Original Research

Effects of Supplementing Linseed Oil in Combination with Natural Antioxidants on Performance of Broiler Chickens

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Abstract

Day old Vencobb broiler chicks were allotted to six dietary treatments: 2% vegetable oil (C), 2% linseed oil (LO), LO+ 0.5% Redox/commercial antioxidant (LOR), LO+ 0.5% curry powder (LOC), LO + 0.5% ginger powder(LOG) and LO + 0.5% turmeric powder (LOT). After six weeks, effect of feeding was analyzed on performance, blood metabolites and immunity. Birds under LOC, LOG and LOT had significantly higher body wt gain compared to LO and LOR group. The average daily feed intake was lowest with highest feed conversion efficiency in LOG group. The positive effect of natural antioxidant treatment on (FCE) was observed up to 5th weeks of age. Although insignificant, comparatively higher IgY level observed in LOR group with no mortality. The study suggests that supplementing 0.5% ginger powder with 2% LO imparts positive effect in terms of FCE and 0.5% turmeric powder with 2% LO reduces plasma cholesterol in broiler birds.

Key words: Body Weight, Blood Metabolite, Broiler, Immunity, Natural Antioxidant

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Introduction

Chicken meat is considered as healthy meat due to low content of saturated fat. Inclusion of linseed oil in broiler feed is good source of α-linolenic acid (ALA). Dietary inclusion of ALA increases the production of long chain omega-3 fatty acid (n-3 FA) like eicosapentaenoic acid (EPA/20:5n3), docosapentaenoic acid (DPA/22:5n3) and docosahexaenoic acid (DHA/22:6n3). An increase of omega-3 in the poultry feed will increase omega-3 in its meat and consumption of this meat may result in improved human health. But these modern nutritional strategies designed to produce value added broiler meat results in compromised health status in broiler chickens which can be prohibited by supplementation of

antioxidants. One of the common strategies to ameliorate undesirable health effects includes mixing high levels of commercial or natural antioxidants along with poultry feed ingredients. Several spices used in traditional Indian cuisine like curry leaf (*Murraya koenigii*), ginger (*Zingiber Officinale* Roscoe) and turmeric powder (*Curcuma longa*) possess antioxidative properties (Samarasinghe *et al*., 2003; Moorthy *et al*., 2009) and their antioxidative properties have been studied both in vitro and in vivo (Rao *et al*., 2007; Khalid *et al*., 2009). Information on effect of supplementing linseed oil (LO) with either curry leaf powder (CP), ginger powder (GP) or turmeric powder (TP) on immunity and blood metabolite in broiler chicken is lacking.

The present study was conducted to investigate the effect of feeding linseed oil (LO) along with curry powder (CP), ginger powder (GP), turmeric powder (TP) and commercial antioxidant for six weeks on performance, blood metabolites and immunity in broiler chickens.

Materials and Methods

A total 180 day old Vencobb broiler chicks weighing 52.35 ± 0.69 g were procured from Venkatesh Hatchery Private Ltd, Bangalore, India. The dietary treatments were a maize soyabean based diet supplemented with 2% vegetable oil (C), 2% linseed oil (LO), 2% linseed oil + 0.5% Redox, a commercial antioxidant (LOR), 2% linseed oil + 0.5% curry powder (LOC), 2% linseed oil + 0.5% ginger powder (LOG) and 2% linseed oil + 0.5% turmeric powder (LOT). The broilers were allotted to 36 wire meshed pens (5 birds/pen) and randomly assigned to above mentioned 6 treatments (6 pen/ treatment). The broilers were fed maize-soyabean based starter diet from d 1 to d 21 and then grower diet from d 22 to d 42 (Table 1 and 2) which was formulated according to the nutrient requirements for broilers (Panda *et al*., 2002).

Ginger, turmeric and curry powder were obtained by drying the fresh ingredients in hot air oven for 48-72 h at 55°C. The powdered materials were kept in zip pouches for feeding the birds. In the beginning the basal ration was prepared without adding oil. Each week a portion of feed from the ration was added with vegetable and linseed oil and then mixed thoroughly before offering. In order to monitor growth, birds were weighed at d 1 of age and then at weekly intervals up to d 42. Consequently the feed offered and leftover was measured each time for each pen. On d 42, all broilers were weighed and two birds from each replicate were chosen for slaughtering. After mechanical stunning the birds were bled for 2-3 minutes, blood was collected; plasma was harvested and kept in -20°C for estimating blood parameters.

The carcasses were evaluated for carcass characteristics. For estimating drip loss chicken breast meat (~100 g) was longitudinally cut from the carcass at 24 h post mortem, weighed and suspended in a plastic zip lock pouch at 4°C for 48 hours.

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Table 1: Ingredients and nutritive value of basal diets during d 1to 21 and d 22 to 42 of growing phases

Ingredient (%)	d 1 to 21	d 22 to 42
Maize	59.00	62.05
Soyabean Meal	34.80	31.90
Vegetable oil/Linseed	2.00	2.00
Curry/ginger/turmeric powder	0.5	0.5
Calcium carbonate	1.00	1.00
Dicalcium phosphate	1.80	1.50
Mineral premix	0.25	0.50
Salt	0.35	0.35
Lysine	0.20	0.10
Methionine	0.10	0.10
Calculated Nutritive Value		
ME, kcal/kg	2980.98	3004.18
Protein, %	21.42	20.28
Crude Fat, %	5.06	5.12
Crude Fibre, %	3.61	3.50
Calcium, %	1.02	1.04
Available Phosphorus,%	0.39	0.37
Sodium,%	0.14	0.14
Lysine,%	1.00	0.93
Mehionine,%	0.35	0.34
Cysteine,%	0.25	0.23

Table 2: Nutritional composition (%) of starter and finisher ration fed to experimental broiler chickens

Groups	DM	TA	OM	EE	CF	CP
Starter Ration Composition						
C	92.90	7.07	92.94	3.40	4.56	23.20
LO	92.73	6.75	93.25	3.90	3.96	21.68
LOR	92.86	6.64	93.37	3.07	3.98	22.16
LOC	92.58	6.90	93.11	3.12	3.99	23.50
LOG	92.94	6.63	93.38	3.36	4.00	20.35
LOT	92.99	6.88	93.13	3.28	3.70	20.60
SEM	0.04	0.05	0.05	0.14	0.10	0.36
Finisher Ration Composition						
C	93.00	8.28	93.08	3.58	4.19	21.60
LO	92.81	6.45	93.56	4.10	4.02	20.23
LOR	92.96	7.31	92.69	4.02	3.94	19.92
LOC	92.43	7.87	92.14	4.05	4.35	20.10
LOG	92.66	7.22	92.78	3.89	4.09	21.22
LOT	93.07	7.43	92.57	3.27	4.00	21.82
SEM	0.10	0.24	0.13	0.07	0.07	0.23

n=2 replicate samples; DM, dry matter; TA, total ash; OM , organic matter; EE, ether extract; CF, crude fibre; CP, crude protein

Following 48 h period, exudates were discarded and the samples were weighed and drip loss was calculated as initial weight minus final weight and expressed as percentage (%). Quantitative

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determination of blood glucose, urea, total protein were done by commercial kits. Estimation of α-amino nitrogen, non esterified fatty acid (NEFA) and cholesterol were done by standard protocols. Total antioxidant capacity assay kit was used to measure the combined nonenzymatic antioxidant capacity in blood. Quantitative measurement of chicken IgY in plasma was done by ELISA kit. Data for average daily gain (ADG), average daily feed intake (ADFI) and feed conversion efficiency (FCE) were analyzed by repeated measures ANOVA using a mixed model taking time and treatment interaction into consideration (PASW statistics 18). Blood metabolite data were subjected to one-way ANOVA considering dietary treatment as the source of variation. Tukey's test was carried out to assess any significant differences for all measured parameters at the probability level of P≤0.05 among the experimental groups.

Results and Discussion

In the current study the respective ADFI during second to fourth week was significantly less in C, LOC and LOG diet groups (Table 3).

Table 3: Effects of treatment on average daily feed intake (ADFI, g), average daily weight gain (ADG, g) and total weight gain (g) in broilers

Group	Weeks						Average	Total (g)
	1st week	2nd week	3rd week	4th week	5th week	6th week		
	ADFI							
C	24.24	55.05^{a}	115.13^{a}	155.77^{a}	190.34^{a}	175.86^{a}	119.40^{a}	-
LO	24.58	68.88^{b}	115.56^{a}	149.50^{a}	160.31^{bc}	178.94^{bc}	116.30^{ab}	-
LOR	24.33	73.89^{b}	88.37^{b}	152.15^{a}	175.57^{ab}	190.60^{bc}	117.49^{a}	-
LOC	23.63	65.40^{ab}	67.76^{c}	146.40^{a}	170.40^{abc}	192.91^{c}	109.82^{b}	-
LOG	22.78	63.00^{ab}	83.36^{b}	122.59^{b}	123.46^{d}	156.80^{a}	95.33^{c}	-
LOT	28.78	72.83^{b}	84.60^{b}	147.14^{a}	151.94^{c}	171.54^{ab}	109.47^{b}	-
SEM	0.62	1.76	4.09	2.56	4.61	3.29	1.73	-
P≤0.05	0.072	0.009	0.001	0.001	0.001	0.007	0.001	-
	ADG							
C	17.14	38.22	68.79^{a}	80.09^{a}	81.62^{ab}	74.56	60.07^{a}	2522.78^{b}
LO	20.81	37.16	62.24^{ab}	63.00^{b}	76.76^{a}	61.62	53.60^{b}	2251.48^{a}
LOR	18.02	39.21	44.40^{c}	80.47^{a}	71.60^{a}	69.54	53.87^{b}	2262.39^{a}
LOC	20.44	36.24	58.94^{ab}	88.82^{a}	96.38^{b}	59.00	59.97^{a}	2516.70^{b}
LOG	20.28	43.19	51.13^{bc}	86.88^{a}	96.69^{b}	64.18	60.39^{a}	2536.57^{b}
LOT	17.57	36.48	67.79^{a}	81.18^{a}	98.80^{b}	53.70	59.59^{a}	2502.59^{b}
SEM	0.63	0.87	2.12	2.41	2.85	2.61	0.68	28.49
P≤0.05	0.36	0.18	0.001	0.02	0.004	0.24	0.001	0.001

n=5 birds per replicate (30 birds/treatment). Means within a column with different superscripts are significantly different (P≤0.05 0.05)

The lowest ADFI was recorded for LOG diet group (P<0.01) supported previous findings in broilers that showed significant reduction in feed intake in broilers fed with 1.5% and 2% dried supplementary red ginger meal (Herawati 2010; Zomrawi *et al.*, 2013). In terms of total weight gain control (C) and natural

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antioxidant supplemented groups performed significantly (P<0.001) better than LOR and LO diet groups (Table 3). Significantly (P<0.05) higher total body weight gain was obtained in broiler birds fed 1% ginger root powder in response to simultaneous increase in feed intake and it was attributed to pungent test or aroma and flavor of ginger (Mohammed *et al*., 2014). In our study in terms of FCE the LOG diet was found to be the most efficient. Ginger is potential as stimulant that improves the efficiency of feed utilization by chickens and same was illustrated by previous studies (Herawati, 2010; Moorthy *et al*., 2009). It was stated that chick may tolerate up to 1.5% ginger powder in diet without adverse effect on growth performance (Zomrawi *et al*., 2013). In our study, the positive impact of natural antioxidant treatment on FCE was observed up to fifth week (Table 4) that was reflected by improved FCE during the particular period in all natural antioxidant supplemented groups as compared to control and LOR. In LOT, LOR and LOC groups the FCE was better compared to LO group, but the variation was not significant.

Table 4: Effects of treatment on feed conversion efficiency (FCE) in broilers

	Weeks						
Group	**1st week**	**2nd week**	**3rd week**	**4th week**	**5th week**	**6th week**	**Average**
C	1.54	1.45^{a}	1.69^{ab}	1.97^{a}	2.34^{a}	2.39	1.85^{ab}
LO	1.18	1.88^{b}	1.88^{ab}	2.38^{c}	2.10^{ab}	3.16	2.10^{c}
LOR	1.40	1.90^{b}	2.01^{a}	1.90^{a}	2.56^{a}	2.78	1.97^{bc}
LOC	1.16	1.81^{b}	1.18^{c}	1.70^{ab}	1.79^{bc}	3.43	1.92^{abc}
LOG	1.14	1.49^{a}	1.64^{b}	1.43^{b}	1.32^{c}	2.48	1.74^{a}
LOT	1.70	1.99^{b}	1.25^{c}	1.84^{a}	1.56^{c}	3.37	1.97^{bc}
SEM	0.07	0.06	0.07	0.07	0.10	0.14	0.03
P≤0.05	0.07	0.006	0.001	0.001	0.001	0.13	0.01

n=5 birds per replicate (30 birds/treatment). Means within a column with different superscripts are significantly different (P≤0.05)

Mortality was nil in commercial antioxidant supplemented group whereas highest mortality was observed in ginger supplemented group (Table 4). Maximum morality occurred during third and fourth week of age due to ascites. Several earlier studies reported low mortality rate in broiler chicken fed 0.1-0.5% turmeric for 35- 42 days due to enhance immune status (Raghdad and Al-Jaleel, 2012). But in our study except commercial antioxidant the other supplementations were not found effective in improving health status and reducing mortality rate in broiler chickens (Table5).

Table 5: Effects of treatment on mortality (%)

Group	Mortality	Age	Cause
C	1 no. (3.3%)	3rd week	Ascites
LO	1 no. (3.3%)	2nd week,	Cold stress
LOR	Nil (0%)	-	-
LOC	2 nos. (6.67%)	1st week, 3rd week	Transportation stress, Ascites
LOG	1 no. (3.3%)	4th week	Ascites
LOT	1 no. (3.3%)	3rd week	Ascites

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The highest and lowest (P<0.05) live carcass wt was found in LOC and in LOR group respectively (Table 6). Following removal of offal dressed wt, hot carcass wt and dressing % did not vary significantly. Similarly, broiler birds fed with different combinations of ginger, pepper and curry powder during first to sixth weeks showed no significant variation in terms of carcass characteristics like pre-slaughter wt and eviscerated weights (Moorthy *et al.*, 2009).

Table 6: Effects of linseed oil and natural antioxidants on carcass quality in broilers

Parameters	C	LO	LOR	LOC	LOG	LOT	SEM	P -value
Live wt., kg	2.74^{ab}	2.58^{ab}	2.30^{a}	2.79^{b}	2.69^{ab}	2.70^{ab}	0.05	<0.05
Wt. of offels*, g	269.17	222.83	223.67	277.17	271.17	242.5	7.82	0.13
Hot carcass wt., kg	1.81	1.7	1.5	1.81	1.75	1.79	0.04	0.72
Dressing, %	65.78	65.8	64.93	64.88	65.1	66.32	0.39	0.88
Drip loss, %	2.64	1.61	2.43	1.88	2.45	1.46	0.26	0.57

*n=2 birds per replicate (12 birds/treatment). Means within a row with different superscripts are significantly different (P≤0.05); *Includes liver, intestine, gizzard, proventriculus*

Some study suggested that the use of turmeric powder as feed additive at a level of 0.5% enhances the growth performances and carcass yield of broiler chicks (Mondal *et al*., 2015). Ice formation in poultry muscle during freezing causes cell disruption and when meat is thawed fluid exudes from meat and collects as drip. In our study drip loss was found to range between 1.61 to 2.64% which was lower than previous report of 3.63 -4.95% (Komiyama *et al.*, 2008).

Our study could not demonstrate any significant effect of feeding treatment on blood glucose, α- amino nitrogen, NEFA and plasma protein concentration in broiler birds (Table 7).

Table 7: Effects of treatment on concentration of blood metabolites in broilers

Group	Glucose (mg/dL)	α-amino N (mg/dL)	Blood Urea (mg/dL)	NEFA (mmol/mL)	TAC (µmol/mL)	Plasma Protein (g/dL)	cholesterol (mg/ml)	IgY (ng/mL)
C	176.56	8.07	12.25^{ab}	0.19	0.83	4.31	0.48^{a}	1.91
LO	166.69	10.27	13.70^{a}	0.22	0.77	4.77	0.76^{b}	1.63
LOR	199.63	10.49	11.47^{ab}	0.23	0.83	4.74	0.81^{b}	2.10
LOC	184.88	7.91	8.46^{b}	0.23	0.86	4.80	0.81^{b}	1.88
LOG	162.44	7.18	13.0^{a}	0.24	0.82	4.55	0.72^{b}	1.67
LOT	200.14	8.76	8.71^{b}	0.26	0.85	4.95	0.51^{a}	1.99
SEM	5.46	0.50	0.42	0.01	0.01	0.11	0.03	0.06
P≤0.05	0.21	0.35	0.05	0.51	0.35	0.66	0.001	0.13

n=2 birds per replicate (12 birds/treatment); Means within a column with different superscripts are significantly different (P≤0.05); NEFA, non-esterified fatty acid

Earlier studies showed that dietary treatment containing ginger root powder and turmeric powder at different levels had no significant effect on blood metabolites like glucose, protein, albumin, globulin etc in broiler chicken (Zomrawi *et al.*, 2013; Elkhair *et al.*, 2014). In the current study the plasma cholesterol

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concentration was significantly (P<0.001) reduced in C and LOT group compared to others. The hypocholesterolemic activity of turmeric was already known and was demonstrated in broiler birds' earlier. But there were some contrasting findings as well (Elkhair *et al.,* 2014). The hypocholesterolemic impact of feeding powdered ginger rhizome and curry powder was not evident in broilers in present study. Nevertheless, there were studies which also could not show any significant difference in blood cholesterol and triglycerides in 1.5% ginger fed broiler birds (Barazesh *et al.,* 2013). The variations observed in the response may be adhered to differences in dose, form and poultry breed. Al-Homidan (2005), observed reduced total protein and globulin contents in the plasma of broilers due to dietary supplementation of ginger at 60 g/ kg, but not at 20 g/kg. It was suggested that chick may tolerate up to 1.5% ginger powder in diet without adverse effect on blood parameter (Zomrawi *et al.,* 2013). Blood urea is an indicator of diet adequacy and nitrogen utilization in broiler birds fed with different feeding regime. In the present study BUN (mg/dL) level was found significantly low in LOC and LOT diet group compared to LO and LOG group. The only dietary variation between these groups was different antioxidants were added in feeds of different groups. The level of IgY is used as an index of the general health status of birds. In the present investigation the blood IgY concentration did not vary significantly between treatment groups. Comparatively higher IgY concentration was observed in LOR diet which can be correlated to zero mortality in the group. Positive effect of turmeric supplementation on immune status was reported earlier (Raghdad and Al-Jaleel, 2012), but it was not evident in our study. However Sadeghi *et al.* (2012) also did not find any positive implication of 21 days turmeric supplementation (5g/ lit. drinking water) to broiler birds in improving immune status. The total blood antioxidant capacity (TAC) was comparatively higher in antioxidant treated groups compared to LO group. But the difference was not significant across the treatment groups. The natural antioxidants like curry leaf possess high antioxidant potency that is attributed due to presence of phytochemicals like mahanimbine, murrayanol and mahanine. Dried ginger can also scavenge superoxide anion and hydroxyl radicals efficiently as it contains monoterpenes and sesquiterpenes. The antioxidative potency of turmeric has also been proved in earlier studies (Elkhair *et al.,* 2014).

Conclusion

Results in this experiment showed that dietary supplementation of natural antioxidants like CP, GP or TP in combination with LO can have significant positive impact on body wt gain of broiler birds. Feeding of 2% LO in combination with 0.5% GP for 5 weeks of age could be recommended for better FCE since the positive effect of natural antioxidant feeding on FCE was most evident up to 5th weeks of age. The study also suggests that addition of 0.5% TP in feed may have a hypocholesterolemic effect in broiler chickens.

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Further studies are recommended to ensure the potentiality of different combinations of CP, GP and TP in enhancing overall performance in broiler birds.

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