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The Effects of Different Levels of Canola Oil and Diet Mixing Time Length on Performance, Carcass Characteristics and Blood Lipids of Broilers

Research Article

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ABSTRACT

This experiment was conducted to investigate the effects of different levels of canola oil and diet mixing time length on performance, carcass traits and blood lipids in broilers. In this experiment 288 Ross-308 broilers were used from 11 up to 42 days as factorial arrangement (3×2) included three levels of canola oil (0, 3 and 6%) and two mixing time length (10 and 15 minute) in 6 treatments, 4 replicates and 12 birds in each replicate in a completely randomized design. Canola oil improved the performance of broilers ($P<0.01$). The highest values of daily weight gain, daily feed intake and final body weight were obtained using 6% of canola oil in diets. Mixing diet more than 10 minute, reduced the amounts of daily weight gain and final weight ($P<0.05$). In interaction between oil level and mixing time length, 6% canola oil × diet mixing for 10 minute, improved the performance of broilers ($P<0.05$). Dietary level of 6% canola oil increased the spleen percentage ($P<0.05$). Canola oil had reducing effect on the level of blood cholesterol ($P<0.05$). The lowest level of blood cholesterol was observed in group supplemented with 3% canola oil. Mixing diet more than 10 minute, increased the amount of low-density lipoprotein (LDL) in blood ($P<0.05$). In interaction effect, the lowest level of blood cholesterol was seen in 6% canola oil × mixed for 10 minute group. The overall conclusion is that using 6% canola oil and 10 minute mixing time for boiler diets could significantly improve the performance, and reduce their blood cholesterol.

KEY WORDS blood lipids, broiler chickens, canola oil, performance.

INTRODUCTION

The most practical method for increasing the energy density of diets in poultry feeding is through the addition of fats and oils (Peebles *et al*. 2000). It was reported that fat metabolism and deposition in poultry could be affected by different dietary fats and fatty acids (Snaz *et al*. 2000). Also they assist vitamin A and Ca absorption (Sklan, 1980; Leeson and Atteh, 1995). Some concerns that should be noted with fat utilization include: use of higher levels of fat may negate the effects of pelleting, measurement of metabolizable energy (ME) content can be difficult, there is the potential for rancidity, equipment needs relative to fat additions must be adequate and potentially poor digestibility of saturated fats by the young bird (Chen and Chiang, 2005). Oils are the most important energy source of broiler rations. In order to get the optimum productivity from chickens, the protein and energy levels of ration should be high. By compensation of energy requirements of chickens with oils instead of carbohydrates, a better performance was attained (Leeson and summers, 2001). There are different sources of oils in the market for consuming, one of the most important of them is canola oil. Canola oil has been recognized as adequate mixture of essential unsaturated fatty acids such linolenic acid (C18:3) with its beneficial effect on broiler performance and linolenic acids that can be con-

verted to longer chain omega-3 fatty acids (Sim *et al.* 1990; Yang *et al.* 2000) which are important factors in promoting the health of animals and human (Bezard *et al.* 1994). Adding 3% of canola oil and poultry fat resulted significant improvement in body weight and better feed conversion ratio than other groups. However, no significant differences were found in liver, breast, thigh weights between fat-supplemented groups in comparison with the control. Addition 6% poultry fat caused significant increasing on abdominal fat, gizzard weight was significantly higher in control group in comparison with supplemented groups (Shahryar *et al.* 2011). It has been accepted that dietary canola oil is excellent supplement for commercial fish such as salmon (Huang *et al.* 2008). However, canola oil contains less than 2% of erucic acid (docosenoic acid, C22:1, (-9) in relation to its total fatty acids content and less than 30 umoles of glucosinolates per gram of free oil on seed dry matter basis. In birds, the adverse effects of adding erucic acid to the diets are reflected on intake, growth performance and the apparent digestibilities of total lipid and individual fatty acids (Leeson and summers, 2001). Furthermore, chicks fed with diets containing erucic acid deposit less fat and utilize energy from this diet less frequently (Leeson and Summers, 2001).

Using 2% of canola oil in broiler diets positively improved their performance and carcass traits (Nobakht *et al.* 2012). In broilers using 5% canola oil increased their weight gain and blood triglyceride (Kiani *et al.* 2016). Adding canola oil up to 5% in diet of native turkeys had no significant effects on their blood lipids parameters (Salamatdoust Nobar *et al.* 2010). In laying hens incorporating 2% canola oil in diets improved their performance and reduced their egg and blood cholesterol level (Ismail *et al.* 2013).

Despite the fact that mixing is one of the most essential and critical operations in the process of feed manufacturing, yet it is frequently given little consideration. The main objective in mixing is to create a completely homogeneous blend. In other words, every sample taken should be identical in nutrient content. A functional definition of uniform mixing can be summarized in one sentence "All nutrients will be present in sufficient quantity in the daily feed intake of the target animal to meet its minimum growth requirements''.

A uniform and precise mixing of diets is very critical for providing energy and nutrients to meet the requirements for animals (Traylor *et al.* 1994). Poor mixing of feedstuffs may cause over supply or under supply of nutrients to animals, resulting in economic loss, poor performance, or both. Detrimental effects of insufficient mixing time on average daily gain and gain to feed ratio have been reported (Groesbeck *et al.* 2007).

Horizontal and vertical feed mixers are widely used for mixing the animal feeds at feed mills. These types of feed mixers have been tested for the degree of uniformity in diet mixing (McCoy, 2005). Cone-bottom type vertical mixers have been tested for mixing performance (Groesbeck *et al.* 2007).

In a newly experiment, Hyunwoong *et al.* (2015) indicated that the most suitable mixing time of broiler diets is 202 seconds. On the base of their recommendation, the mixing length should not be least than 200 seconds.

As fats have beneficial role in diet mixing and diet mixing time is very critical for having a uniform diet, in the current study the effects of different levels of canola oil as a fat source and different mixing time length of diets on broiler performance and their blood lipids profile have been investigated.

MATERIALS AND METHODS

In this experiment 288 Ross-308 broilers were used from 11 up to 42 days as factorial arrangement (3×2) included three levels of canola oil (0, 3 and 6%) and two mixing time of diets (10 and 15 minutes) in 6 treatments, 4 replicates and 12 birds in each replicate in a completely randomized design. The diets were formulated to meet the requirements of birds established by the Ross Company (2014) for broilers in grower (11-24 days) and finisher (25-42 days) periods (Tables 1 and 2).

In all experiment periods the diets and water were provided *ad-libitum* for birds. The lighting program during the experimental periods consisted of a period of 23 hours light and 1 hour of darkness. Environmental temperature was gradually decreased from 33 ˚C to 25 ˚C on day 21 and was then kept constant. Body weight, feed intake and feed conversion ratio were determined at the end of each experimental period. Mortality was also recorded if it occurred. At the end of the experiment, two birds from each replicate were randomly chosen for blood collection and approximately 5 ml blood samples were collected from the brachial vein of randomly chosen birds. The blood was centrifuged to obtain serum for determining the blood lipids which included cholesterol, triglyceride, low-density lipoprotein (LDL) and high-density lipoprotein (HDL). Kit packages (Pars Azmoon Company; Tehran, Iran) were used for determining the blood biochemical parameters using Anision-300 auto-analyzer system (Nazifi, 1997). Also, at 42 day of age, two birds from each replicate randomly chosen based on the average weight of the group and sacrificed. Dressing yield was calculated by dividing eviscerated weight by live weight. Abdominal fat, gizzard, liver, spleen, breast and thigh were collected, weighed and calculated as a percentage of carcass weight.

Table 1 Ingredients and chemical composition of broiler diets in grower period (11-24 days)

Feeds ingredients	Canola oil level		
	0%	3%	6%
Corn grain	62.83	56.13	47.43
Soybean meal (42% CP)	3317	35.28	37.39
Canola oil	0.00	3.00	6.00
Inert (sand)	0.27	1.90	5.52
Oyster shell	0.25	0.21	0.17
Bone meal	2.11	2.14	2.17
Salt	0.40	0.40	0.41
Vitamin premix[1]	0.25	0.25	0.25
Mineral premix[2]	0.25	0.25	0.25
DL-methionine	0.28	0.29	0.30
L-lysine hydrochloride	0.19	0.15	0.11
Calculated composition			
Metabolizable energy (kcal/kg)	2900	2900	2900
Crude protein (%)	19.80	19.80	19.80
Ca (%)	0.83	0.83	0.83
Available phosphorus (%)	0.42	0.42	0.42
Sodium (%)	0.18	0.18	0.18
Lysine (%)	1.14	1.14	1.14
Methionine + cysteine (%)	0.88	0.88	0.88
Tryptophan (%)	0.24	0.24	0.24

[1] Vitamin premix per kg of diet: vitamin A (retinol): 2.7 mg; vitamin D_3 (cholecalciferol): 0.05 mg; vitamin E (tocopheryl acetate): 18 mg; vitamin K_3: 2 mg; Thiamine: 1.8 mg; Riboflavin: 6.6 mg; Panthothenic acid: 10 mg; Pyridoxine: 3 mg; Cyanocobalamin: 0.015 mg; Niacin: 30 mg; Biotin: 0.1 mg; Folic acid: 1 mg; Choline chloride: 250 mg and Antioxidant: 100 mg.
[2] Mineral premix per kg of diet: Fe ($FeSO_4.7H_2O$, 20.09% Fe): 50 mg; Mn ($MnSO_4.H_2O$, 32.49% Mn): 100 mg; Zn (ZnO, 80.35% Zn): 100 mg; Cu ($CuSO_4.5H_2O$): 10 mg; I (K_1, 58% I): 1 mg and Se ($NaSeO_3$, 45.56% Se): 0.2 mg.

Table 2 Ingredients and chemical composition of broiler diets in finishing period (25-42 days)

Feeds ingredients	Canola oil level		
	0%	3%	6%
Corn grain	65.30	57.59	50.91
Soybean meal (42%CP)	30.22	32.34	34.35
Canola oil	0	3.00	6.00
Inert (sand)	1.18	3.81	5.47
Oyster shell	0.14	0.11	0.07
Bone meal	2.07	2.10	2.14
Salt	0.37	0.37	0.37
Vitamin premix[1]	0.25	0.25	0.25
Mineral premix[2]	0.25	0.25	0.25
DL-methionine	0.18	0.18	0.19
L-lysine hydrochloride	0.04	0	0
Calculated composition			
Metabolizable energy (kcal/kg)	2900	2900	2900
Crude protein (%)	18.58	18.58	18.58
Ca (%)	0.77	0.77	0.77
Available phosphorus (%)	0.40	0.40	0.40
Sodium (%)	0.17	0.17	0.17
Lysine (%)	0.96	0.96	0.96
Methionine + cysteine (%)	0.75	0.75	0.75
Tryptophan (%)	0.22	0.22	0.22

[1] Vitamin premix per kg of diet: vitamin A (retinol): 2.7 mg; vitamin D_3 (cholecalciferol): 0.05 mg; vitamin E (tocopheryl acetate): 18 mg; vitamin K_3: 2 mg; Thiamine: 1.8 mg; Riboflavin: 6.6 mg; Panthothenic acid: 10 mg; Pyridoxine: 3 mg; Cyanocobalamin: 0.015 mg; Niacin: 30 mg; Biotin: 0.1 mg; Folic acid: 1 mg; Choline chloride: 250 mg and Antioxidant: 100 mg.
[2] Mineral premix per kg of diet: Fe ($FeSO_4.7H_2O$, 20.09% Fe): 50 mg; Mn ($MnSO_4.H_2O$, 32.49% Mn): 100 mg; Zn (ZnO, 80.35% Zn): 100 mg; Cu ($CuSO_4.5H_2O$): 10 mg; I (K_1, 58% I): 1 mg and Se ($NaSeO_3$, 45.56% Se): 0.2 mg.

Statistical analyses

The data were subjected to one-way analysis of variance procedures appropriate for a factorial arrangement as completely randomized design using the general linear model procedures of SAS, (2005).

Means were compared using the Toky test (Valizadeh and Moghaddam, 1994). Statements of statistical significance were based on ($P<0.05$).

RESULTS AND DISCUSSION

Performance

The effects of different levels of canola oil and diet mixing time length on performance of broilers are shown in Table 3. Adding canola oil into diets without having any effects on feed conversion ratio, increased the amounts of daily weight gain, daily feed intake and final live weight (P<0.01). Diet mixing for 15 minutes significantly reduced the amounts of final live weight (P<0.05). In interaction between canola oil levels and mixing time length, the best performance was obtained with 6% canola oil × 10 minute mixing time length. Therefore the highest amounts of daily weight gain, daily feed intake and final body weight belonged to this experimental group.

Carcass traits

The effects of different levels of canola oil and diet mixing time length on carcass traits of broiler chicks are shown in Table 4.

Except for spleen percentage, canola oil had no significant effects on carcass traits of the birds (P>0.05). Adding 6% canola oil to the diet increased the spleen percentage (P<0.05).

Using canola oil at 3% did not affect the size of spleen compared to control group (group without oil). Diet mixing time and interaction between diet mixing time and canola oil levels did not have any significant effects on carcass traits of chicks (P>0.05).

Blood lipids

The effects of different levels of canola oil and diet mixing time length on blood lipids of broiler chicks are provided in Table 5. The incorporation of canola oil in diets significantly reduced the amount of blood cholesterol (P<0.05). Mixing diet for 15 minute increased the blood level of LDL (P<0.05). In interaction between canola oil and mixing time, using 6% canola oil × 10 minute mixing diet, reduced the amount of blood cholesterol (P<0.05).

Canola oil more than energy is a rich source of essential fatty acids and fat soluble vitamins. So, using it in broilers diet support their performance by supplying the essential nutrient requirements. One of the most important roles of fats in diets is to improve the diets palatability (Leeson and summers, 2001). As, the palatability increase the amount of feed intake, for this reason, the amount of broilers feed intake, increased by increasing to canola oil level in diets. If we accept that the amount of weight gain in this experiment was in line with the amount of feed intake, then using canola oil could not significantly change the feed conversion ratio. There is strange positive relation between daily weight gain and final live weight (Leeson and summers, 2001). As the highest amount of daily weight gain was obtained by using 6% canola oil in diets, so, the highest final live weight was seen in group contained 6% canola oil in it diet. Our findings in the present study about the effects of incorporating of canola oil in broiler diets on their performance is in agree to previous research (Nobakht *et al.* 2012; Ismail *et al.* 2013; Kiani *et al.* 2016).

Table 3 The effects of canola oil and diet mixing time length on performance of broilers (11-42 days)

Treatments	Weight gain (g/d/h)	Feed intake (g/d/h)	FCR	Final weight (g)	Livability (%)	Production index
Canola oil level (%)						
0	66.77^{c}	109.32^{c}	1.64	2217.00^{c}	97.92	318.29
3	68.93^{b}	112.72^{b}	1.64	2290.42^{b}	97.22	323.79
6	70.38^{a}	116.90^{a}	1.66	2327.92^{a}	96.53	322.80
SEM	0.50	1.03	0.01	11.88	1.27	3.56
P-value	0.0001	0.0001	0.2349	0.0001	0.7436	0.5172
Diet mixing time length (minute)						
10	69.35^{a}	113.99	1.64	2299.16^{a}	97.22	325.40
15	67.97^{b}	111.97	1.65	2257.83^{b}	97.20	317.90
SEM	0.40	0.84	0.01	9.70	1.04	2.91
P-value	0.0232	0.1024	0.8302	0.0056	.9999	0.0791
Canola oil levels (%) × diet mixing time (minute)						
0 × 10	67.21^{ab}	110.40^{b}	1.65	2240.84^{bc}	97.23	319.32
0 × 15	66.32^{b}	108.25^{b}	1.63	2194.67^{c}	98.62	317.27
3 × 10	69.56^{a}	112.99^{ab}	1.63	2300.84^{a}	97.23	328.29
3 × 15	68.11^{a}	112.46^{ab}	1.65	2280.00^{a}	97.23	319.30
6 × 10	71.29^{a}	118.60^{a}	1.66	2357.00^{a}	97.23	328.58
6 × 15	69.48^{a}	115.21^{a}	1.67	2298.84^{ab}	95.84	317.02
SEM	0.69	1.46	0.02	16.80	1.79	5.03
P-value	0.0411	0.0236	0.3194	0.0344	0.7436	0.6260

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
FCR: feed conversion ratio.
SEM: standard error of the means.

Table 4 The effects of canola oil levels and diet mixing time length on carcass traits (carcass %) of broilers (42 days)

Treatments	Carcass	Abdominal fat	Gizzard	Liver	Spleen	Breast	Thigh
Canola oil level (%)							
0	70.75	3.72	3.95	3.83	0.21[b]	35.37	28.78
3	69.67	3.92	4.19	2.80	0.21[b]	34.50	29.00
6	70.60	3.76	4.05	2.92	0.023[a]	34.96	28.46
SEM	0.85	0.09	0.1	0.08	0.01	0.76	0.79
P-value	0.6308	0.3097	0.2503	0.5896	0.0364	0.7235	0.9200
Diet mixing time							
10	70.61	3.80	4.12	2.86	0.22	34.93	28.55
15	70.08	3.75	4.02	2.84	0.23	34.96	28.87
SEM	0.70	0.07	0.08	0.07	0.01	0.63	0.64
P-value	0.5895	0.9532	0.3934	0.7908	0.7916	0.9718	0.7315
Canola oil levels × diet mixing time (minute)							
0 × 10	70.79	3.71	4.07	2.88	0.21	36.21	29.48
0 × 15	70.72	3.74	3.84	2.78	0.21	34.54	28.07
3 × 10	71.28	3.86	4.15	2.72	0.22	33.87	27.93
3 × 15	68.07	3.97	4.24	2.88	0.20	35.13	29.88
6 × 10	69.78	3.83	4.13	2.99	0.23	35.72	28.26
6 × 15	71.43	3.71	3.98	2.85	0.24	35.21	28.67
SEM	1.21	0.12		0.14	0.01	1.08	1.11
P-value	0.8825	0.6444	0.4926	0.4218	0.4886	0.3901	0.3333

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 5 The effects of canola oil and diet mixing time length on blood lipids (mg/dL) of broilers (42 days)

Treatments	Cholesterol	Triglyceride	HDL	LDL
Canola oil level (%)				
0	129.12[a]	84.92	60.71	51.36
3	113.30[b]	78.88	55.30	47.94
6	122.30[ab]	68.58	51.08	54.00
SEM	3.85	12.68	5.48	5.51
P-value	0.0258	0.3566	0.4712	0.7403
Diet mixing time (minute)				
10	120.70	63.00	65.26	42.64[b]
15	122.74	78.58	46.83	59.55[a]
SEM	3.14	10.36	4.47	4.50
P-value	0.6625	78.58	0.0060	0.0138
Canola oil levels × diet mixing time (minute)				
0 × 10	120.46[ab]	78.77	59.27	45.39
0 × 15	137.78[a]	91.07	62.15	57.33
3 × 10	122.40[ab]	54.48	73.44	42.04
3 × 15	124.21[a]	63.28	37.17	53.84
6 × 10	119.45[b]	55.77	63.09	40.50
6 × 15	126.21[ab]	81.39	39.07	67.50
SEM	5.45	17.94	7.75	7.79
P-value	0.0100	0.8853	0.0624	0.5416

LDL: low-density lipoprotein and HDL: high-density lipoprotein.
The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Homogenous mixing of diets has been shown can improve the production performance of broilers (Traylor *et al.* 1994; Groesbeck *et al.* 2007). Therefore, the confirmation of mixing efficiency of a mixer is very important before using the mixer for animal feed production. The uniformity of mixing diet is affected many factors including particle size, ingredient density, sequence of ingredient addition, amount of ingredients mixed, mixer design, mixing time and cleanliness of the mixer (McCoy, 2005).

In the present study, reducing the amounts of daily weight gain and final live weight in mixing diets more than 10 minutes may be related to de mixing and separating of diets particles. For having optimum performance, the poultry diets uniformity is critical (McCoy, 2005).

In an experiment, 202 seconds recommended as the best mixing time of broiler diet, but mixing for 300 and 420 seconds had adverse effect in this respect (Hyunwoong *et al.* 2015).

Improving of the performance by using 6% canola oil and diet mixing for 10 minutes, clearly showed the efficacy of high levels of fat and moderate diet mixing time on performance of broiler, whereas omitting of canola oil and prolonged of mixing time, had adverse effects on performance of broilers. These results may be related to the beneficial effects of canola oil (Nobakht *et al.* 2012; Ismail *et al.* 2013; Kiani *et al.* 2016) and optimum mixing time (McCoy, 2005) on performance of broilers. Using canola oil without enlargement in spleen size had no effect on carcass traits of broilers. Spleen is an immune organ and enlarge in the spleen size may be related to immune upgrading (Nazifi, 1997).

Canola oil such other fat sources, contain highly amount of fat soluble vitamins. Fat soluble vitamins such as A and E have important role on increasing of body immunity and disease prevention (Leeson and summers, 2001). Increase in the size of spleen by using canola oil in the present research may be related to fat soluble vitamins content of this oil. Our findings in the present study not in line with Shahryar *et al*. (2011) and Nobakht *et al.* (2012) reported results that those indicated using 2% and 3% of canola oil in broiler diets have beneficial effects on their carcass traits improvement.

Oils those originated from plants, such other plant derivatives do not have cholesterol in their compounds, so, in contrast to animal originated fats, using them, not only do not increase the level of blood cholesterol, but also can reduce it.

As canola oil usually is free of cholesterol, so, using it in broiler diets in contrast to control group, without having any effects on other blood lipids, significantly reduced the amount of blood cholesterol. This result is in agree with findings of Ismail *et al.* (2013), how indicated that using 2% canola oil in laying hens diets reduced their egg and blood cholesterol content.

Whereas is not agree with Salamatdoust Nobar *et al.* (2010) report that using canola oil up to 5% of native turkeys diets had no effects on their blood lipids.

Increase in the amount of blood LDL in mixing diets for 15 minutes may be related to de mixing and separating of diets particles from each other and lowering the feed quality. Significantly reducing the blood level of cholesterol in group contained 6% canola oil with 10 minutes of mixing time, show the efficacy of using high level of canola oil and diet optimum mixing time in this respect.

CONCLUSION

The overall conclusion is that using 6% canola oil and 10 minute mixing time for boiler diets could significantly improve the performance, and reduce their blood cholesterol.

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