture Faculty. Animal experiment was carried out according to the local ethics committee directives of Selçuk University. A total number of 100 quail (*Coturnix coturnix Japonica*), 1-day old were randomly distributed in to two groups of 50 quail and then subdivided in to 5 replicates. Each group was fed on the two experimental diet, 1-Control(SO) diet with 4.4% soybean oil, 2-Hemp seed oil(HSO) diet with 4.4% hemp seed oil no supplemented soybean oil (Table 1). The Soybean-corn based experimental diets were formulated according to recommendation National Research Council (NRC, 1994). The quails were reared in 33 × 40 × 28 cm size cages and under the semi-controlled environment terms (ventilation controlling system) and every compartment of cages had a water nipple, manger, and heater. The lighting program was 23 - hours light - 1 hour dark and during the trial, feed, and water provided as *ad-libitum*. Trial period was 5 weeks. Hemp (*Cannabis sativa*) seeds were provided from a local supplier and seeds were pressed in a cold press machine (Karaerler Machine, NF 100 model, Ankara) at about 45 - 50°C and crude hemp seed oil was obtained. Crude soybean oil was provided from a commercial feed factory. The nutrient composition of experimental diets was shown in Table 1.

At the beginning of the study (at 1 d of age) and at day 7, 14, 21, 28 and 35 the quails and feed intake were weighed to 1 g accuracy using an electronic balance. Quails live weight (LW) (g) was recorded and body weight gains (BWG) were calculated in weekly periods. Feed conversion ratio (FCR) was calculated with feed intake/body weight gain (FI/BWG) formulation.

At the end of the study (on d 35 of age), 3 quails(2 male, 1 female) from each replicate were randomly selected, weighed and slaughtered. After dressing, the carcass

weight was measured (g) and dressing percentage calculated. Liver weight was measured.

Breast meat color values ( $L^*$ ,  $a^*$ ,  $b^*$ ) of quails were determined by a Konica Minolta chroma meter CR-400 (Minolta Camera Co., Osaka, Japan). The L value indicates the brightness, the a value indicates the redness and the b value indicates the yellowness.

Breast meat value of quails was determined by using portable pH meter(WTW 2A20-1012 Waterproof pH-Meter) (Horwitz and Latimer, 2000).

Statistical analysis of data were using 2 sample t-test in Minitab(2000).

Table 1. Nutrient composition of experimental growth period diets

Ingredients (%)	SO diet	HSO diet
Corn	47.93	47.93
Soybean meal	44.52	44.52
Soybean oil	4.40	-
Hemp seed oil	-	4.40
Limestone	1.20	1.20
DCP	1.00	1.00
Salt	0.30	0.30
Vitamin mineral Premix <sup>A</sup>	0.25	0.25
Lysine	0.20	0.20
Methionine	0.20	0.20
Total	100	100
Calculated nutrients		
Crude Protein (%)	24.0	24.0
Metabolizable energy (kcal/kg)	2900	2900
Calcium (%)	0.80	0.80
Available phosphorus (%)	0.30	0.30
DL-Methionine (%)	0.50	0.50
Methionine + Cysteine (%)	0.83	0.83
L-Lysine (%)	1.30	1.30

SO: Soybean oil, HSO: Hempseed oil, \*\*: Analyzed value, A:Vitamin-mineral premix (per kilogram of diet): Vitamin A 15000 IU; Vitamin D3 1500 IU; Vitamin K 5 mg; Vitamin B1 3 mg; Vitamin B2 6 mg; Vitamin B6 5 mg; Vitamin B12 0.03 mg; Niacin 30 mg; Biotin 0.1 mg; calcium D-pantotenat 12.0 mg; folic acid 1.0 mg; coline chloride 400 mg; Manganese 80 mg; Iron 35 mg; Zinc 50 mg; Copper 5.0 mg; Iodine 2 mg; Cobalt 0.04 mg.

## Results and Discussions

The effects of hemp seed oil in diets on growth performance parameters of quails were given in Table 2. The use of hemp seed oil (HSO) instead of soybean oil in the quail diet significantly affected FBW(final body weight), FCR, FI and WG ( $P<0.05$ ). Performance parameters of the HSO group were lower than the control group.

In the literature, there is almost no research on the addition of hemp oil to poultry diets. Current studies are mostly focused on hemp seed meal, hempseed cake and hemp seeds. Gakhar et al. (2012) reported that the inclusion of the hemp products hemp seed or hemp seed oil in the diets of laying hens up to a maximum level of 20 and 12%, respectively, does not negative effect the performance. Ondrej et al. (2015) reported that with the addition of 15% hemp seed cake in the broiler diet, FBW and FCR significantly decreased compared control group. Vispute et al. (2019) demonstrated that supplemented level of 0.2% and 0.3% whole hemp seed to basal broiler ration affected

negatively FI and BWG at first 21 days period, however, among 21 and 42 days were not observed a significant difference between treatments. Mahmoudi et al. (2015) reported that whole hemp seed addition to ration affected daily FI and BWG of broilers depending on the level and it has been demonstrated that in the lower level (25 g/kg feed) of whole hemp seed decreased these parameters compared to higher levels (50-75 gr/kg feed). Bahari et al. (2014) have reported that added different levels of whole hemp seed to broiler diets were effect on feed conversion ratio and in treatment groups, the FI was decreased in 3rd, 4th, 5th and 6th weeks compared control groups. Konca et al. (2014) have revealed that FI and FCR of broiler chickens were not affected by supplemental whole hemp seed in the rations however FBW significantly decreased at the group which has the highest hemp seed level. Adding different levels (50 g/kg<sup>-1</sup> and 150 g/kg<sup>-1</sup>) of hempseed expellers to broiler rations has been negatively affects LW and FCR(P<0.05). The best values were recorded in the control group. However, it has been reported to appears to affect

the colour and odour of broiler chicken's meat which is positive for the consumers (Štátník et al., 2019). Eriksson and Wall (2012) reported that supplemented of hempseed cake in organic broiler's diets did not affect production performance and mortality.

According to the results of this study performance parameters negative affected by hempseed oil which replaced soybean oil(P<0.05). Results of previous studies have indicated that supplemental level, varieties of hempseed, differences of by-products of hempseed, oil content of by-products, and effective components such as THC, cannabinoids, phenolics, and their levels may be considered influential on performance parameters in the growth period of poultry. Hemp oil, due to the lipophilic nature of THC, could be expected to contain more THC than the seed (Additives and Feed, 2011). In our study, if there were groups with all soybean oil and certain levels of additives in the ration, the amount of hemp seed oil that could be used without negative effects could be determined.

Table 2. The effects of hemp seed oil in diets on growth performance parameters of quails.

Diets	FBW(g)	BWG(g)	FI(g)	FCR
Control (SO)	173.06±2.4 <sup>a</sup>	164.50±2.3 <sup>a</sup>	479.5±11 <sup>a</sup>	2.92±0.09 <sup>a</sup>
Hemp seed oil (HSO)	164.47±2.3 <sup>b</sup>	155.93±2.4 <sup>b</sup>	395.2±21 <sup>b</sup>	2.53±0.12 <sup>b</sup>

a, b: Means with different minuscule in the same column are significantly different at P<0.05, (FBW: Finishing body weight, WG: Weight gain, FI: Feed intake, FCR: Feed conversion ratio, SO: Soybean oil HSO: Hempseed oil)

Table 3. The effects of hemp seed oil in diets on carcass yield, liver weight and breast meat pH of quails.

Diets	CY(%)	LW(g)	pH
Control (SO)	69.67±0.48 <sup>a</sup>	3.61±0.14	5.77±0.02 <sup>a</sup>
Hemp seed oil (HSO)	67.92±0.29 <sup>b</sup>	3.30±0.01	5.69±0.02 <sup>b</sup>

a, b: Means with different minuscule in the same column are significantly different at P<0.05, (CY: Carcass yield, LW: Liver weight, SO: Soybean oil HSO: Hempseed oil).

Table 4. The effects of hemp seed oil and soybean oil in diet on quail breast meat colour values.

Diets	Skinned			Skinless		
	L*	a*	b*	L*	a*	b*
Control (SO)	59.64±1.30	6.17±0.57	5.96±0.76	57.13±3.10	5.61±0.42	3.8±1.20
Hemp seed oil (HSO)	59.56±0.93	6.71±0.45	6.16±0.29	52.19±1.40	6.64±0.99	2.19±0.43

HSO: Hempseed oil, SO: Soybean oil

The effects of dietary oils in diets on carcass yield, liver weight and breast meat pH of quails were given Table 3. Hempseed oil was decreased significantly in carcass yield and breast meat pH compared to soybean oil (P<0.05) however, liver weight were not affected by treatments.

The quality of a meat is shaped by a complex interaction between the genotype of the animal from which it is obtained and the environment (Bihan-Duval, 2004). As a result of the decrease in pH, the meat becomes more moisture and tender (Savell et al., 2005). Using hemp oil instead of soybean oil in the diet has decreased the pH value and positively affected the meat quality. Meat pH value can be affected by amounts of antioxidants and some other compounds in the diet (Khan et al., 2015) and it is clear that the level of antioxidants and the other components can be effective on meat pH able to show alterations between oil and by-products of hempseed.

Carcass yield is significantly higher in the SO group compared to the HSO group (P<0.05). Liver weight was found higher in the soybean oil group but not significant

statistically. Konca et al. (2014) noticed that whole hemp seed at the level of 0% (control group), 5%, 10% and 20% in the ration were significant on carcass and liver weights, and 10% hemp seed supplementation increased carcass weight but the highest liver weight was found in the control group. Khan et al. (2010) revealed that the hemp seed powder added to the feed at the level of 20% has a positive effect on the carcass quality of broiler chicks. Outcomes of various studies regard the effect of hemp seed oil or by-products on carcass and liver weights have shown that many factors such as poultry species, supplement level, and potential effective components are efficient on the results. Ondrej et al. (2015) reported that 5% and 15% hemp seed cake supplemented rations were not significantly effective in terms of broiler carcass yield.

The effect of dietary oils on quail breast meat color values (L\*, a\*, b\*) in Table 4 was shown. Color values of skinless and skinned breast meat were not affected significantly by the hemp seed oil supplement.

Despite no significant difference between groups in terms of color value,  $L^*$ ,  $a^*$  and  $b^*$  values of skinned and skinless breast meat were differential as estimated. In this study, hemp seed oil affected the pH value but not changed the color values of breast meat. Despite muscle pH and meat color have consistently been reported to be highly correlated however similarly to this study, several scientists have not found consistent relationships between color and pH in “normal” conditions and it has been reported that meat pH and color strongly related under the extreme conditions (Fletcher, 2002). Reports regarding the effects of hemp seed oil on poultry meat color have not found but a study that has investigated the effect of two levels of hemp seed expeller (50 and 150 gr/ kg feed) on broiler meat color values and reported that  $L^*$  value not changed by treatments but%15 hemp seed cake in the diet affected  $a^*$  and  $b^*$  values significantly and caused more intense color (Štástník et al., 2019). Aminzade et al. (2012) have notified that the effectiveness of oxidative processes affected the meat discoloration. The present study has revealed that supplemental hemp seed oil replaced soybean oil was not changed the color values of meat samples and any oxidative case has not been able to change of meat color.

## Conclusions

Results of this study demonstrated that hemp seed oil replaced soybean oil in the diet was effective on finishing body weight, feed intake, feed conversion ratio, weight gain and carcass yield ( $P < 0.05$ ). All of these parameters were lower than the soybean oil group. Liver weight, and breast meat color values ( $L^*$ ,  $a^*$ , and  $b^*$ ) have shown similarities between experimental groups. The breast meat pH value decreased significantly in the hemp seed oil treatment group ( $P < 0.05$ ). Using hemp seed oil instead of soybean oil used in quail rations negatively affects performance parameters (except feed conversion ratio). Hemp seed oil is a product that has the potential to have very important effects in poultry feeding. Studies are needed to determine the levels of hemp seed oil that can be used in poultry diets without any adverse effects.

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