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Effect of dietary supplementation of linseed (*Linum usitatissimum*) on the growth performance and lipid profile of broiler chickens

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Poultry farming has been growing rapidly in India, with broiler production increasing by 7.52% annually (BAHS 2019). Compared to other meats, chicken meat contains a higher amount of protein and a lower amount of cholesterol (Kralik *et al.* 2018). At present, people are more health-conscious and want functional food to improve their long-term health. Broiler diets mostly consist primarily of corn and soybean meal or both with the addition of fats and oils. Lipids (fats) are one of the essential factors for the growth of broilers. In this context, linseed (LS) might be an important alternative source of fats and oils enriched with functional PUFA and MUFA. Linseed (*Linum usitatissimum*) is considered as a prominent source of plant-based Ω-3 fatty acid (FA) since it contains about 40% oil, with a high quantity of α-linolenic acid (ALA; 50 to 60% of total FA). It also contains less linoleic acid and saturated fatty acid (SFA) than most other oilseeds such as soybean, cotton seed, and sunflower (Neetika *et al.* 2019). Linseed is a strong source of Ω-3 PUFA, which has been demonstrated in several studies to reduce the susceptibility towards coronary artery diseases, hypertension, and diabetes. However, LS also contains antinutritional factors that may limit its use in broiler diets, including mucilage from hulls, linatin dipeptides (an antagonist of vitamin B_6), cyanogenic glycosides, and trypsin inhibitors (Kumar *et al.* 2015). Therefore, the current investigation was performed to study the effect of linseed supplementation on growth performance and lipid profile of broiler chickens.

Seven-day old commercial broiler chicks (Cobb-400, 200) were randomly allotted in deep litter system into 5 separate groups. Each group comprised 40 broilers each, with 5 replicates of 8 broilers per replicate. Fresh water and feed were provided *ad lib.* Five iso-caloric and iso-nitrogenous experimental diets were formulated as per NRC (1994). Besides the basal control diet, four experimental diets were formulated to contain LS (2.5, 5, 7.5, and 10%) . The feed weight was recorded daily and body weight (BW) of birds was taken on weekly intervals till 42 days. The cumulated overall and weekly weight gains, feed intake (FI) and feed conversion ratio (FCR) data was calculated for the entire experimental period. Blood lipid profile was analyzed as per Aba *et al.* (2019) by using commercial diagnostic kits (Qualigens India Pvt. Ltd.).

Data of this study was analyzed by one way ANOVA of variance followed by Duncan's multiple post-hoc range tests using standard statistical procedure (Snedecor *et al*. 1989). Statistical treatments were performed by using SPSS version 25th. Significance was declared at $P<0.05$ level.

The body weight gain was significantly ($P<0.05$) higher in birds fed with 0% LS followed by 2.5, 5, 7.5 and 10% LS (Table 1). There was no ($P>0.05$) difference in Feed Intake among groups. Mir *et al.* (2021) reported that flaxseed with chromium supplementation decreased the bodyweight. A similar result was also observed in the body weight of the broiler chickens up to 44 days of age, fed with 6.5 to 26% of linseed meal (Tamasgen *et al.* 2021). These negative effects can be attributed to the low digestibility of LS, along with the high viscosity of jejuna digesta. Moreover, LS contains many anti-nutritional factors, such as mucilage from hulls, linatine, cyanogenic glycosides, trypsin inhibitors, phytic acid, and water-soluble non-starch polysaccharides, which can exert a negative impact on growth performance (Pirmohammadi *et al.* 2019).

Table 1. Effect of supplementation of linseed on growth performance of broiler chickens at 42d

Level of linseed (%) in diet	Attribute		
	Body weight (g)	Feed intake (g)	Feed conversion ratio
0	2148.32^{a}	3496.02	1.62^{c}
2.5	2113.37^{b}	3492.29	1.65^{b}
5	2097.39^{c}	3495.77	1.66^{ab}
7.5	2078.60^{c}	3483.30	1.67^{a}
10	2063.97^{d}	3479.46	1.68^{a}
SEM	9.68	4.60	0.10
P value	<0.01	0.065	<0.01

^{a,b,c,d} Means bearing different superscripts within a column differ significantly ($P<0.05$).

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Table 2. Effect of supplementation of linseed on blood lipid profile of broiler chickens at 42d

Level of linseed (%)	Attribute				
	CHO (mg/dl)	HDL-C (mg/dl)	LDL-C (mg/dl)	TRI (mg/dl)	VLDL-C (mg/dl)
0	139.91[a]	36.94[c]	79.09[a]	119.34[a]	23.86[a]
2.5	131.48[b]	38.48[c]	73.23[b]	110.40[b]	21.53[b]
5	124.28[c]	40.45[b]	64.38[c]	102.54[c]	18.42[c]
7.5	116.49[cd]	41.32[a]	56.30[cd]	93.37[d]	16.59[c]
10	107.43[d]	41.26[a]	49.34[d]	90.44[d]	14.46[d]
SEM	0.76	0.60	0.75	0.69	0.63
P value	<0.01	<0.01	<0.01	<0.01	<0.01

[a,b,c,d] Means bearing different superscripts within a column differ significantly (P<0.05). CHO, Total cholesterol; HDL-C, High density lipoprotein-cholesterol; LDL-C, Low density lipoprotein-cholesterol; TRI, Triglyceride; VLDL-C, Very low density lipoprotein-cholesterol.

Increasing levels of LS supplementation in the diet significantly decreased serum total cholesterol (CHO), low density lipoprotein (LDL-C), triglyceride (TRI), and very low density lipoprotein (VLDL-C) except for high density lipoprotein (HDL-C) (Table 2). A similar type of result was found in the study of Al-Hilali *et al.* (2018), in which the level of CHO, TRI, LDL and VLDL decreased significantly in birds fed with different levels of flaxseed oil. The reduction in total CHO, TRI, LDL and VLDL may be due to the fact that LS is rapidly absorbed by the intestines, which helps reduce saturated fat absorption. One of the important roles of LS is that it inhibits hydroxyl methylglutaryl-CoA (HMG-CoA) reductase, which is a rate-limiting enzyme of CHO synthesis in the liver (Teng *et al*. 2019). The levels of HDL in broiler birds (P<0.05) increased in treated groups as compared to control. This increase could be explained by the fact that LS contains Ω-3 PUFAs (ALA, EPA and DHA), which control expression of some specific genes that increase the HDL activity in liver (Shahidi and Ambigaipalan 2018).

It is concluded that the increasing levels of supplemental linseed in diet have negative effect on growth performance of broiler chickens. However, the higher levels of linseed decreased the level of CHO and increased the level of HDL in blood serum.

SUMMARY

Broiler diets frequently include fats and oils to improve energy density, feed palatability, and functionality associated with Ω-3 PUFA. The purpose of this research was to examine how dietary supplementation of linseed affects growth performance and lipid profile of broiler chickens. The study was carried out at the poultry farm of the Banaras Hindu University, Varanasi. The experiment is approved by the Central Animal Ethics Committee of the University (IAEC/3036). Total 200 male Cobb-400, 7-day-old broiler chicks were randomly distributed into 5 treatment groups and fed with different levels of LS (0, 2.5, 5, 7.5, and 10%), respectively. The chickens fed rations supplemented with different levels of LS resulted in significantly decreased body weight and significantly increased feed conversion ratio. In blood lipid profile, CHO, TRI, LDL-C, and VLD-C concentrate levels decreased when fed with different level of LS, while HDL-C increased significantly.

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