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Influence of Dietary Vegetable Oil Sources and Red Cranberry Powder Levels on Growth Performance, Carcass Yield, some Blood Parameters and Gut Morphology on Broiler Chickens

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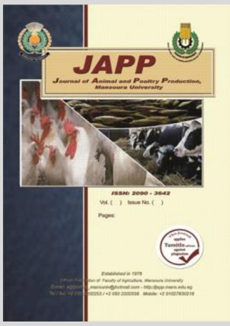

ABSTRACT

The present study was carried out to investigate the influence of dietary supplementation with vegetable oil sources and dietary red cranberry powder (RB)on growth performance, carcass yield, blood parameters and gut morphology of broiler chickens. In all, 192 1-day-old Ross 308 broiler chickens were randomly divided into 8 treatment groups, each of which included 3 replicates. A completely randomized block design with a 4×2 factorial arrangement of treatments was used for four different sources of oil (1.5% olive oil (OO), 1.5 % flaxseed oil (FO), 1.5% soybean oil (SO) and 1.5% their mixtures oil (MO) in the diets) then each treatment sub-divided into two dietary RB (0.0 or 1.0 g RB/kg diet). Supplementation of flaxseed oil at the level of 15 g/kg diet produced a positive effect on the production performance of chicks during the whole experimental period compared to the other different oils. Also adding the RB at level 1 g/kg improved the production performance significantly of broiler chickens during the whole experimental period. On the other hand, significantly lower serum levels of total protein and globulin were found with dietary supplementation of FO for broiler chickens compared with the groups fed OO or SO. The duodenum of birds fed a MO and FO showed greater villus height compared with those fed OO and SO. The present study shows that supplementing with FO of diet and adding RB has a positive effect on productivity, some blood parameters and gut morphology in broiler chickens.

Keywords: broiler chickens, vegetable oil, cranberry, performance, blood, gut morphology

INTRODUCTION

The strong genetic potential of hybrids used to make chicken meat allows them to fulfil consumer demand at 35 days of age, and chicken meat with altered lipid composition and polyunsaturated omega-3 fatty acids significantly lowers the risk of cardiovascular disease. The effects of dietary oils and fats on health, which is mostly dependent on the presence of individual fatty acids, as well as their interaction, have received considerable attention in recent years. Poultry is a very important industry. Indeed, it is estimated that in 2020, chicken would be the most popular animal protein worldwide. To improve the concentration of energy, fat and oil are typically utilized in poultry diets. Feeds with added fat improve poultry productivity and feed energy efficiency Attia *et al.* (2019). Additionally, the oil increases the digestion of meals, enhances the absorption of fat-soluble vitamins, reduces the amount of dust in feeds, and slows the rate at which feeds pass through the gut, giving nutrients more time to be properly absorbed Poorghasemi *et al.* (2015).

The fatty acid composition affects how easily dietary fats can be digested. Due to improved intestinal absorption than saturated fats, diets high in unsaturated fats have higher metabolizable energy levels (Celebi and Utlu 2006 and Khatun *et al.,* 2018). Lopez-Ferrer *et al.* (2011) the fatty acid composition of tissue is affected by the inclusion of 2 and 4% flaxseed oil in broiler diets, along with fat additions of up to 8%, but production characteristics only slightly varied across treatments. The finest source of -linolenic acid (C18:3) for broiler meat enrichment to date is flaxseed oil, which is an excellent source of n-3 fatty acids. (Kumar *et al.,* 2019)

Typically, flaxseed is grown for its dietary fiber (250-280 g/kg) and oil (350-450 g/kg), but it also contains lignins, lecithin, vitamins, and minerals, as well as a source of vital amino acids and proteins (200-240 g/kg) Al-Hilali (2018). It has been demonstrated that flaxseed, a high source of omega-3 PUFAs, can help prevent cardiovascular disease and lessen the risk of cancer, particularly breast and colon cancer Koriem, 2017. The antinutritional components of flaxseed, including as phytic acid, cyanogenic glycosides, linatin dipeptides (a vitamin B6 antagonist), mucilage from the hulls, and trypsin inhibitors, may limit its use in poultry diets (Kajla *et al.,* 2015). To put it another way, just a negligible rise in EPA and DHA was seen in chickens fed flaxseed or flaxseed oil Rymer and Givens (2005) which may be due to desaturase and elongase enzymes activity Palmquist (2009) or direct deposition of alpha-linolenic acid Wood *et al.* (2008).

It is believed that olive oil, which has a large amount of MUFAs, not only adds nutrients to diets (Stark and Madar, 2002) but also influences the fatty acids profiles in muscles and fat in monogastric animals (Krejčí-Treu *et al.,* 2010). However, little evidence of the use of olive oil in broilers. The antioxidant action of these products is partly responsible for the hypoglycemic, anti-atherogenic, anticancer, anti-inflammatory, immunomodulatory, and antiviral activities that may be linked to the polyphenols in olive oil (Rigacci and Stefani, 2016). The most often utilized fat source for chicken diet formulation in the Middle East is soybean oil (SO), especially after various hydrations, filtrations, and degumming processes Beauregard *et al.,* 1996.

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Berries are rich in polyphenols including anthocyanins and flavanols, which have been shown to be useful in reducing cholesterol and preventing oxidative stress and inflammation. People adore it since it is a healthy food. Similar to how the juice is extracted from the blueberry pomace (20% of the fruit) is also rich in minerals, lipids, carbs, proteins, and polyphenols Ross *et al.,* 2017. Therefore, this study evaluated the effect of feeding a diet that contained 15g/kg of OO, FO, SO, or a mixture of the three oils (MO) and adding red cranberry powder on the production performance, carcass yield, some blood parameters, and gut morphology of broilers chickens.

MATERIALS AND METHODS

The current study was carried out in a private poultry farm near Daqahlia Governorate, Egypt from February to March 2023. The objective of the present study was to evaluate the effect of feeding a diet that contained 15g/kg of olive oil, flaxseed oil, soybean oil or a mixture of the three oils and adding red cranberry powder on the production performance, carcass yield, some blood parameters, and gut morphology of broilers chickens.

Birds, management and experimental design:

A total of 192 one-day-old Ross 308 broiler chickens (n = 192), with an average body weight of 40 g, were divided into 8 treatment groups, with three replicates (cages) in each group. A completely randomized block design with a 4×2 factorial arrangement of treatments was used for four different sources of oil (1.5% olive oil (OO), 1.5% flaxseed oil (FO), 1.5% soybean oil (SO) and 1.5% their mixtures oil (MO) in the diets) then each treatment sub-divided into two dietary red cranberry powder (0.0 g/kg red cranberry or 1.0 g/kg red cranberry for diet). A battery cage with dimensions measuring 100 cm in length, 60 cm in width, and 45 cm in height was used to house each replicate set of birds. There were eight birds maintained in each cage. The same management and immunization program was applied to the birds. According to NRC (1994), the trial meals were designed to provide the broiler chicken nutrient dosages. Free feed and water were offered (through nipple drinkers). Table 1 displays the experimental diets' composition and calculated analyses.

Table 1. Broiler chicken basal diet composition and calculated analysis.

Ingredients	Starter %				Grower %			
(%)	OO	FO	SO	MO	OO	FO	SO	MO
Yellow corn	60.6	60.6	60.6	60.6	63.15	63.15	63.15	63.15
Soybean meal 44	21.52	21.52	21.52	21.52	23.7	23.7	23.7	23.7
Corn Gluten Meal 60.2	12.0	12.0	12.0	12.0	8.1	8.1	8.1	8.1
Di calcium Phosphate	1.85	1.85	1.85	1.85	1.35	1.35	1.35	1.35
Limestone	1.53	1.53	1.53	1.53	1.40	1.40	1.40	1.40
DL-methionine	0.10	0.10	0.10	0.10	0.0	0.0	0.0	0.0
L-Lysine	0.30	0.30	0.30	0.30	0.20	0.20	0.20	0.20
Sodium chloride	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vit+Min Premix[1]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Olive oil	1.5	0.0	0.0	0.5	1.5	0.0	0.0	0.50
Flaxseed oil	0.0	1.5	0.0	0.5	0.0	1.5	0.0	0.50
Soybean oil	0.0	0.0	1.5	0.5	0.0	0.0	1.5	0.50
Total	100	100	100	100	100	100	100	100
				Calculated Analysis				
ME, kcal/Kg	3088	3088	3088	3088	3077	3077	3077	3077
CP, %	22.46	22.46	22.46	22.46	21.02	21.02	21.02	21.02
Crude Fiber, %	2.99	2.99	2.99	2.99	3.15	3.15	3.15	3.15
Ether extract %	2.77	2.77	2.77	2.77	2.79	2.79	2.79	2.79
Calcium %	1.06	1.06	1.06	1.06	0.91	0.91	0.91	0.91
Av-Phosphorus, %	0.46	0.46	0.46	0.46	0.37	0.37	0.37	0.37
Methionine, %	0.52	0.52	0.52	0.52	0.38	0.38	0.38	0.38
Meth. +Cys. (TSAA, %)	0.9	0.9	0.9	0.9	0.74	0.74	0.74	0.74
Lysine, %	1.16	1.16	1.16	1.16	1.08	1.08	1.08	1.08

[1] Premix provided the following per kilogram of diet: Vitamin A (retinyl acetate), 2654 µg; Vitamin D_3 (cholecalciferol), 125 µg; Vitamin E (dl-α-tocopheryl acetate), 9.9 mg; Vitamin K_3 (menadione dimethylpyrimidinol), 1.7 mg; Vitamin B_1 (thiamin mononitrate), 1.6 mg; Vitamin B_{12} (cyanocobalamin), 16.7 µg; Vitamin B_2 (riboflavin), 5.3 mg; niacin (niacinamide), 36 mg; calcium pantothenate, 13 mg; folic acid, 0.8 mg; biotin, 0.1 mg; choline chloride, 270 g ; BHT, 5.8 g; Fe (iron sulphate monohydrate), 50 mg; Cu (copper sulphate pentahydrate), 12 mg; I (calcium iodate), 0.9 mg; Zn (zinc oxide), 50 mg; Mn (manganous oxide), 60 mg; Se (sodium selenite), 0.2 mg and Co (cobalt sulphate), 0.2 mg.

[2] Calculated from data provided by NRC (1994).

Performance of broiler chickens:

Broiler chickens' Live Body Weight (LBW), Feed Intake (FI), and Body Weight Gain (BWG) were recorded weekly during the study period. Then, the Feed Conversion Ratio (FCR), calculates the proportion of feed to gain in grams. Birds in each replication were weighed in the early morning prior to getting any food or water at the start of the trial (day-old), and then against weekly intervals after that. Every day during the study, deaths and medical conditions were visually observed and recorded.

Carcass traits:

At the end of the study (42 days of age), three birds per treatment were randomly chosen for slaughter, and the carcass, liver, gizzard, heart, and lymphoid organs (spleen, bursa of Fabricius, and thymus) were collected. The weight of these organs /live body weight was calculated.

Biochemical evaluation and blood sample:

Blood samples were collected in tubes after the slaughter of three chickens from each treatment. The serum from the blood samples was obtained by centrifuging at 4000 rpm for 15 minutes, and it was then stored at -20°C for analysis. According to the instructions provided by the manufacturers, commercial kits were used to analyze serum samples calorimetrically. Glucose, total protein, albumin, total lipids triglycerides, cholesterol, high-density lipoprotein (HDL), thyroid hormones [triiodothyronine (T3) and thyroxine (T4)], immunoglobin G (IgG, IgA, and IgM), total antioxidant capacity (TAC), superoxide dismutase (SOD), malonaldehyde (MDA), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP).

Tissue specimens and histological procedures:

After being promptly fixed in 10% formalin-saline solution, representative tissue samples from the duodenum were obtained. These samples were subsequently dehydrated in alcohol solutions with escalating alcohol concentrations, ranging from 70% to 100% ethanol alcohol. Samples were washed in xylene and then embedded in melted paraffin wax to produce tissue blocks. Hematoxylin and eosin stain were used to segment and color them (Junquerira *et al.,* 1971). A digital camera was utilized to snap pictures while a light microscope was used to examine the sections.

Statistical analysis:

Each trial in this study had a totally random design. Using the SAS program (SAS, 2006), the data were statistically analyzed as a factorial design arrangement (4^x2). The Tukey multiple range test was employed to distinguish between means with significant differences (Tukey, 1977)

RESULTS AND DISCUSSION

Growth performance of broiler chicks:

Live body weight:

The effects of dietary different sources of vegetable oil and dietary red cranberry powder on live body weight of broiler chickens from 0 to 42 days of age are given in Table 2. In the present study, supplementation of different vegetable oils in the diet influenced the LBW of broiler chicks at 7, 14, 21, 28, 35 or 42 days of age. In addition to the impact of red cranberry powder, supplementation of flaxseed oil at a level of 15 g/kg diet had a positive effect (P≤0.05) on LBW of chicks during the whole experiment period compared to other different oils (olive oil, soybean oil, and mixture oils, 15g/kg, respectively). However, adding the red cranberry powder at level 1 g/kg led to a significance increase (P≤0.05) in LBW of broiler chicks during the whole experimental period compared to without adding red cranberry powder, regardless of the results of adding dietary oil. However red cranberry powder did not effect on LBW of chicks at 7 and 14 days of age. Dietary different oils supplementation by adding red cranberry powder interactions had no effect (P>0.05) on LBW at different ages. Crespo and Esteve-Garcia (2001) found that the final live weight and feed conversion ratio of broilers did not change when olive oil was applied at rates of 6 and 10%. El-Deek *et al.* (2005) furthermore discovered that broiler growth performance under heat stress was unaffected by olive oil at different levels (0.0 versus 2.5 and 5.0%). On the other hand, Taher (2018) showed that feeding 0.6% flaxseed oil increased (p≤ 0.05) the growth rate of broiler chickens. Similar results were found by Sahib *et al.* (2012) when compared to the control group, the live body weight of the 0.6% flaxseed oil considerably increased (P>0.05). The existence of essential fatty acids in flaxseed oil may be the cause of this large rise over the course of the entire study period. Due to the fact that flaxseed is high in omega-3, which activates the bile and increases the digestion of fats in the colon, the benefits of the diet are increased (Al-Zuhairy and Alasadi, 2013). In addition, Das *et al.* (2020) discovered that adding supplements to commercial broilers' feed during their growing and starting phases dramatically enhanced their body weight.

Table 2. Effects of dietary different sources of vegetable oil and red cranberry powder on live body weight (LBW; kg) of broiler chicks from 0-42 days of age

Main effects:	LBW-٠ day	LBW-٧ day	LBW-١٤ day	LBW-2١ day	LBW-٢٨ day	LBW-٣٥ day	LBW-4٢ day
				Dietary oil sources (DOS)			
Olive oil (OO)	0.0397	0.0910^b	0.2116^b	0.4955^b	1.0155^c	1.5430^d	2.0855^d
Flaxseed oil (FO)	0.0397	0.0956^a	0.2270^a	0.5243^a	1.0700^a	1.6283^a	2.2180^a
Soybean oil (SO)	0.0397	0.0920^b	0.2101^b	0.4986^b	1.0214^c	1.5601^c	2.1216^c
Mixture oil (MO)	0.0397	0.0926^b	0.2186^{ab}	0.5188^a	1.0533^b	1.6060^b	2.1926^b
SEM	0.0001	0.0005	0.0024	0.0013	0.0032	0.0038	0.0054
p-value	0.9492	0.0001	0.000١	0.0001	0.0001	0.0001	0.0001
				Red cranberry powder (RB)			
Without (RB0)	0.0397	0.0924	0.2144	0.5057^b	1.0330^b	1.5745^b	2.1364^b
With (RB1)	0.0397	0.0932	0.2193	0.5129^a	1.0470^a	1.5941^a	2.1725^a
SEM	0.00007	0.0003	0.0017	0.00096	0.0023	0.0027	0.0038
p-value	0.7056	0.1289	0.0642	٠.0001	0.000١	0.0001	0.0001
				Interaction DOS * RB			
OO*RB0	0.0397	0.0906	0.2086	0.4900	1.0093	1.5330	2.0633
OO*RB1	0.0397	0.0913	0.2146	0.5010	1.0216	1.5530	2.1076
FO*RB0	0.0397	0.0950	0.2260	0.5223	1.0666	1.6210	2.2063
FO*RB1	0.0397	0.0963	0.2280	0.5263	1.0733	1.6356	2.2296
SO*RB0	0.0398	0.0916	0.2073	0.4950	1.0146	1.5513	2.1030
SO*RB1	0.0397	0.0923	0.2130	0.5023	1.0281	1.5690	2.1403
MO*RB0	0.0397	0.0923	0.2156	0.5156	1.0416	1.5930	2.1730
MO*RB1	0.0396	0.0930	0.2216	0.5220	1.0650	1.6190	2.2123
SEM	0.00015	0.00073	0.00349	0.0019	0.0046	0.0054	0.0077
p-value	0.9756	0.9574	0.9246	0.3632	0.3733	0.7599	0.5824

As demonstrated in the table below, for each of the key impacts, the means in the same column with different superscripts differ considerably (P≤ 0.05).

Body weight gain:

Table 3 displays the effects of feeding with various sources of vegetable oil and red cranberry powder on body weight gain (BWG) in broiler chickens from 0 to 42 days of age. It was observed that dietary flaxseed oil at a level of 15 g/kg did significantly influence (P≤ 0.05) BWG of broiler chicks for the whole experimental period (0-42 days of age) compared to other supplementation oils (olive oil (15g/kg), soybean oil (15g/kg) and mixture oil 15 g/kg)), irrespective of the effect of adding red cranberry powder. However, adding red cranberry powder led to significant increases (P≤0.05) in BWG of broiler chicks for the whole experimental period compared without red cranberry powder, regardless of the effect of dietary different vegetable oil supplementation. The interactions between dietary different vegetable oil and red cranberry powder were not significant (P>0.05) for all age intervals examined. Contrary to these investigations, El Shanti et al. (2011) observed that 6% olive oil sediments improved the BWG. According to Zhang *et al.* (2013), the starting phase (0 to 21d) BWG and FI were reduced when 5% olive oil was added to the diet. In line with our findings, Zhang *et al.* (2003) found that feeding broiler hens diets containing 2 to 5% plant oils significantly reduced BWG and feed conversion ratio. Stanaćev *et al.,* 2013 showed that when compared to groups receiving therapy with 8% rapeseed and soybean oil, chickens receiving treatment with 4% flaxseed oil in the food had considerably higher body mass at the end of the experiment. On the other hand, Aldemi, 2022 discovered that adding juniper berries to the broiler diet at a rate of 0.5–1% improves body weight by 3–6 weeks.

Table 3. Effects of dietary different sources of vegetable oil and red cranberry powder **on body weight gain (BWG; kg) of broiler chicks from 0-42 days of age.**

Main effects:	BWG 0-7 day	BWG 7-14 day	BWG 14-21 day	BWG 21-28 day	BWG 28-35 day	BWG 35-42 day	TBWG 0-42 day
			Dietary oil sources (DOS)				
Olive oil (OO)	0.0512^{b}	0.1206^{b}	0.2838^{c}	0.5200^{c}	0.5275^{c}	0.5425^{c}	2.0457^{d}
Flaxseed oil (FO)	0.0555^{a}	0.1313^{a}	0.2973^{ab}	0.5456^{a}	0.5583^{a}	0.5896^{a}	2.1782^{a}
Soybean oil (SO)	0.0522^{b}	0.1181^{b}	0.2885^{bc}	0.5227^{c}	0.5387^{b}	0.5615^{b}	2.0818^{c}
Mixture oil (MO)	0.0529^{b}	0.1260^{ab}	0.3001^{a}	0.5345^{b}	0.5526^{a}	0.5866^{a}	2.1529^{b}
SEM	0.0005	0.0024	0.0025	0.0025	0.0014	0.0022	0.0055
p-value	<.0001	0.0066	0.001	<.0001	<.0001	<.0001	<.0001
			Red cranberry powder (RB)				
Without (RB0)	0.0526	0.1220	0.2913	0.5273^{b}	0.5415^{b}	0.5618^{b}	2.0966^{b}
With (RB1)	0.0535	0.1260	0.2935	0.5341^{a}	0.5471^{a}	0.5783^{a}	2.1327^{a}
SEM	0.0003	0.0017	0.0017	0.0017	0.0010	0.0016	0.0039
p-value	0.1009	0.1103	0.3886	0.0153	0.0013	<.0001	<.0001
			Interaction DOS * RB				
OO*RB0	0.0509	0.1180	0.2813	0.5193	0.5236	0.5303	2.0236
OO*RB1	0.0515	0.1233	0.2863	0.5206	0.5313	0.5546	2.0679
FO*RB0	0.0552	0.1310	0.2963	0.5443	0.5543	0.5853	2.1666
FO*RB1	0.0566	0.1316	0.2983	0.5470	0.5623	0.5940	2.1899
SO*RB0	0.0518	0.1156	0.2876	0.5196	0.5366	0.5516	2.0631
SO*RB1	0.0526	0.1206	0.2893	0.5258	0.5408	0.5713	2.1006
MO*RB0	0.0526	0.1233	0.3000	0.5260	0.5513	0.5800	2.1332
MO*RB1	0.0533	0.1286	0.3003	0.5430	0.5540	0.5933	2.1726
SEM	0.0007	0.0034	0.0035	0.0035	0.0020	0.0032	0.0078
p-value	0.9533	0.8787	0.9278	0.1523	0.4962	0.1190	0.5911

As demonstrated in the table below, for each of the key impacts, the means in the same column with different superscripts differ considerably (P≤ 0.05).

Feed intake:

Table 4 displays the effects of dietary various sources of vegetable oils and red cranberry powder on the feed intake (FI) of broiler chicks aged 0 to 42 days. In addition to the effect of adding red cranberry powder, diet with flaxseed oil at a level of 15 g/kg led to a significant reduction in the FI of chicks over the course of the entire experimental period in comparison to other oils (15 g/kg each of olive oil, soybean oil, and mixture oil). On the other hand, adding red cranberry powder had no effect (P>0.05) on FI of chicks during the periods of 0-7, 14-21, 21-28, 35-42, or 0-42 days of age while, the adding red cranberry powder significantly increased (P≤0.05) FI of birds during the period of 7-14 days of age, but adding red cranberry powder significantly reduced FI of birds during the period of 28-35 days of age compared without adding red cranberry powder, independently from the effect of dietary different sources of oils. Meanwhile, dietary different sources of vegetable oils and red cranberry powder interactions had no effect (P>0.05) on FI for all age intervals examined. The current study's findings on feed intake throughout the starter and finisher phases contrast with those of Azman *et al.* (2004) and Abdulla *et al.* (2016), who found that adding additional dietary lipids to broilers had no effect on their FI. Ayed *et al.* (2015) found that the beginning phase (0–16 days) of dietary oil inclusion had no effect on feed intake, indicating that the dietary fatty acid composition had no impact on the performance of broilers at this stage. The consumption of feed was higher for chickens fed a regular diet and a diet based on palm oil throughout the subsequent periods than it was for birds fed a diet based on soybean oil. These findings show that feed intake is decreased when soybean oil is added to broiler diets.

Feed conversion ratio:

Table 5 shows the effects of various vegetable oil sources on the feed conversion ratio (FCR) of broiler chicks aged 0 to 42 days. In addition to the effect of adding red cranberry powder, adding flaxseed oil to the diet at a rate of 15 g/kg significantly (P≤0.05) increased the FCR of chicks over the course of the entire experimental period compared to adding olive oil (15 g/kg), soybean oil (15 g/kg), and mixture oil (15 g/kg).On the other hand, adding red cranberry powder had no effect (P>0.05) on FCR of chicks during the periods of 0-7, 7-14, or 21-28 days of age but, the adding red cranberry powder improved significantly FCR of birds during the periods of 14-21, 28-35, 35-42 or 0-42 days of age compared without adding red cranberry powder, irrespective of the effect of dietary different sources of vegetable oils. Additionally, across all age ranges tested, there were no statistically significant interactions (P>0.05) between various vegetable oil sources and cranberry powder on FCR of broilers. The results of the current study are consistent with those of Mirshekar *et al.* (2012) who found that supplementing flaxseed oil for only a short time of one week (between 29 and 35 days of age) improved FCR. This improvement may be attributed to the high content of -linolenic acid in the flaxseed oil, as Duarte *et al.* (2014) explained that dietary -linolenic acid may have potential advantages on broiler performance. Stanaćev et al., 2013 discovered that the group's feed conversion ratio was highest with the addition of 8% flax oil and was lowest with the addition of 4% flax oil and rapeseed oil.

Table 4. Effects of dietary different sources of vegetable oil and red cranberry powder on feed intake (FI; kg) of broiler chicks from 0-42 days of age.

Main effects:	FI 0-7 day	FI 7-14 day	FI 14-21 day	FI 21-28 day	FI 28-35 day	FI 35-42 day	TFI 0- 42 day
			Dietary oil sources (DOS)				
Olive oil (OO)	0.0975	0.1495	0.4399^{ab}	0.8729	0.9565^{ab}	1.0033^{b}	3.5198^{a}
Flaxseed oil (FO)	0.0941	0.1501	0.3945^{c}	0.8483	0.9048^{c}	1.0029^{b}	3.3950^{b}
Soybean oil (SO)	0.0803	0.1442	0.4406^{a}	0.8748	0.9598^{a}	1.0208^{ab}	3.5206^{a}
Mixture oil (MO)	0.0945	0.1518	0.4207^{b}	0.8556	0.9173^{bc}	1.0519^{a}	3.4919^{ab}
SEM	0.0071	0.0019	0.0047	0.0111	0.0103	0.0089	0.0269
p-value	0.3628	0.0670	0.0001	0.2922	0.0028	0.0041	0.0136
			Red cranberry powder (RB)				
Without (RB0)	0.0873	0.1462^{b}	0.4288	0.8610	0.9488^{a}	1.0150	3.4874
With (RB1)	0.0959	0.1516^{a}	0.4190	0.8647	0.9204^{b}	1.0244	3.4763
SEM	0.0050	0.0013	0.0033	0.0078	0.0072	0.0063	0.0190
p-value	0.2498	0.0123	0.0577	0.7447	0.0139	0.3102	0.6849
			Interaction DOS * RB				
OO*RB0	0.0966	0.1464	0.4417	0.8808	0.9582	1.0041	3.5279
OO*RB1	0.0983	0.1526	0.4382	0.8650	0.9548	1.0026	3.5116
FO*RB0	0.0940	0.1490	0.4023	0.8476	0.9217	1.0053	3.4202
FO*RB1	0.0943	0.1512	0.3867	0.8490	0.8880	1.0005	3.3698
SO*RB0	0.0660	0.1416	0.4494	0.8747	0.9753	1.0160	3.5232
SO*RB1	0.0946	0.1467	0.4319	0.8748	0.9443	1.0255	3.5181
MO*RB0	0.0926	0.1476	0.4220	0.8411	0.9401	1.0347	3.4783
MO*RB1	0.0963	0.1560	0.4194	0.8701	0.8945	1.0691	3.5056
SEM	0.0101	0.0027	0.0067	0.0157	0.0145	0.0126	0.03807
p-value	0.4739	0.7275	0.5832	0.5689	0.5389	0.4270	0.7874

As demonstrated in the table below, for each of the key impacts, the means in the same column with different superscripts differ considerably (P≤ 0.05).

Table 5. Effects of dietary different sources of vegetable oil and red cranberry powder on feed conversion ratio (FCR; kg feed: kg gain) of broiler chicks from 0-42 days of age.

Main effects:	FCR 0-7 day	FCR 7-14 day	FCR 14-21 day	FCR 21-28 day	FCR 28-35 day	FCR 35-42 day	TFCR 0-42 day
			Dietary oil sources (DOS)				
Olive oil (OO)	1.902	1.240^{a}	1.550^{a}	1.655^{a}	1.815^{a}	1.850^{a}	1.720^{a}
Flaxseed oil (FO)	1.683	1.143^{b}	1.327^{c}	1.519^{c}	1.620^{b}	1.701^{c}	1.558^{c}
Soybean oil (SO)	1.540	1.221^{a}	1.528^{a}	1.623^{ab}	1.781^{a}	1.818^{ab}	1.691^{a}
Mixture oil (MO)	1.784	1.206^{ab}	1.401^{b}	1.548^{bc}	1.660^{b}	1.793^{b}	1.621^{b}
SEM	0.139	0.0192	0.0177	0.0209	0.0184	0.0129	0.0121
p-value	0.3387	0.0152	0.0001	0.0009	0.0001	0.0001	0.0001
			Red cranberry powder (RB)				
Without (RB0)	1.660	1.201	1.474^{a}	1.591	1.753^{a}	1.809^{a}	1.665^{a}
With (RB1)	1.794	1.205	1.429^{b}	1.581	1.684^{b}	1.772^{b}	1.631^{b}
SEM	0.0989	0.0136	0.0125	0.0147	0.0130	0.0091	0.0086
p-value	0.3526	0.8446	0.0210	0.6334	0.0016	0.0117	0.0135
			Interaction DOS * RB				
OO*RB0	1.899	1.242	1.570	1.682	1.830	1.893	1.743
OO*RB1	1.906	1.238	1.530	1.628	1.797	1.808	1.698
FO*RB0	1.701	1.138	1.358	1.529	1.662	1.717	1.578
FO*RB1	1.665	1.149	1.296	1.510	1.579	1.684	1.536
SO*RB0	1.280	1.226	1.563	1.630	1.817	1.841	1.707
SO*RB1	1.800	1.217	1.493	1.617	1.745	1.795	1.674
MO*RB0	1.761	1.198	1.407	1.525	1.705	1.784	1.630
MO*RB1	1.807	1.214	1.396	1.570	1.615	1.802	1.613
SEM	0.1978	0.0272	0.0250	0.0295	0.0260	0.0183	0.0172
p-value	0.4823	0.9604	0.6516	0.4323	0.7002	0.0787	0.8551

As demonstrated in the table below, for each of the key impacts, the means in the same column with different superscripts differ considerably (P≤ 0.05).

Broiler chick lymphoid organs and carcass characteristics:

Table 6 shows the impact of nutritional supplementation with various sources of vegetable oils and red cranberry powder on the carcass characteristics and percentage of lymphoid organs in broiler chicks (42 days old). The percentage of the carcass, gizzard, heart, abdominal fat, and thymus of broilers fed different oil were significant between-group oils, whereas a better percentage was found in broiler group fed flaxseed oil and mixture oil. However, the lowest percentage of abdominal fat was in birds fed a diet containing flaxseed oil. On the other hand, there is no significant difference among the experimental groups fed different oils in the percentage of liver, spleen, and bursa of Fabricius. Adding red cranberry powder had no effect (P>0.05) in all organ percentage weights, except the weight of the percentage thymus gland was lower when the birds fed red cranberry powder. Interactions between dietary different oils and added red cranberry powder were not significant for all carcass traits studied except gizzard, spleen and abdominal fat. The present results agree with the findings of Stanaćev *et al.* (2012), which examined how different vegetable oils affected broiler chickens' diets came to the conclusion that using 4 and 8% flaxseed oil did not significantly alter production metrics or carcass quality. According to Stanaćev *et al.,* 2013 all measured parameters show very little variation, and the effect of feeding treatment on carcass yield (which included 4% and 8% soybean, 4% and 8% flaxseed oil, and 4% and 8% rapeseed oil) was not statistically significant (P>0.05). Similarly, the weight and percentage of the thymus were significantly impacted by the source of the fat. Poorghasemi e*t al.* (2013). However, oil treatments had no impact on the weight of the bursa of Fabricius, the weight and proportion of the spleen to SRBC injections, or the response to NDV, IBDV, or IBV vaccinations Poorghasemi *et al.* (2015). A broilers diet supplemented with multi-enzyme and emulsifiers along with a low-density diet had no effect on breast yield with a high-density diet Cho *et al.,* 2012. However, Nobakht *et al.* (2011) reported a significant effect of different levels and oil sources on the relative weight of gizzard. However, Vazquez *et al.,* 2017 reported that the properties of hot and cold carcasses were unaffected by different aromatic plants or essential oils.

Table 6. Effects of dietary different sources of vegetable oil and red cranberry powder on carcass and lymphoid organs weights of 42-day-old broiler chicks.

Main effects:	LBW (g)	Carcass (%)	Liver (%)	Gizzard (%)	Heart (%)	Spleen (%)	Abdominal fat (%)	Thymus (%)	Bursa (%)
Dietary oil sources (DOS)									
Olive oil (OO)	2085^{d}	70.00^{c}	2.900	1.493^{b}	0.5591^{b}	0.123	0.549^{bc}	0.337^{b}	0.1758
Flaxseed oil (FO)	2218^{a}	73.83^{a}	2.863	1.698^{a}	0.6840^{a}	0.112	0.413^{c}	0.540^{a}	0.1501
Soybean oil (SO)	2121^{c}	72.00^{b}	2.805	1.508^{b}	0.6281^{ab}	0.102	0.817^{a}	0.51^{ab}	0.1415
Mixture oil (MO)	2192^{b}	73.00^{ab}	2.842	1.657^{a}	0.6611^{ab}	0.098	0.623^{b}	0.578^{a}	0.1595
SEM	5.492	0.3430	0.0604	0.0327	0.0280	0.0096	0.0348	0.0458	0.0231
p-value	0.0001	0.0001	0.7345	0.0006	0.0323	0.2827	0.0001	0 .0087	0.7523
Red cranberry powder (RB)									
Without (RB0)	2136^{b}	72.33	2.851	1.576	0.6225	0.106	0.585	0.5679^{a}	0.1559
With (RB1)	2172^{a}	72.08	2.854	1.601	0.6436	0.111	0.616	0.4198^{b}	0.1575
SEM	3.88	0.242	0.0427	0.0231	0.0198	0.0068	0.0246	0.0324	0.0163
p-value	0.0001	0.4774	0.9719	0.4501	0.4630	0.6051	0.3797	0.0053	0.9434
Interaction DOS * RB									
OO*RB0	2063	70.00	2.890	1.389	0.533	0.0890	0.4036	0.4523	0.1616
OO*RB1	2107	70.00	2.909	1.597	0.585	0.1586	0.6960	0.2216	0.1900
FO*RB0	2206	74.33	2.856	1.692	0.680	0.1360	0.4226	0.5433	0.1510
FO*RB1	2229	73.33	2.870	1.704	0.687	0.0896	0.4036	0.5380	0.1493
SO*RB0	2103	72.00	2.822	1.537	0.617	0.0950	0.8246	0.5703	0.1426
SO*RB1	2140	72.00	2.788	1.479	0.638	0.1090	0.8100	0.4676	0.1403
MO*RB0	2173	73.00	2.837	1.687	0.659	0.1073	0.6900	0.7056	0.1683
MO*RB1	2212	73.00	2.847	1.627	0.533	0.0903	0.5573	0.4520	0.1506
SEM	7.767	0.485	0.0855	0.0462	0.0396	0.0136	0.0493	0.0649	0.0327
p-value	0.5824	0.6685	0.9880	0.0332	0.9245	0.0041	0.0036	0.2289	0.9129

As demonstrated in the table below, for each of the key impacts, the means in the same column with different superscripts differ considerably (P≤ 0.05).

Blood serum parameters: -

Results of serum parameters (total protein, albumin, globulin, triglycerides, cholesterol, total lipids, HDL, glucose, antioxidant status, immunoglobin G, thyroid hormones ALT, AST, and ALP) for the different experimental groups of broiler chickens fed diets supplemented with different sources of vegetable oils and red cranberry powder are illustrated in Table 7 and 8. Feeding diets with different oil sources had no significant effect on albumin, triglycerides, total lipids, HDL, glucose, antioxidant status, immunoglobin G, thyroid hormones AST, and ALP among all groups. But significantly lower serum levels of total protein and globulin for broilers fed flaxseed oil compared with those fed olive oil or soybean oil. On the other hand, the olive oil-fed supplement group had significantly higher levels of cholesterol than the other groups. However, serum ALT levels were significantly higher with flaxseed oil supplementation of broiler chickens than in the other groups. While dietary red cranberry powder had no significant effect on all serum parameters investigated among with or without berry powder groups. In addition, no significant interactions (P>0.05) were observed between different sources of vegetable oils and berry powder on serum parameters of broilers for at all age intervals investigated.

On the other hand, dietary fat sources had no impact on T4 and T3:T4 ratio. In weather that is warmer, thyroid hormones are less active, and they play a role in controlling the anabolic and catabolic pathways of protein, lipid, and carbohydrate metabolism Lachowicz *et al.,* 2009.

According to Attia *et al.,* 2020 different oil sources had no discernible impact on IgA, but FO supplementation significantly reduced IgG and IgM levels in comparison to the other oil groups. However, Yildirim *et al.* (2014) found no discernible differences in IgG among their experimental groups supplemented with sunflower oil and cocoa butter. However, the humoral immune response to SRBC injections or to NDV, IBDV, or IBV vaccines administered by various oil sources did not differ significantly from one another Poorghasemi *et al.* (2015). In addition, the total protein or albumin and globulin were not affected by dietary cranberry pomace Greenacre *et al.,* 2008. While there were non-significant differences in ALP levels between the enzyme-treated and non-enzyme-treated cranberry pomace (Brugere-Picoux *et al.* 2015).

Table 7. Effects of dietary different sources of vegetable oil and red cranberry powder on serum parameters total protein, albumin, globulin, triglycerides, cholesterol, total lipids, HDL and glucose of 42-day-old broiler chicks.

Main effects:	T. Protein g/dl	Albumin g/dl	Globulin g/dl	Triglycerides mg/dl	Cholesterol mg/dl	T.Lipids mg/dl	HDL mg/dl	Glucose mg/dl
				Dietary oil sources (DOS)				
Olive oil (OO)	5.982[a]	2.763	3.219[a]	179.1	217.08[a]	5.809	39.23	84.29
Flaxseed oil (FO)	5.293[c]	2.529	2.764[ab]	177.6	203.2[b]	6.298	42.92	83.33
Soybean oil (SO)	5.865[ab]	2.540	3.325[a]	177.6	200.8[b]	6.298	41.75	82.45
Mixture oil (MO)	5.376[bc]	2.862	2.514[b]	177.7	204.4[b]	5.815	39.59	82.06
SEM	0.125	0.0917	0.1657	3.115	2.676	0.273	1.652	2.768
p-value	0.0022	0.0494	0.0099	0.9833	0.0025	0.3972	0.364	0.9419
				Red cranberry powder (RB)				
Without (RB0)	5.575	2.629	2.944	176.2	207.3	6.173	40.32	84.78
With (RB1)	5.689	2.717	2.967	179.8	205.4	5.937	41.43	81.29
SEM	0.088	0.0648	1.892	2.202	1.892	0.1936	1.168	1.957
p-value	0.3872	0.3470	0.8949	0.2666	0.5042	0.4014	0.5111	0.2256
				Interaction DOS * RB				
OO*RB0	6.065	2.779	3.286	175.1	217.7	5.976	38.55	85.60
OO*RB1	5.899	2.745	3.153	183.0	216.4	5.643	39.92	82.98
FO*RB0	5.298	2.445	2.853	173.9	194.5	6.498	45.25	86.96
FO*RB1	5.287	2.612	2.675	181.2	212.0	6.098	40.59	79.71
SO*RB0	5.665	2.479	3.186	181.3	207.1	6.343	38.88	82.84
SO*RB1	6.065	2.601	3.464	173.9	194.5	6.254	44.62	82.05
MO*RB0	5.265	2.812	2.453	174.3	209.8	5.876	38.59	83.72
MO*RB1	5.487	2.912	2.575	181.0	198.9	5.754	40.59	80.41
SEM	0.171	0.1297	0.234	4.405	3.784	0.3873	2.336	3.915
p-value	0.4189	0.8811	0.7389	0.2869	0.0039	0.9705	0.2075	0.8662

As demonstrated in the table below, for each of the key impacts, the means in the same column with different superscripts differ considerably (P≤ 0.05).

Table 8. Effects of dietary different sources of vegetable oil and red cranberry powder on serum parameters antioxidant status, immunoglobin G, thyroid hormones, ALT, AST, and ALP of 42-day-old broiler chicks.

Main effects:	SOD U/mg	TAC Umol/l	MDA Umol/l	IgG mg/100ml	IgA mg/100ml	IgM mg/100ml	T3 Ug/100ml	T4 Ug/100ml	ALT Iu/l	AST Iu/l	ALP u/100ml
					Dietary oil sources (DOS)						
Olive oil (OO)	3136	425.7	1.125	997.4	83.041	252.84	0.1780	7.805	64.05[b]	57.75	7.796
Flaxseed oil (FO)	3136	426.6	1.060	997.1	81.320	255.51	0.1665	8.009	68.40[a]	59.39	7.739
Soybean oil (SO)	3122	426.2	1.072	998.9	84.098	251.17	0.1796	7.727	65.09[ab]	57.62	7.539
Mixture oil (MO)	3127	425.2	1.093	991.87	84.265	258.73	0.1750	7.622	67.53[ab]	54.41	7.540
SEM	4.648	2.878	0.0484	4.404	2.2077	5.461	0.0144	0.2133	0.889	1.347	0.160
p-value	0.1371	0.9878	0.7952	0.6945	0.7715	0.7788	0.9188	0.6319	0.0104	0.1064	0.5680
					Red cranberry powder (RB)						
Without (RB0)	3128	425.2	1.109	999.1	81.32	254.0	0.175	7.876	66.33	57.090	7.531
With (RB1)	3132	426.6	1.066	993.5	85.04	255.1	0.174	7.705	66.21	57.50	7.776
SEM	3.286	2.035	0.0342	3.114	1.561	3.862	0.010	0.150	0.6292	0.9525	0.113
p-value	0.4356	0.6390	0.392	0.2252	0.1112	0.8414	0.9231	0.4345	0.8930	0.7620	0.1464
					Interaction DOS * RB						
OO*RB0	3128	421.0	1.162	998.8	82.65	254.5	0.178	8.092	62.59	58.08	7.529
OO*RB1	3144	430.5	1.088	995.9	83.43	251.1	0.178	7.519	65.51	57.43	8.063
FO*RB0	3138	425.2	1.059	999.7	79.32	248.3	0.183	7.866	67.59	59.87	7.581
FO*RB1	3133	428.0	1.062	994.5	83.32	262.6	0.150	8.152	69.21	58.92	7.896
SO*RB0	3125	427.4	1.022	1002	80.09	251.4	0.166	7.789	65.59	56.27	7.622
SO*RB1	3118	424.9	1.122	995.5	88.10	250.9	0.193	7.666	64.59	58.97	7.455
MO*RB0	3122	427.3	1.193	995.5	83.21	261.6	0.175	7.759	69.54	54.13	7.392
MO*RB1	3133	423.1	0.993	988.2	85.32	255.7	0.175	7.485	65.52	54.69	7.689
SEM	6.573	4.07	0.0685	6.228	3.122	7.724	0.0204	0.3017	1.258	1.905	0.224
p-value	0.2522	0.3576	0.2046	0.9842	0.6827	0.5707	0.5489	0.5649	0.0627	0.7689	0.4890

As demonstrated in the table below, for each of the key impacts, the means in the same column with different superscripts differ considerably (P≤ 0.05).

Histological observations of duodenum **gut: -**

The gut morphology characteristics of broiler chicken fed different sources of vegetable oils and red cranberry powder are shown in Table 9 and Fig.1. The duodenum of birds fed a mixture of oils and flaxseed oil showed greater villus height ($P < 0.05$) compared with those fed olive oil or soybean oil in finisher phases. However, the villus width and crypt depth of the duodenum were greater in birds fed a mixture of oils and soybean oil than in olive oil and flaxseed oil in the finisher phases. On the other hand, the muscle thickness in the duodenum gut of broiler chickens fed olive oil was greater than other treatments in phase finisher. However the dietary red cranberry powder significantly improved the villus height, crypt depth, and muscle thickness of birds during the finisher periods compared to without red cranberry powder. Moreover, the villus width of the duodenum was better in birds fed diets without red cranberry powder than in those fed red cranberry powder. The interactions among the various sources of oil and red cranberry powder levels were not statistically significant ($P >0.05$) in villus width and crept depth but were significantly different in villus height and muscle thickness. Demonstrated that adding flaxseed meal to a diet had positive impacts on the duodenum and jejunum's morphology, as evidenced by a notable rise in villus height, which almost certainly boosted nutritional absorption. The features of the intestine absorptive surface regulate absorption efficiency Kielaa and Ghishan (2016). The digestive tract's intestinal villi serve as a critical location for nutrition absorption. The amount of nutrient-available surface area determines how effectively nutrients are absorbed. Due to greater absorptive surface area, higher villus height of the gut is correlated with increased absorptive and digestive processes of the intestine (Amat *et al.* 1996). In addition, Aldemir (2022) The villi lengths of the juniper groups displayed a stronger tendency in response to linearly increasing juniper berry contents in the diets. Increased villi lengths boost nutrient digestion and absorption, which has a positive impact on body weight, feed intake, and FCR.

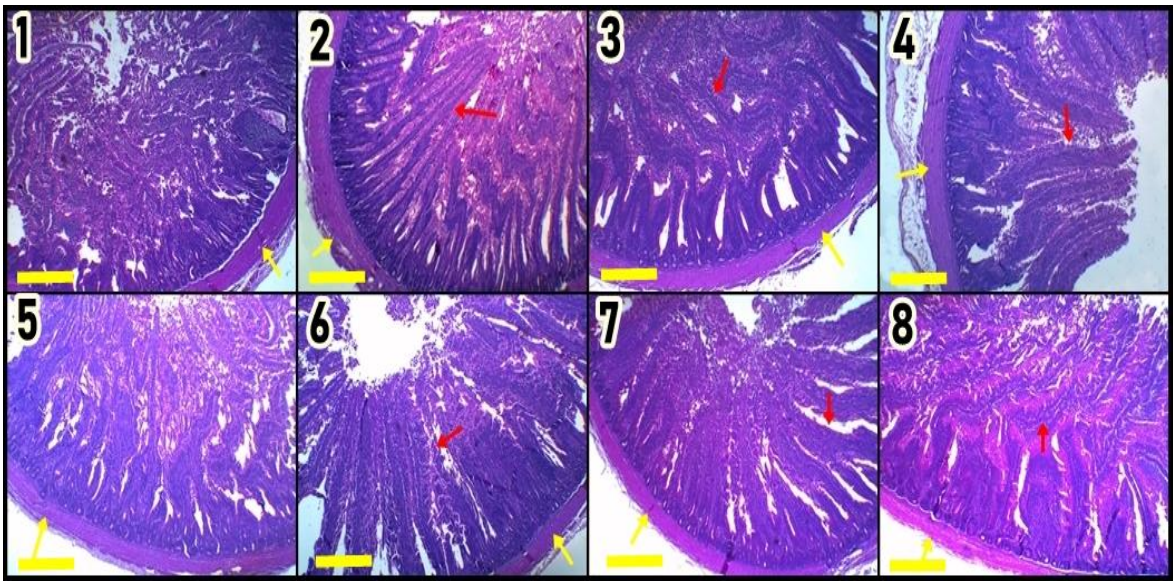

Fig. 1. The sections of the small intestines(duodenum) showing villus height (red arrow), villus width, Crypt depth and Muscular is thickness (yellow arrow) in all group. Hematoxylin and eosin staining. Scale bars represent 200µm. number 1:- T. S. of duodenum from group content 1.5% Oliva oil , number 2:- T. S. of duodenum from group content 1.5% Oliva oil plus 1g/kg Red cranberry powder(RB), number3:-T. S. of duodenum from group content 1.5% flaxseed oil , number 4:- T. S. of duodenum from group content 1.5% flaxseed oil plus 1g/kg RB, number 5:-T. S. of duodenum from group content 1.5% soybean oil , number 6:- T. S. of duodenum from group content 1.5% soybean oil plus 1g/kg RB, number7:- T. S. of duodenum from group content 1.5% mixture oil , number8:- T. S. of duodenum from group content 1.5% mixture oil plus 1g/kg RB.

Table 9. Villus height, villus width, crypt depth and muscle thickness in the duodenum of broiler chickens at 42 days of dietary with different sources of oil and red cranberry powder.

Main effects:	Villus height (µm)	Villus width (µm)	Crept depth (µm)	Muscle thickness µm
Dietary oil sources (DOS)				
Olive oil (OO)	393.9^{c}	28.10^{b}	84.36^{b}	70.62^{a}
Flaxseed oil (FO)	506.2^{b}	28.71^{b}	88.97^{b}	54.19^{b}
Soybean oil (SO)	423.8^{c}	43.07^{a}	113.5^{a}	43.23^{c}
Mixture oil (MO)	605.8^{a}	44.99^{a}	123.6^{a}	45.68^{c}
SEM	16.61	2.023	4.780	1.728
p-value	0.0001	0.0001	0.0001	0.0001
Red cranberry powder (RB)				
Without (RB0)	422.6^{b}	39.95^{a}	93.44^{b}	50.10^{b}
With (RB1)	542.3^{a}	32.48^{b}	111.7^{a}	56.76^{a}
SEM	11.75	1.431	3.380	1.222
p-value	0.0001	0.0007	0.0006	0.0004
Interaction DOS * RB				
OO*RB0	268.7	32.62	70.95	63.26
OO*RB1	519.0	23.58	97.77	77.99
FO*RB0	455.7	28.37	88.41	45.42
FO*RB1	556.8	29.05	89.53	62.96
SO*RB0	410.8	50.30	108.57	47.64
SO*RB1	436.9	35.84	118.42	38.83
MO*RB0	555.1	48.52	105.83	44.10
MO*RB1	656.6	41.45	141.44	47.26
SEM	23.50	2.862	6.760	2.444
p-value	0.0003	0.0823	0.0624	0.0001

As demonstrated in the table below, for each of the key impacts, the means in the same column with different superscripts differ considerably ($P \leq 0.05$).

CONCLUSION

The results of this study indicate that adding flaxseed oil to the diet at a level of 15g/kg and red cranberry powder at a level of 1g/kg has a good impact on broiler chickens' productive performance, carcass yield, some blood parameters, and gut morphology.

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تأثير مصادر الزيوت النباتية الغذائية ومستويات مسحوق التوت البري الأحمر علي الأداء الأنتاجي وجودة الذبيحة وبعض مقاييس الدم ومورفولوجيا الأمعاء علي كتاكيت التسمين

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الملخص

أجريت هذه الدراسة لمعرفة تأثير أضافة مصادر الزيوت النباتية ومسحوق التوت البري الأحمر علي الأداء الإنتاجي وجودة الذبيحة ومقاييس الدم ومورفولوجيا الأمعاء لكتاكيت التسمين. حيث تم تقسيم عدد ١٩٢ كتكوت تسمين عمر يوم من سلالة روس٣٠٨ عشوائيا إلي ثمانية مجموعات حيث كانت كل مجموعة تحتوي علي ثلاث مكررات. حيث تم أستخدام تصميم تجربة عاملية ٤ x ٢ و هي عبارة عن أربع معاملات من الزيوت النباتية علي النحو التالي (١,٥% زيت زيتون و ١,٥% زيت كتان و ١,٥% زيت فول صويا و ١,٥% زيت مخلوطهم ثم تم تقسيم كل معاملة منهم إلي جزئين حيث الجزء الأول لا يحتوي علي مسحوق التوت البري الأحمر أما الجزء الثاني فيحتوي علي ١ جم/كجم من مسحوق التوت البري الأحمر. حيث أظهرت النتائج أن أستخدام زيت بذور الكتان بمستوي ١٥جم/كجم كان لة تأثير إيجابي علي الأداء الأنتاجي خلال فترة التجربة مقارنة بالزيوت الأخرى. كما أدت إضافة مسحوق التوت البري الأحمر بمستوي ١ جم/كجم إلي تحسين معنوي في الأداء الأنتاجي لكتاكيت التسمين خلال فترة التجربة بأكملها. ومن ناحية أخري وجد أن أضافة زيت بذور الكتان أدي إلي أنخفاض معنوي في مستوي سيرم الدم لكل من البروتين الكلي والجلوبيولين مقارنة بزيت كل من الذيتون والصويا. كما وجد أن طول الخملات في منطقة الأثني عشر بالأمعاء للطيور المغذاه علي زيت بذور الكتان و الزيت الخليط كانت أطول مقارنة بالطيور التي غذيت علي زيت كل من الزيتون والصويا. أظهرت هذه الدراسة أن أضافة زيت بذور الكتان ومسحوق التوت البري الأحمر كان له تأثير أيجابي علي الأداء الإنتاجي وبعض مقاييس الدم ومورفولوجيا الأمعاء في كتاكيت التسمين.