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Effect of dietary turmeric (*Curcuma longa)* on serum cholesterol in Jabalpur colour layer birds

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Abstract
Turmeric (*Curcuma longa)*, a medicinal plant, is extensively used in Ayurveda, Unani and Siddha medicine as a home remedy for various diseases. The normal level of blood cholesterol in human beings is 150-250mg/dl but when its level rises to more than 250mg/dl, it may lead to cardiovascular diseases like atherosclerosis, hypertension and coronary heart disease. Hypocholestremic effect of turmeric has been widely used in human beings and rats. However, its use in poultry has not been extensively studied. The present study was planned to know the effect of turmeric powder on serum cholesterol of poultry birds. The study was conducted on 30 Jabalpur colour birds of 32 weeks age. Thirty healthy birds were randomly divided into 5 groups with 6 birds in each group. One group C was kept as control and other four groups, T_1-T_4 were kept as treatment groups and were supplemented with turmeric powder @1.5 (T_1), 3.0 (T_2) 4.5 (T_3) and 6g (T_4) /kg of feed, respectively. Two ml blood was collected from all experimental birds with all aseptic precautions and serum was separated for serum cholesterol and HDL cholesterol, LDL cholesterol and VLDL cholesterol estimation. The result of study indicated maximum reduction in serum cholesterol, LDL and VLDL cholesterol whereas maximum increase in serum HDL cholesterol in T_3 on day 56.

Keywords: Atherosclerosis, turmeric, HDL, LDL, VLDL cholesterol

1. Introduction
Coronary vascular diseases such as hyperlipidemia, hypercholesterolemia, atherosclerosis, stroke and hyperglycemias have been the number one cause of deaths in many countries. The elevated serum lipids e.g. cholesterols and triglycerides cause deposition of fat onto the vascular endothelium and arterial walls that progressively develop into atheroma and atherosclerosis [1]. Several plant products are known to have creditable medicinal properties. Notable among these, the active principle of turmeric (*Curcuma longa*) i.e. curcumin has been reported to have anti-hypercholesterolemic, anti-inflammatory as well as anticancer activities. Curcumin is the active ingredient that is present at 1.5-2% of weight by turmeric root. Turmeric contains 3 different analogues of curcumin, which contains 5% bisdemethoxycurcumin, 18% demethoxycurcumin, and 77% diferuloylmethane. Curcumin is insoluble in water and soluble in imethylsulfoxide, ethanol, oils, and acetone. It is conceivable that decreasing the plasma cholesterol and lipid level would decrease the chance of atherosclerosis and arteriosclerosis. Turmeric has been widely used as a hypocholestremic agent in human beings and rats. However, its use in poultry has not been extensively studied. The present study was planned to know the effect of turmeric powder on serum cholesterol of poultry birds.

2. Materials and Methods
The study was conducted on 30 Jabalpur colour birds of 32 weeks age. Birds were kept in individual cages under standard managemental conditions during the entire period. Thirty healthy birds were randomly divided into 5 groups with 6 birds in each group. One group C was kept as control and other four groups, T_1-T_4 were kept as treatment groups. Diet of the treatment groups was supplemented with turmeric powder @1.5 (T_1), 3.0 (T_2) 4.5 (T_3) and 6g (T_4) /kg of feed, respectively. The basal diet consisted of 2700 ME Kcal/kg of feed and 17% protein. Two ml blood was collected from all experimental birds with all aseptic precautions and serum was separated for biochemical estimations on days 0, 14, 28, 42 and 56 of the experiment. Serum cholesterol and HDL cholesterol were estimated by using a diagnostic kit

(Erba). LDL cholesterol and VLDL was estimated by using the formula given by [2].

2.1 Statistical Analysis
Data were statistically analysed by using CRD [3].

3. Results and Discussion
3.1 Serum cholesterol
The mean values of serum cholesterol as affected by supplementation of various doses of medicinal pulv are shown in Tables 1. Highly significant (P<0.01) variations was recorded between days, treatments and interactions between days x treatments. Percentage reduction in serum cholesterol was 3.25, 8.49, 12.76 and 18.68 in T_1; 11.37, 19.02, 23.32 and 28.48 in T_2 while it was 16.92, 25.86, 29.43 and 38.00 and 12.20, 20.73, 27.50 and 32.31 in birds fed 4.5g and 6.0g turmeric pulv/kg feed, respectively as compared to control. Thus, hypocholestremic effect of turmeric was in the order T_3>T_4>T_2>T_1.

[4] Observed that curcumin admixed with the diet (0.5% w/w) decreased serum total cholesterol (TC) by about 21% in rats fed a high-cholesterol diet (HCD). Curcumin could increase the lecithin cholesterol acyltransferase activity in the plasma significantly and decrease the level of free cholesterol in the plasma [5]. Adding 250 mg/kg or 350 mg/kg curcumin in diet of Wanjiang Yellow chickens reduced total serum cholesterol significantly [6, 7, 8, 9, 10] Also observed reduced synthesis of cholesterol and fatty acids [11]. Reported that curcumin reduced the activities of hepatic cholesterol-7 α-hydroxylase and HMG CoA reductase in chicken.

Feed supplemented with turmeric powder reduced total cholesterol values by 38% to 52% at dose dependent manner as compared to control [12]. Supplementation of curcumin in feed decreased serum cholesterol content duration dependently [13].

Table 1: Serum cholesterol (mg/dl) in Jabalpur colour birds under various treatments and durations

Treatments	Durations				
	Day 0	Day 14	Day 28	Day 42	Day 56
C	174.401±2.24	175.921^{4}±2.64	175.408^{4}±2.83	175.288^{5}±2.52	176.015^{5} ±2.53
T_1	176.402^{e}±4.22	170.202^{d3}±3.84	160.51^{c3} ±3.77	152.916^{b4}±3.47	143.128^{a4}±3.80
T_2	175.408^{e}±3.28	155.918^{d2}±2.77	142.05^{c2} ±3.47	134.412^{b3}±2.44	125.892^{a3}±2.83
T_3	174.586^{e}±3.87	146.164^{d1}±2.91	130.052^{c1}±1.92	123.698^{b1}±2.37	109.136^{a1}±1.88
T_4	176.038^{e}±3.73	154.458^{d2}±3.76	139.042^{c2}±2.72	127.082^{b2}±3.26	119.140^{a2}±3.43

Mean ± SE of serum cholesterol with different alphabets and numbers in superscripts vary significantly (P<0.05) in a row or in a column, respectively.

3.2 Serum HDL-cholesterol
The mean values of serum HDL-cholesterol level on supplementing various doses of turmeric powder are shown in Table 2. In the present study, percentage increases in serum HDL-cholesterol values observed in 14, 28, 42 and 56 days were 2.93, 7.37, 9.88 and 11.24 and 1.58, 6.64, 12.26, and 14.08 for groups T_1 and T_2, respectively while those for groups T_3 and T_4 the values were 0.70, 10.21, 16.32, 20.65 and 0.78, 9.81, 13.48 and 15.87, respectively. The maximum increase in serum HDL-cholesterol was observed in T_3 (20.65 %) on day 56.

Epidemiological studies have shown that high HDL concentrations could potentially contribute to prevention of atherogenesis, inhibition of LDL-oxidation and protection of endothelial cells from the cytotoxic effects of oxidized LDL [13, 14]. Feed supplemented with turmeric powder in laying birds increased the HDL cholesterol values at dose dependent manner as compared to control [12].

Curcumin admixed with the diet (0.5% w/w) increased serum HDL by 50%. The atherogenic indices (LDL-C/HDL-C and TC/HDL-C) were reduced by 52% and 35%, respectively [3]. Administration of curcumin to one-day-old Huainan chickens increased HDL-cholesterol by 20.29 %, 43.45 % and 68.31 % in 28, 42 and 56 days age respectively [13]. Similarly, dietary supplementation of turmeric rhizome powder in diet of day-old male broiler chickens for 6 weeks significantly increased plasma HDL-cholesterol concentrations as compared to the control [16].

Oral supplementation of curcumin significantly increases HDL-cholesterol levels [17]. Similarly, diet supplemented with turmerol extracts significantly increased HDL cholesterol levels in Japanese big-eared [18] Wanjiang Yellow chickens supplemented with 150, 250 and 350 mg/kg curcumin [8]. [19] Also reported significant increase in HDL cholesterol levels by supplementing curcumin @ 250 mg/kg or 350 mg/kg feed.

Table 2: Serum HDL cholesterol (mg/dl) in Jabalpur colour birds under various treatments and durations

Treatments	Durations				
	Day 0	Day 14	Day 28	Day 42	Day 56
C	43.058±1.42	43.528 ±1.35	43.585±1.07	44.0251 ±1.89	44.358^{1} ±1.69
T_1	43.895±1.11	44.863 ±1.50	46.231±1.79	47.830^{1-2} ±1.53	48.975^{2} ±1.45
T_2	43.133^{a}±1.28	44.275^{a}±1.21	45.918^{ab}±1.80	48.863^{b2} ±1.57	50.225^{b2}±1.26
T_3	42.260^{a}±1.37	43.888^{ab}±1.85	47.453^{b} ±1.71	50.633^{b2} ±1.17	53.115^{b2}±1.21
T_4	42.835^{a}±2.11	43.923^{ab}±2.11	47.287^{b} ±1.72	49.397^{b2} ±1.47	51.010^{b2}±1.74

Mean ± SE of HDL-cholesterol with different alphabets and numbers in superscripts vary significantly (P<0.05) in a row or in a column, respectively.

3.3 Serum LDL-cholesterol
Table 3 showing the mean values of LDL-cholesterol in birds on treatment with turmeric powder supplementation. Percentage reduction of LDL-cholesterol values in T_1 and T_2 groups were 3.37, 9.82, 15.43 and 26.42 and 17.75, 30.05, 37.35 and 45.36 on days 14, 28, 42 and 56, respectively whereas the values in T_3 and T_4 groups were 27.21, 44.14, 50.19 and 67.25 and 17.64, 34.02, 47.00 and 54.24 on days 14, 28, 42 and 56, respectively. Serum LDL-cholesterol showed highly significant differences (P<0.01) between days, between treatments and interactions between days x treatments. The maximum reduction in serum LDL-

cholesterol was observed in T_3 (67.25 %) on day 56.

[10, 16] Showed that turmeric preparations significantly reduced plasma LDL-cholesterol in rats. Administration of 250 mg/kg or 350 mg/kg curcumin in feed caused significant (P<0.05) decrease in LDL cholesterol levels in Wanjiang Yellow chickens [8]. Curcumin supplementation caused 42.5% decrease in LDL cholesterol in rats fed a high-cholesterol diet [3].

The radioactivity of radiolabeled I^{125} low density lipoprotein in the blood, liver, kidney, spleen, gall bladder and adrenal was measured by injecting cucurmin into the body of hedgehogs 2 min before the radiolabled I^{125} low density lipoprotein. Absorption of LDL in liver, adrenal and gall bladder increased 228.1%, 86.7% and 70.3%, respectively, but decreased 54.4% in spleen and 25.8% in blood. The experiment proved that cucurmin might promote the metabolism of LDL in liver and adrenal and increased the excretion of LDL by gall bladder and inhibited the absorption of LDL in spleen [18].

By supplementing turmeric powder in diet of laying hen the LDL cholesterol values were reduced by 62-73% at the given dose rate as compared to control [12]. Administration of curcumin to Huainan chickens decreased LDL cholesterol by 13.68 %, 10.08 and 23.31 % at 28, 42 and 56 day age, respectively [13]. Similarly rabbits orally treated with turmeric extract at the dose of 1.66 mg/kg body weight significantly decreased serum LDL cholesterol levels [20].

Table 3: Serum LDL cholesterol (mg/dl) in Jabalpur colour birds under various treatments and durations

Treatments	Durations				
	Day 0	Day 14	Day 28	Day 42	Day 56
C	77.628 ±3.17	78.962^{3}±2.09	77.837^{4} ±2.90	78.362^{4} ±2.96	78.780^{5} ±3.08
T_1	79.26^{c} ±5.52	76.300^{c3} ±5.06	70.193^{bc3}±4.00	66.274^{b3}±4.57	57.968^{a4}±4.37
T_2	79.127^{d} ±3.19	64.946^{c2}±2.33	54.450^{b2} ±2.85	49.097^{b2}±2.02	43.045^{a3}±2.27
T_3	79.341^{d} ±3.68	57.479^{c1}±3.94	43.484^{b1} ±2.40	39.034^{b1}±3.85	25.798^{a2}±1.74
T_4	79.881^{e} ±2.77	65.030^{d2}±4.40	51.355^{c2} ±2.86	41.530^{b1}±3.92	36.049^{a1}±4.39

Mean ± SE of LDL-cholesterol with different alphabets and numbers in superscripts vary significantly (P<0.05) in a row or in a column, respectively.

3.4 Serum VLDL-cholesterol

The mean values of serum VLDL-cholesterol of birds during different time intervals of the experiment have been presented in Table 4. Percentage reduction values of serum VLDL-cholesterol were 7.34, 19.30, 27.16 and 31.93 in T_1, 12.24, 23.77, 31.74 38.50 in T_2, 16.67, 28.15, 36.02 and 42.87 in T_3 and 15.13, 26.00, 32.81 and 39.58 in T_4 on days 14, 28, 42 and 56, respectively. The variations between days, between treatments and interactions between days x treatments were highly significant (P<0.01). The maximum reduction in VLDL-cholesterol was observed in group T_3 (42.87%) on day 56 [19]. Reported that administration of curcumin orally to broilers @ 150 mg/kg, 250 mg/kg and 350 mg/kg for 42 days significantly decreased serum VLDL-cholesterol levels. Dietary supplementation of turmeric rhizome powder (TRP) @ 0.25%, 0.50% and 0.75% in the diets significantly decreased (P<0.05) VLDL-cholesterol levels [16]. Similar reduction (P<0.05) observed in VLDL-cholesterol levels in male Sprague-Dawley rats supplemented with 1.0 g curcuminoids/100 g diet [21].

Table 4: Serum VLDL-cholesterol (mg/dl) in Jabalpur colour birds under various treatments and durations

Treatments	Durations				
	Day 0	Day 14	Day 28	Day 42	Day 56
C	52.415 ±0.54	53.374^{4} ±0.75	54.512^{4} ±0.42	53.397^{4} ±0.80	53.209^{4} ±0.61
T_1	53.525^{e} ±0.66	49.455^{d3}±0.68	43.988^{c3} ±0.44	38.895^{b3} ±0.43	36.219^{a3} ±0.58
T_2	52.783^{e} ±0.74	46.839^{d2}±0.35	41.557^{c2} ±0.36	36.448^{b2} ±0.51	32.726^{a2} ±0.63
T_3	53.186^{e} ±0.65	44.478^{d1}±0.69	39.168^{c1} ±0.76	34.163^{b1} ±0.50	30.399^{a1} ±0.47
T_4	53.220^{e} ±0.65	45.297^{d12}±0.64	40.338^{c1-2} ±0.65	35.875^{b1-2} ±0.46	32.148^{a1-2}±0.58

Mean ± SE of VLDL-cholesterol with different alphabets and numbers in superscripts vary significantly (P<0.05) in a row or in a column, respectively.

4. Conclusion

In conclusion, the present study showed that T_3 group supplemented with 4.5 g turmeric /kg of feed with basal diet consisted of 2700 ME Kcal/kg of feed and 17% protein showed better results in all parameters include maximum reduction in serum cholesterol (hypocholestremic effect), maximum increase in serum HDL-cholesterol, maximum reduction in serum LDL-cholesterol and maximum reduction in VLDL-cholesterol was observed in group T_3 on day 56. Thus, use of dietary turmeric (*Curcuma longa)* may be useful to decrease serum cholesterol levels.

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