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Effect of Curcumin, Mixture of Curcumin and Piperine and Curcum (Turmeric) on Lipid Profile of Normal and Hyperlipidemic Rats

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Abstract

Curcumin is a polyphenolic, yellow pigment obtained from rhizomes of *Curcuma longa* (curcum), used as a spice and food colouring. The extracts have several pharmacological effects. We evaluated the effect of curcum, curcumin, and mixture of curcumin and piperine on plasma lipids in normal and hypercholesterolemic rats. A total of 270 rats, divided into 27 groups, were used. G1, G1[1]: control, G2-G11: normal rats fed control diet supplemented with different levels of curcumin and curcum (G2-G6: 0.1%, 0.25%, 0.5%, 1.0%, 2.0% respectively, G7-G11: 1.67%, 4.167%, 8.34%, 16.67%, and 33.34). G12-G26: at first fed control diet supplemented with 2% cholesterol then G13-17, 21-25 fed a control diet supplemented with different levels of curcumin, and curcum [the same levels as G2-G11; G18-20 fed control diet supplemented with mixture of curcumin (0.1, 0.25, 0.5%) and piperine (20 mg/kg BW)], G12 was sacrificed before addition of studied materials, G26 were fed control diet. Lipid profile, triacylglycerol and phospholipids of plasma and organs as liver and heart were measured. Serum cholesterol (total, LDL-C, VLDL-C), triacylglycerol and phospholipids contents were elevated in cholesterol-fed rats, while HDL-C were decreased. Curcum, curcumin have hypocholesterolemic effect on both normal and hypercholesterolemic rats being more effective in hypercholesterolemic rats. Curcumin reduces cholesterol by interfering with intestinal cholesterol uptake, increasing the conversion of cholesterol into bile acids and increasing the excretion of bile acids. Using curcumin+piperine is better than using curcumin alone. All doses had the same effect, but using the lower level (0.5%) is better than using 2.0% level. Liver cholesterol, triacylglycerol and phospholipids contents and cardiac cholesterol were elevated in hypercholesterolemic conditions. Dietary curcumin showed a distinct tendency to counter these changes. Piperine was added to curcumin to enhance its bioavailabilty through increasing curcumin absorption and reducing its metabolism in liver. The use of curcum, curcumin, and mixture of curcumin and piperine may be useful in the management of cardiovascular disease. Using the lower level (0.5%) is better than using 2.0%. Piperine enhances the bioavailabilty of curcumin.

Keywords: *Curcuma longa L.*; Atherosclerosis; Antioxidant, Cholesterol, HDL-C, LDL-C, VLDL-C, Triacylglycerol, Phospholipids, Curcumin, Piperine, Hypercholesterolemia, Liver, Heart

Introduction

Curcuma longa L. plant (known as curcum hence the name *Curcuma*, turmeric) is a member of the *Curcuma* botanical group, which is part of the ginger family of herbs, Zingiberaceae. It is widely cultivated in tropical regions of Asian countries including India. The root and rhizome (underground stem) of the *Curcuma longa L.* plant is crushed and powdered into ground Turmeric. Ground Turmeric is used worldwide as the main ingredient in curry, the spice, and as a source for curcumin or curcuminoids. Curcum is a well-known spice and food colorant commonly consumed in different parts of the world. Recently, much attention has been focused on the biological and medicinal properties of curcumin. Curcumin, a group of polyp-

henolic plant pigments, is responsible for turmeric's characteristic canary yellow color. Curcuminoids include mostly curcumin, demethoxycurcumin and bisdemethoxycurcumin. Turmeric powder also is used for medicinal purpose and in Ayurvedic medicine (Ivan 1999 and WHO 2002). Turmeric is on the FDA's GRAS (Generally Recognized as safe) list. No LD_{50} has been discovered for curcumin (Bratman and Girman 2003). Cheng *et al.* 2001 found that curcumin is not toxic in oral human doses up to 8000 mg/day for 3 months. Curcumin has a wide range of therapeutic actions as the ability to halt or prevent certain types of cancer (Aggarwal *et al.* 2003, Bharti *et al.* 2003 and Chan *et al.* 2003), anti-inflammation (Ramsewak *et al.* 2000); improve cardiovascular health (Ramirez-Tortosa *et al.* 1999, Quiles *et al.* 2002 and Mesa *et al.* 2003); prevent cataracts (Suryanarayana *et al.* 2003); anti-microbial, anti-fungi (Saleheen *et al.* 2002); remarkable antioxidant reagent (Ramirez-Boscá *et al.* 1995, Sreejayan and Rao 1996 and Phan *et al.* 2001). Curcum (*Curcuma longa*), curcumin has hypocholesterolemic effect on hypercholesterolemic rats. Curcumin (turmeric) or curcum decrease (suppress) the raised level of liver cholesterol of cholesterol-fed rats (Reddy and Lokesh 1994). The hypocholesterolemic effect of curcum may be due the presence of curcumin and/or curcumonoinds (mixture of curcumin and relative compounds). Curcumin reduces cholesterol by interfering with intestinal cholesterol uptake, increasing the conversion of cholesterol into bile acids, and increasing the excretion of bile acids Ravindranath and Chandrasekhara 1980 and 1981 and Ammon and Wahl 1991 indicated that pharmacokinetic properties of curcumin reveal that curcumin when given orally is less active due to its poor absorption by the gastrointestinal tract and its glucuronidation in the liver. Addition of piperine (extract of black pepper, *Piper nigrum L.*) to curcumin enhances its bioavailabilty through increasing curcumin absorption and reducing its metabolism in liver (Shoba *et al.* 1997).

Materials and Methods

A-Experimental Animals

Two hundred and seventy male albino, Sprague-Dawley (local strain), rats were housed individually in suspended wire-mesh cages on two steps. All rats were initially fed basal (control) diet for 10 days before starting the experiment. Rats were then divided into 27 groups, each of 10 rats. Their mean body weight was 164.0 g ranging between 151-179 g. Water and diets were given ad libitum. The first experiment lasted for 7 weeks; the second experiment lasted for another 7 weeks.

B-Animal Grouping

Group 1 (control): fed on control diet. From the 2^{nd} to the 6^{th} group animals were fed on control diet supplemented with different levels of curcumin (0.1%, 0.25%, 0.5%, 1.0%, and 2.0% respectively). From the 7^{th} to the 11^{th} group animals were fed on control diet supplemented with different levels of curcum that contain the same concentration of curcumin that were given to groups 2-6 (1.67%, 4.167%, 8.34%, 16.67%, and 33.34% respectively). From the 12^{th} to the 26^{th} group animals were fed on control diet supplemented with 2% cholesterol in order to make a hyperlipidemic rats. The 27^{th} (or 1^{1}) group was fed a control diet to act as a control for the second experiment (treatment of the hyperlipidemic rats with curcum, curcumin and a mixture of curcumin and piperine). Curcum and curcumin were dissolved in oil. The addition of curcum, curcumin and cholesterol was at the expense of cornstarch. The diets were prepared fresh every week and kept at 4^{o}C. The control diet was prepared according to National Research Council, NRC, (1978) and Reeves *et al*. (1993).

At the end of first 7 weeks of the experiment, the rats (from group 1-11 and 26) were fasted overnight, lightly anaesthetized with diethyl ether to collect blood samples into dry clean centrifuge tube for biochemical analysis of Cholesterol (total, HDL, LDL and VLDL),

triacylglycerol (TG) and total phospholipids (PhL).

Liver and heart were removed immediately after dissection and rinsed with saline, dried between two filter papers and weighed. Lipoprotein (lipid pattern, total cholesterol, total TG and total phospholipids) was also measured in liver. Total cholesterol was also measured in heart.

At the second experiment part, Groups 12-25, 26 became hyperlipidemic, group 27 (1^1) was used as normal control rats. In Group 26, analytical parameters were used as the initial level of lipid profile of hypercholesterolemic rats. Group 12 were kept on control diet with no supplementation during the other 7 weeks where it was considered as hypercholesterolemic control group of rats. From the 13^{th} to the 17^{th} group animals were fed on control diet supplemented with different levels of curcumin (0.1%, 0.25%, 0.5%, 1.0%, and 2.0% respectively). From the 18^{th} to the 20^{th} group animals were fed on control diet supplemented with different levels of curcumin (0.1%, 0.25%, 0.5% respectively) and piperine (20 mg/kg BW) for the 3 groups. From the $21^{st}$to the 25^{th} group animals were fed on control diet supplemented with different levels of curcumin that contain the same concentration of curcumin that were given to groups 13-17 (1.67%, 4.167%, 8.34%, 16.67%, and 33.34% respectively).

At the end of last 7 weeks of the experiment, the rats were fasted overnight, lightly anaesthetized and sacrificed. Then biochemical analysis of blood, heart, liver was done as previous.

C-Measured Parameters

Initial body weight (IBW), final body weight (FBW) and body weight gain (BWG). Absolute organs weight (AOW: g upon autopsy) and relative organs weight (ROW) and atherogenic indices were calculated.

D-Chemical Analysis

The contents were determined using suitable kits reagents. Total cholesterol, TC, (Bio Mérieux kits -Richmond 1973 and Allain *et al.* 1974), total triacylglycerol, TG, (Bicon kits -Bucolo and David 1973), total phospholipids (Connerty *et al.* 1961), serum HDL (Bio Mérieux kits -Burstein *et al.* 1970 and Lopes Virella *et al.* 1977), serum LDL (Bio Mérieux kits -Friedewald *et al.* 1972, Levy *et al.* 1981 and Fruchart 1982). VLDL-C was determined by using the following equation: VLDL-C=total cholesterol - (HDL-C + LDL-C).

Lipids were extracted from the liver and heart using Folch *et al.* (1957) and Carr *et al.* (1993) methods, then TC, TG, Tphl content was determined in them.

E-Chemicals used

Curcumin and piperine were purchased from Sigma. Curcumin is natural yellow, 1,7-bis (4-hydroxy-3-methylphenyl) 1-6 heptadiene-3-dione. Its Molecular weight is $C_{21}H_{20}O_6$. Piperine molecular weight is $C_{17}H_{19}NO_3$.

Statistical Analysis

Data were expressed as Mean ±SE and assessed by paired t-test (Avram 1964) and Duncan test (Steel and Torrie 1960).

Results

Table (1-a) revealed that body weight gain (BWG) of curcumin- or curcum-fed normal rats was similar with no significant differences between them. The treated groups showed slightly non significant decrease in their BWG [-1.46 (G 2): -9.02 (G 10)] than control.

Table (1-b) revealed that FBW of cholesterol fed rats was significantly higher than that of their respective control group or their respective initial groups (244.19±0.59 vs 227.0±2.51 and 164.55±1.91 respectively). Body weight gain was significantly higher than control group especially group 12 where they reached 34.35%.

Table (1-c) revealed that all groups (G: 13-25) showed no significant change than their respective hypercholesterolemic control groups (G 12), although they showed slightly higher weights. Also body weight showed a tendency to increase with increasing concentration of the added curcumin, curcumin+piperine and curcum.

Body weight gain was significantly lower than normal control group.

Regarding organs weight, Table (2-a) showed that relative liver and heart weight of curcumin- or curcum-fed normal rats showed no significant differences when compared with the control group with tendency of heart weight to be slightly lower than control. Relative liver and heart weight of cholesterol-fed group (G 26; Table 2-b) showed a significant increase when compared with the control group. Relative liver weight of all treated hypercholesterolemic groups (G: 13-25) showed a highly significant decrease when compared with normal control group or compared with initial hypercholesterolemic group (G 26). Also no significant differences for RLW were found when compared with the untreated hypercholesterolemic control group (G 12), which is quite different for relative heart weight. All groups (G: 13-25) showed no significant change when compared with normal controls ($G1^1$) and a significant decrease was found on comparing with G 12. Relative heart weight of curcumin-fed (G: 14-17); curcumin+piperine-fed (G 20) and curcum-fed (G:22-25) of hypercholesterolemic rats was significantly lower than initial hypercholesterolemic group (G 26).

Table (3-a, b) revealed that serum cholesterol (total, HDL-C, LDL, VLDL) triacylglycerol, and phospholipids levels of 0.1% and 0.25% curcumin- or curcum- fed normal groups (2-3 and 7-8) showed no significant differences when compared with the control, but serum cholesterol (total, LDL, VLDL) of the remaining groups (G: 4-6 and 9-11) of curcumin- or curcum- fed groups was significantly lower than control group. Also serum HDL-C of groups (G: 4-6 and 9-11) of curcumin- and/or curcum-fed groups was significantly higher than control group. Most of cholesterol decreases occured in LDL and VLDL fraction (≈ 20% each). Triacylglycerol and phospholipids levels of low level of curcumin- or curcum- fed groups (G: 2-4; 7-9) showed no significant differences when compared with the control group, while high level of curcumin- or curcum-fed groups (G: 11; 5-6) showed a significant decrease when compared with the control group except G 10 which showed no significant change.

Table (4-a, b, c) revealed that serum cholesterol (total, LDL, VLDL); triacylglycerol and phospholipids levels of cholesterol-fed groups were significantly higher than control group, while HDL-C was significantly lower than control group. The increase reached 109.77%, 295.39%; 281.64%, 96.76%; and 81.85% respectively, while the decrease in serum HDL-C reached 46.01%. The present study also showed that approximately 53.75% of normal control rats' serum cholesterol was present in HDL form and relatively little in LDL and VLDL (32.04 and14.19%), while in hypercholesterolemic rat it was quite different, approximately 13.83 in HDL, and 60.37 and 25.8 in LDL and VLDL. Table (4-a) also revealed that serum cholesterol (total, LDL, VLDL); triacylglycerol and phospholipids levels of untreated hyperlipidemic control groups (G 12) were significantly higher than control group, while HDL-C was significantly lower than control group but the opposite was true when they are compared with the initial level of cholesterol-fed group.

Tables (4-a, b, c) revealed that serum cholesterol (total, LDL, VLDL); triacylglycerol and phospholipids levels of groups (13; 18; 21, low level) behave like G 12, then the remaining groups (14-17; 19-20; 22-25) were significantly decrease in cholesterol (total, LDL, VLDL); triacylglycerol and phospholipids, while their HDL-C was significantly increasing. This is true for all groups except groups (17, 20, 25) where the levels became close to normal where cholesterol (total, HDL-C), triacylglycerol and phospholipids showed no significant change when compared with the normal group (1^1) but LDL-C and VLDL-C of G 17 showed significant change (increase). Data of table (4-b) revealed that curcumin+piperine is much better than curcumin alone as hypocholesterolemic agents.

Regarding atherogenic indices, data of table (3-a and b) reveal that groups 2-3 and 7-8 (normal rats) showed no significant change for all indicated atherogenic indices

when compared with the normal control. G: 4-6 and 9-11 showed a significant decrease in cholesterol/HDL-C, LDL-C/HDL-C. Also no significant change was observed when comparing between each group and its match (7, 8, 9, 10, 11 vs 2, 3, 4, 5, 6 respectively).

Data of cholesterol/HDL-C and LDL-C/HDL-C showed significantly higher levels in cholesterol-fed group (G 26) than control one.

Group 12 (untreated hypercholesterolemic control) behaved like G 26 when compared with the normal control, but the opposite is true when comparing it with G 26. Groups 13-25 showed significant changes when compared with G 1^1; 26, 12. The atherogenic indices showed a tendency to either increase or decrease with increasing concentration of the added curcumin, curcumin+piperine and curcum when compared with G 1^1; 26, 12 (Table 4-a, b and c) i.e. cholesterol/HDL-C, LDL-C/HDL-C of G 13 (lower level) showed significant increase than normal control group and G 12 (untreated hypercholesterolemic control group) and showed a significant decrease when compared with G 26 (initial hypercholesterolemic control group). The levels decrease with increasing concentration of the added test material (revert into significant decrease) till it became significantly higher than G 1^1, and significantly lower than G 26 and 12.

Table (5-a) revealed that hepatic cholesterol content of all groups (3-6, 8-11) of normal curcumin- or curcum- fed groups showed a significantly lower values when compared with the control except group (2, 7) which showed non significant change, while liver triacylglycerol content showed no significant change for all groups except groups (5,6 and 10,11, high level fed) which showed a significant decrease when compared with the normal group. Hepatic phospholipids and cardiac cholesterol content showed non significant change.

Table (5-b) showed significantly higher levels of hepatic cholesterol, triacylglycerol and phospholipids concentrations; and cardiac cholesterol concentration in cholesterol-fed group (G 26) or the untreated hypercholesterolemic control group (G 12) than control group.

The untreated hypercholesterolemic control group (G 12) showed significantly lower levels of hepatic cholesterol, triacylglycerol and phospholipids concentrations; and a non significant change of cardiac cholesterol than cholesterol-fed group (G 26).

Data of table (5-b) showed significantly lower levels of hepatic cholesterol, triacylglycerol concentrations; and cardiac cholesterol concentration in curcumin-fed (G: 13-17), curcumin+ piperine-fed (G: 18-20), curcum-fed (G: 21-25) groups when compared with control (G 1^1), or with untreated hypercholesterolemic control group (G 12) or with control hyperlipidemic group (G 26) except G 18 and 22 when compared with G 12 where no significant change was observed.

Hepatic phospholipids contents of all groups showed no significant change when compared with G 12 or G 1^1 except G 13 and G 21, which showed significant increase when compared with G 1^1. Hepatic phospholipids contents of all groups showed a significant decrease when compared with G 26 except G 13 and G 21, which showed non significant decrease.

Cardiac cholesterol contents of groups (G: 15-17; 19-20; 23-25) showed no significant change when compared with G 1^1 except G 13-14; 18; 21-22 which showed significant increase when compared with G 1^1. Cardiac cholesterol contents of all groups showed no significant change when compared with G 12 or G26 except G 16-17, 20, 23-25, which showed a significant decrease when compared with G 26 and G 17, 25, which showed a significant decrease when compared with G 12.

Table (1-a): Body weight gain, g, (BWG) of normal rats supplemented with different of curcum or curcumin

	G1: Control	G 2:Curn 1	G 3:Curn 2	G 4:Curn 3	G 5:Curn 4	G 6:Curn 5	G 7: Cur 1	G 8:Cur 2	G 9:Cur 3	G 10:Cur 4	G 11:Cur 5
M±SE*	62.45±2.03	61.55±4.18	59.18±2.46	58.45±5.02	58.18±2.15	57.00±1.69	60.18±2.47	58.91±1.58	57.64±1.86	56.82±1.94	57.00±1.76

Table (1-b): Body weight gain, g, (BWG) of hypercholesterolemic rats

	G 1	G 12	G 13	G 14	G 15	G 16	G 17	G 18	G 19	G 20	G 21	G 22	G 23	G 24	G 25	G 26
Addition	Control Non	Cholesterol treated (3%Cholesterol)														
M±SE	62.45±2.03	83.91±1.59	80.36±3.19	80.18±3.65	80.36±3.60	79.64±2.75	76.91±2.55	80.64±2.43	80.55±1.38	78.45±1.65	81.82±1.83	79.45±2.21	79.18±3.68	80.27±2.30	79.00±3.26	78.45 ±2.42
P≤		0.0001	0.0001	0.0004	0.0003	0.0001	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001	0.0007	0.0001	0.0003	0.0001

Table (1-c): Body weight gain, g, (BWG) of hypercholesterolemic rats supplemented with different levels of curcum or curcumin or curcumin +piperine

	G 1[1]	G 12	G 13	G 14	G 15	G 16	G 17	G 18	G 19	G 20	G 21	G 22	G 23	G 24	G 25
	Control	Cholesterol treated (3%Cholesterol)													
Addition	Non	Non	Curn 1	Curn 2	Curn 3	Curn 4	Curn 5	Curn 1+pip	Curn2+pip	Curn 3+pip	Cur 1	Cur 2	Cur 3	Cur 4	Cur 5
M±SE	75.0±2.20	59.18±4.81	61.18±2.36	65.09±5.10	67.18±2.97	69.82±1.44	71.45±3.01	64.09±3.89	66.00±2.94	69.27±3.26	61.00±2.24	64.00±3.88	65.55±2.08	66.91±2.55	68.27 ±2.81
P≤		0.007	0.0004	NS	0.047	NS	NS	0.03	0.03	NS	0.0002	0.02	0.005	0.03	NS

Table (2-a): Relative weight [(organ weight/FBW)*100] of liver and heart of normal rats fed different levels of curcum or curcumin. Results are expressed as M±SE

	G1: Control	G 2:Curn 1	G 3:Curn 2	G 4:Curn 3	G 5:Curn 4	G 6:Curn 5	G 7: Cur 1	G 8:Cur 2	G 9:Cur 3	G 10:Cur 4	G 11:Cur 5
RLW*	3.79±0.05	3.82±0.03	3.87±0.05	3.86±0.04	3.90±0.04	3.90±0.03	3.85±0.06	3.87±0.03	3.91±0.05	3.91±0.03	3.91±0.03
RHW*	0.3528±0.004	0.3475±0.003	0.3549±0.004	0.3478±0.004	0.3506±0.003	0.3477±0.003	0.3538±0.006	0.3525±0.003	0.3523±0.004	0.3518±0.003	0.3481±0.003

*: non significant from control

Table (2-b): Relative weight [(organ weight/FBW)*100] of liver and heart of hypercholesterolemic rats fed different levels of curcum or curcumin or curcumin+piperine

	G 1[1]	G 26	G 12	G 13	G 14	G 15	G 16	G 17	G 18	G 19	G 20	G 21	G 22	G 23	G 24	G 25
	Control	Cholesterol treated(3%Cholesterol)														
Addition	Non	Non (I)	Non (II)	Curn 1	Curn 2	Curn 3	Curn 4	Curn 5	Curn 1+pip	Curn2+pip	Curn 3+pip	Cur 1	Cur 2	Cur 3	Cur 4	Cur 5
RLW	3.75±0.05	4.09±0.10 [1]	2.99±0.06 [1,2]	3.12±0.09 [1,2]	3.07±0.05 [1,2]	3.02±0.07 [1,2]	2.98±0.08 [1,2]	2.93±0.06 [1,2]	3.01±0.06 [1,2]	3.00±0.11 [1,2]	2.99±0.08 [1,2]	3.03±0.10 [1,2]	3.03±0.09 [1,2]	2.99±0.05 [1,2]	2.98±0.09 [1,2]	2.950.10 [1,2]
RHW	0.3375 ±0.005	0.3685 ±0.01[1]	0.382± 0.008[1]	0.3495 ±0.008 [3]	0.3453 ±0.006[2,3]	0.344±0.007 [2,3]	0.3407 ±0.01 [2,3]	0.3375 ±0.006[2,3]	0.35±0.006 [3]	0.3430 ±0.01 [3]	0.339± 0.01 [2,3]	0.350± 0.01 [3]	0.343± 0.008[2,3]	0.3412 ±0.008 [2,3]	0.3401± 0.01 [2,3]	0.3374± 0.012[2, 3]

The superscripts refer to G no., which are significant with (1: G 1[1]; 2: G 26; 3: G 12;)

Table (3-a): Effect of feeding different levels of curcum on lipid profile of normal rats (mg%)

			Cholesterol	HDL-C	LDL-C	VLDL-C	Triacyl-glycerol	Phospho-Lipids	Cholesterol / HDL-C	LDL-C / HDL-C
1	Control I	M±SE	83.39±1.19	44.84±0.87	26.71±0.72	11.82±0.36	102.47±1.19	541.72±3.48	1.86±0.015	0.60±0.02
2	Curcum	M±SE	81.16±2.14	42.77±0.91	26.59±1.28	11.8±0.35	100.21±1.86	536.47±6.29	1.90±0.027	0.62±0.025
		P≤	NS	NS	NS	NS	NS	NS	NS	NS
3	Curcum	M±SE	79.91±1.16	42.3±0.93	25.88±1.15	11.73±0.47	99.18±1.31	532.47±5.29	1.89±0.032	0.61±0.027
		P≤	NS	NS	NS	NS	NS	NS	NS	NS
4	Curcum	M±SE	78.88±1.25	47.24±0.54	21.79±1.04	9.85±0.19	98.82±1.70	533.82±5.92	1.67±0.02	0.46±0.02
		P≤	0.02	0.03	0.001	0.0001	NS	NS	0.0001	0.0001
5	Curcum	M±SE	77.86±1.04	47.13±0.52	21.59±0.58	9.14±0.29	97.53±1.41	528.69±3.56	1.65±0.01	0.46±0.01
		P≤	0.003	0.036	0.0001	0.0001	0.015	0.02	0.0001	0.0001
6	Curcum	M±SE	77.67±0.99	47.11±0.51	21.47±0.57	9.09±0.27	95.22±1.32	524.46±2.39	1.65±0.01	0.46±0.02
		P≤	0.002	0.04	0.0001	0.0001	0.0007	0.0007	0.0001	0.0001

Table (3-b): Effect of feeding different levels of curcumin on lipid profile of normal rats (mg%)

			Cholesterol	HDL-C	LDL-C	VLDL-C	Triacyl-glycerol	Phospho-Lipids	Cholesterol / HDL-C	LDL-C / HDL-C
1	Control I	M±SE	83.39±1.19	44.84±0.87	26.71±0.72	11.82±0.36	102.47±1.19	541.72±3.48	1.86±0.02	0.60±0.02
7	Curcumin	M±SE	80.40±2.11	42.33±0.94	26.38±1.23	11.69±0.36	99.18±1.31	534.78±5.93	1.90±0.028	0.62±0.025
		P≤	NS	NS	NS	NS	NS	NS	NS	NS
8	Curcumin	M±SE	78.98±1.20	41.80±0.92	25.59±1.16	11.54±0.45	.98.31±1.95	532.04±5.31	1.89±0.03	0.61±0.028
		P≤	NS	NS	NS	NS	NS	NS	NS	NS
9	Curcumin	M±SE	79.24±1.25	47.66±0.76	21.65±0.78	9.93±0.26	97.89±1.85	531.86±5.56	1.66±0.02	0.45±0.01
		P≤	0.03	0.03	0.0001	0.0005	NS	NS	0.0001	0.0001
10	Curcumin	M±SE	79.03±1.03	47.58±0.56	21.56±0.54	9.89±0.27	96.46±1.60	526.84±3.44	1.66±0.01	0.45±0.01
		P≤	0.01	0.02	0.0001	0.0005	0.007	0.007	0.0001	0.0001
11	Curcumin	M±SE	79.17±0.99	47.65±0.58	21.45±0.57	9.87±0.21	94.24±1.31	522.65±2.29	1.66±0.01	0.45±0.01
		P≤	0.014	0.01	0.0001	0.0002	0.0002	0.0002	0.0001	0.0001

Table (4-a): Effect of feeding different levels of curcumin on lipid profile of hypercholesterolemic rats (mg%)

			Cholesterol	HDL-C	LDL-C	VLDL-C	Triacyl-glycerol	Phospho Lipids	Cholesterol / HDL-C	HDL-C / LDL-C
1[1]	Control I	M±SE	83.39±1.19	44.84±0.87	26.71±0.72	11.82±0.36	102.47±1.19	541.72±3.48	1.86±0.015	1.69±0.051
26	Control II	M±SE	174.93±3.08	24.21±0.62	105.61±2.1	45.11±1.36	201.62±7.02	985.14±12.9	7.24±0.103	0.23±0.004
		(26 vs 1[1])P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
12	Control III	M±SE	144.09±2.95	37.5±3.99	75.32±1.57	31.27±1.17	154.43±5.44	658.37±12.8	3.87±0.099	0.50±0.017
		(12 vs1[1])P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(12 vs 26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
13	Curcumin	M±SE	160.53±2.77	26.94±1.33	95.32±1.32	38.27±1.59	171.11±3.08	820.57±8.45	6.06±0.244	0.28±0.017
		(13 vs 1[1])P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(13 vs 26)P≤	0.003	0.049	0.0006	0.004	0.0009	0.0001	0.0003	0.006
		(13 vs 12)P≤	0.0007	0.0001	0.0001	0.002	0.0001	0.0001	0.0001	0.0001
14	Curcumin	M±SE	139.76±2.56	33.27±1.31	82.41±1.90	24.11±0.93	134.85±4.65	684.72±13.6	4.24±0.123	0.41±0.019
		(14 vs 1[1])P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(14 vs 26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(14 vs 12)P≤	NS	0.032	0.01	0.00015	0.013	NS	0.03	0.002
15	Curcumin	M±SE	108.12±2.18	41.41±1.30	48.15±0.82	18.56±0.70	120.98±3.04	603.17±9.14	2.62±0.04	0.86±0.03
		(15 vs 1[1])P≤	0.0001	0.042	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(15 vs 26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(15 vs 12)P≤	0.0001	0.045	0.0001	0.0001	0.0001	0.0025	0.0001	0.0001
16	Curcumin	M±SE	100.39±2.33	42.01±0.96	42.31±1.38	16.07±0.66	112.18±4.67	586.17±10.2	2.39±0.02	1.00±0.02
		(16 vs 1[1])P≤	0.0001	0.04	0.0001	0.0001	NS	0.0006	0.0001	0.0001
		(16 vs 26)P≤	0.0001	7.17E-12	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(16 vs 12)P≤	0.0001	0.011	0.0001	0.0001	0.0001	0.0003	0.0001	0.0001
17	Curcumin	M±SE	90.06±3.26	42.86±2.07	33.55±0.90	13.65±0.61	109.21±1.96	556.13±8.43	2.12±0.046	1.28±0.05
		(17 vs 1[1])P≤	NS	NS	0.0001	0.02	0.009	NS	0.0001	0.0001
		(17 vs 26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(17 vs 12)P≤	0.0001	0.04	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Table (4-b): Effect of feeding different levels of Curcuminin+piperine on lipid profile of hypercholesterolemic rats (mg%)

			Cholesterol	HDL-C	LDL-C	VLDL-C	Triacyl-glycerol	Phospho-Lipids	Cholesterol / HDL-C	LDL-C / HDL-C
1[1]	Control I	M±SE	83.39±1.19	44.84±0.87	26.71±0.72	11.82±0.36	102.47±1.19	541.72±3.48	1.86±0.015	0.60±0.02
26	Control I	M±SE	174.93±3.08	24.21±0.62	105.61±2.1	45.11±1.36	201.62±7.02	985.14±12.9	7.24±0.103	4.37±0.071
12	Control II	M±SE	144.09±2.95	37.5±3.99	75.32±1.57	31.27±1.17	154.43±5.44	658.37±12.8	3.87±0.099	2.02±0.063
18	Curcumin + Piperine	M±SE	149.67±2.48	30.58±1.39	84.77±1.11	34.32±1.85	160.99±3.07	716.06±9.53	4.96±0.18	2.83±0.14
		(18 vs 1[1])P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(18 vs26)P≤	0.0001	0.0006	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001
		(18 vs12)P≤	NS	0.002	0.0001	NS	NS	0.002	0.0001	0.0001
19	Curcumin + Piperine	M±SE	122.06±2.19	36.68±1.26	70.22±1.21	15.16±0.46	120.85±3.71	627.12±12.0	3.35±0.07	1.93±0.07
		(19 vs 1[1])P≤	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001
		(19 vs26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(19 vs12)P≤	0.0001	NS	0.02	0.0001	0.0001	NS	0.0006	NS
20	Curcumin + Piperine	M±SE	100.42±1.87	42.92±0.90	45.15±1.14	12.35±0.56	103.08±2.58	558.77±8.33	2.34±0.03	1.05±0.02
		(20 vs 1[1])P≤	0.0001	NS	0.0001	NS	NS	NS	0.0001	0.0001
		(20 vs26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(20 vs12)P≤	0.0001	0.0026	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Table (4-c): Effect of feeding different levels of curcum on lipid profile of hypercholesterolemic rats (mg%)

			Cholesterol	HDL-C	LDL-C	VLDL-C	Triacyl-glycerol	Phospho-Lipids	Cholesterol / HDL-C	LDL-C / HDL-C
1[1]	Control I	M±SE	83.39±1.19	44.84±0.87	26.71±0.72	11.82±0.36	102.47±1.19	541.72±3.48	1.86±0.015	0.60±0.02
26	Control II	M±SE	174.93±3.08	24.21±0.62	105.61±2.1	45.11±1.36	201.62±7.02	985.14±12.9	7.24±0.103	4.37±0.071
12	Control III	M±SE	144.09±2.95	37.5±3.99	75.32±1.57	31.27±1.17	154.43±5.44	658.37±12.8	3.87±0.099	2.02±0.063
21	Curcum	M±SE	156.32±2.65	25.98±1.24	93.08±1.58	37.26±1.70	168.78±2.75	817.39±7.79	6.12±0.254	3.67±0.197
		(21 vs 1[1])P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(21 vs 26)P≤	0.0002	NS	0.00015	0.002	0.0004	1.62E-09	0.0007	0.003
		(21 vs 12)P≤	0.006	0.0001	0.0001	0.0095	0.03	0.0001	0.0001	0.0001
22	Curcum	M±SE	137.48±2.05	32.27±1.06	81.63±1.86	23.58±0.92	130.82±4.33	679.97±14.0	4.29±0.119	2.56±0.113
		(22 vs 1[1])P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(22 vs 26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(22 vs 12)P≤	NS	0.0052	0.02	0.0001	0.002	NS	0.01	0.0006
23	Curcum	M±SE	114.83±1.99	36.95±1.24	60.56±0.85	17.32±0.52	117.68±2.86	600.54±9.35	3.13±0.067	1.66±0.059
		(23 vs 1[1])P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(23 vs 26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(23 vs 12)P≤	0.0001	NS	0.0001	0.0001	0.0001	0.0018	0.0001	0.0005
24	Curcum	M±SE	97.92±1.89	39.47±0.86	42.92±1.09	15.53±0.58	110.76±4.36	583.46±10.3	2.48±0.025	1.09±0.024
		(24 vs 1[1])P≤	0.0001	0.0003	0.0001	0.0001	NS	0.001	0.0001	0.0001
		(24 vs 26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(24 vs 12)P≤	0.0001	NS	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001
25	Curcum	M±SE	88.6±3.13	42.26±2.25	33.12±0.53	13.22±0.60	106.37±1.59	553.54±8.11	2.12±0.047	0.80±0.04
		(25 vs 1[1])P≤	NS	NS	0.0001	NS	NS	NS	0.0001	0.0002
		(25 vs 26)P≤	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		(25 vs 12)P≤	0.0001	NS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Table (5-a): Lipid profile of normal rats' liver and heart fed different levels of curcum or curcumin (mg/100g)

		G 1-Control	G 2-Curn 1	G 3-Curn 2	G 4-Curn 3	G 5-Curn 4	G 6-Curn 5	G 7-Cur 1	G 8-Cur 2	G 9-Cur 3	G 10-Cur 4	G 11-Cur 5
Liver Cholesterol	M±SE	717.15±9.79	697.98±17.53	686.37±9.86	678.37±10.23	669.60±8.54	658.67±8.66	691.44±17.3	679.23±9.81	674.58±9.92	665.04±8.44	655.06±8.09
	P≤		NS	0.049	0.018	0.003	0.0005	NS	0.018	0.009	0.0012	0.0002
Liver Triacylglycerol	M±SE	1383.35±15.27	1352.84±23.94	1338.93±16.88	1334.07±21.93	1316.66±18.20*	1285.47±16.95	1338.93±16.88	1327.19±25.11	1321.52±23.87	1302.21±20.57	1272.24±16.88
	P≤		NS	NS	NS	0.015	0.0007	NS	NS	NS	0.007	0.0002
Liver Phospholipids	M±SE	1969.89±197.39	1950.80±196.40	1936.25±194.57	1941.16±195.29	1922.51±192.68	1907.13±190.91	1944.65±195.64	1934.69±194.42	1934.04±194.45	1915.78±191.98	1900.55±190.24
	P≤		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Heart Cholesterol	M±SE	833.9±118.09	811.6±116.42	798.1±113.09	788.8±111.84	778.6±110.18	765.9±108.42	804.0±115.32	789.8±111.92	784.4±111.18	773.3±109.43	761.7±107.76
	P≤		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table (5-b): Lipid profile of rats' liver and heart of hypercholesterolemic rats fed different levels of curcum or curcumin or curcumin+piperine (mg/100g)

		G 1	G 26	G 12	G 13	G 14	G 15	G 16	G 17	G 18	G 19	G 20	G 21	G 22	G 23	G 24	G 25
	M±SE	717.15 ± 9.79	1504.40 ± 25.24	1239.17 ± 24.22	1380.56 ± 22.69	1201.94 ± 20.99	1015.83 ± 17.87	863.35 ± 19.12	774.52 ± 26.76	1287.16 ± 20.31	1049.72 ± 17.93	863.61 ± 15.37	1344.35 ± 21.71	1182.33 ± 16.81	987.54 ± 16.32	842.11 ± 15.54	761.96 ± 25.69
Liver	(vs 1)P≤		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	NS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	NS
Cholesterol	(vs 26)P≤			0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	(vs 12)P≤				0.0001	NS	0.0001	0.0001	0.0001	NS	0.0001	0.0001	0.0001	NS	0.0001	0.0001	0.0001
	M±SE	1383.35 ± 15.27	2721.87 ± 90.38	2084.81 ± 69.98	2309.99 ± 39.58	1820.48 ± 59.83	1633.23 ± 39.18	1514.43 ± 60.15	1474.34 ± 25.22	2173.37 ± 39.49	1631.48 ± 47.75	1391.58 ± 33.19	2278.53 ± 35.36	1766.07 ± 55.69	1588.68 ± 36.82	1495.26 ± 56.08	1436.00 ± 20.46
Liver	(vs 1)P≤		0.0001	0.0001	0.0001	0.0001	0.0001	NS	0.0001	0.0001	0.0001	NS	0.0001	0.0001	0.0001	NS	NS
triacylglycerol	(vs 26)P≤			0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	(vs 12)P≤				0.016	0.014	0.0001	0.0001	0.0001	NS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	M±SE	1969.89 ± 197.39	3582.33 ± 361.24	2394.07 ± 243.81	2983.89 ± 299.95	2489.89 ± 253.79	2193.35 ± 221.81	2131.53 ± 216.32	2022.29 ± 204.52	2603.85 ± 262.66	2280.44 ± 232.14	2031.89 ± 205.41	2972.33 ± 298.56	2472.62 ± 252.39	2183.78 ± 220.99	2121.67 ± 215.40	2012.87 ± 203.42
Liver	(vs 1)P≤		0.0009	NS	0.01	NS	NS	NS	NS	NS	NS	NS	0.011	NS	NS	NS	NS
Cholesterol	(vs 26)P≤			0.013	NS	0.02	0.004	0.003	0.001	0.04	0.007	0.0013	NS	0.020	0.004	0.002	0.001
	(vs 12)P≤				NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	M±SE	833.9 ± 118.09	1749.3 ± 248.41	1440.9 ± 205.22	1605.3 ± 227.89	1397.6 ± 198.61	1181.2 ± 167.88	1003.9 ± 143.43	900.6 ± 131.26	1496.7 ± 212.34	1220.6 ± 173.39	1004.2 ± 142.75	1563.2 ± 221.85	1374.8 ± 194.78	1148.3 ± 163.03	979.2 ± 139.29	886 ± 128.92
Heart	(vs 1)P≤		0.002	0.014	0.005	0.018	NS	NS	NS	0.009	NS	NS	0.006	0.02	NS	NS	NS
Cholesterol	(vs 26)P≤			NS	NS	NS	NS	0.013	0.005	NS	NS	0.013	NS	NS	0.046	0.01	0.004
	(vs 12)P≤				NS	NS	NS	NS	0.03	NS	NS	NS	NS	NS	NS	NS	0.026

Discussion

BWG of cholesterol fed rats was significantly higher than that of their respective control group or their respective initial groups, which are in agreement with Hulbron *et al.* (1982) and disagree with Sérougne *et al.* (1995).

The significant increase of liver and heart weight may be attributed to fat deposit (Table 2-a). As recorded by several investigators, increased cholesterol level increases the fat accumulation in liver (Kahlone *et al.* 1997 and Murray *et al.* 2000).

Table (3-a, b) revealed that serum cholesterol (total, LDL, VLDL) of groups (G: 4-6 and 9-11) of curcumin- or curcum-fed groups was significantly lower than control group. Also serum HDL-C of groups (G: 4-6 and 9-11) of curcumin- or curcum- fed groups was significantly higher than control group. Cholesterol decrease occurs in LDL and VLDL fraction (≈ 20% each). Soni and Kuttan (1992) found that oral curcumin given to healthy human volunteers resulted in a significant decrease in the level of serum lipid

peroxides (33%), significant increase in HDL-C (29%), and a significant decrease in total serum cholesterol (11.63%).

Tables (4-a, b, c) revealed that serum cholesterol (total, LDL, VLDL); triacylglycerol and phospholipids levels of cholesterol-fed groups were significantly higher than control group, while HDL-C was significantly lower than control group. The significant increase in serum cholesterol level may be due to type and amount of oil in which cholesterol was dissolved (Grundy and Denke 1990 and Tebib *et al.* 1994). Serum total cholesterol was significantly higher in cholesterol-fed rats due substantially to greater VLDL concentration due to increased intery of cholesterol into the circulation (Abbey *et al.* 1993) and suppression of cholesterol transport by HDL. The significant increase in serum LDL-C levels may be due to suppression of LDL receptor activity in cholesterol-fed rats (Sorci-Thomas *et al.* 1989), which allow for an increased conversion of VLDL remnants to LDL since VLDL remnants are partially removed by LDL receptors. This will lead to an over production of LDL (Kovanen *et al.* 1981 and Sorci-Thomas *et al.* 1989). The data also showed that using 0.5 % level (G 15, 23) is better than using 2.0% level which is 4x (G 23, 25) since degree of change does not go with using this high level. Curcum is slightly better than curcumin as hypocholes-terolemic agent. Curcumin reduces choles-terol by interfering with intestinal choles-terol uptake, increasing the conversion of cholesterol into bile acids, and increasing the excretion of bile acids or through interfering with exogenous cholesterol absorption **(**Srinivasan and Sambaiah 1991**).** Also HDL cleans off the walls of blood vessels, thus removing excess cholesterol, LDL. The HDL then carries this cholesterol to the liver where it is processed, or by decreasing thiobarbityric acid (TBA) value and improved total anti-oxidation capability. Also through enhancing the activities of SOD (superoxide dismutase) and GSH-PX in liver (Wang *et al.* 2000). The hypocholes-terolemic effect may also be due to the significantly increased activity of hepatic acyl-CoA oxidase of treated hypercholes-terolemic rats. Furthermore, epididymal adipose tissue weight was significantly reduced with curcuminoid intake in a dose-dependent manner, which means that dietary curcuminoids have lipid-lowering potency in vivo, probably due to alterations in fatty acid metabolism (Asai and Miyazawa 2001). Babu and Srinivasan (1997) suggested that the hypocholesterolemic activity is properly due to increased hepatic cholesterol-7a-hydroxylase activity thus leading to higher rate of cholesterol catabolism. Soudamini *et al.* (1992) and Sreejayan and Rao (1994) stated that curcumin and curcumoniods act as inhibitors of lipid peroxidation which lead to cholesterol reduction. The results agree with Patil and Srinivasan (1971); Soudamini *et al.* (1992), and Sreejayan and Rao (1994); And disagree with Deters *et al. (*2001) who conclude that curcumin is not able to prevent cyclosporine-induced cholestasis and hyperlipidemia after prolonged administration in bile fistula rats.

Curcumin or curcum lower cholesterol, LDL-C, VLDL-C and raising HDL-C, which act as independent factor. The National cholesterol Education Program's new guidelines now recognize that low HDL levels as a strong independent risk factor for coronary artery disease and recommend raising HDL, which is another important factor to reduce risk of heart disease.

Pharmacokinetic properties of curcumin indicate that curcumin when given orally is less active, this may be because it is absorbed poorly by the gastro-intestinal tract and/or underlies presystemic transformation since after oral application only traces of curcumin were found in the blood and this may be due to transform-ation of curcumin into unidentified compo-unds in absorption and its glucuronidation in the liver, and that, on the other hand, most of the curcumin is excreted via the faeces (Ravindranath and Chandrasekhara 1980 and 1981 and Ammon and Wahl 1991). Due to the low bioavailabilty of curcumin, piperine (1 piperoylpiperidine), active ingredients of black pepper (*Piper nigrum L.*) and others, were added to curcumin to enhance its bioavailabilty by

increasing absorption and reducing its metabolism in liver (Shoba *et al.* 1997) since piperine is known to enhance drugs by inhibition of glucuronidation in the liver and small intestine (Atal *et al.* 1985 and Singh *et al.* 1986).

Regarding atherogenic indices, it agrees with Dixit *et al.* (1988), who found that extract of *Curcuma longa L.* reduces significantly HDL-C/cholesterol ratio.

Significantly higher levels of hepatic cholesterol, triacylglycerol and phospho-lipids concentrations; and cardiac cholesterol concentration in cholesterol-fed group (G 26) or the untreated hypercho-lesterolemic control group (G 12) than control group was found. The reason for the higher hepatic cholesterol, triacylglycerol and phospholipids concentrations as reported by Fungwe *et al.* (1993) may be as a result of addition cholesterol to rats' diet, which leads to stimulation of the synthesis of triacylglycerol and/or reduced fatty acid synthesis. Dietary cholesterol may stimulate biosynthesis of triacylglycerol through increased activity of glycerophosphate acylt-ransferase which catalyze the first comm-itted step in glycerolipid synthesis, phosp-hatide phosphohydrolase which control the rate of diglyceride production and diacyltr-ansferase which may regulate the channeling of diglyceride into triglyceride (Fukada and Ontko 1984, Fungwe *et al.* 1993 and Liu *et al.* 1995). The significantly higher cardiac cholesterol concentration agrees with Hulbron *et al.* (1982) and Kris-Etherton *et al.* (1984) and it reflects sensibility of heart to cholesterol feeding.

Significantly lower levels of hepatic cholesterol, triacylglycerol concentrations; and cardiac cholesterol concentration in almost all groups (G: 13-17, 18-20, 21-25) groups when compared with (G 1^1, 12, 26) was found. These results agree with Asai and Miyazawa (2001). The change may be because dietary turmeric lowers lipid peroxi-dation by enhancing the activities of antioxidant enzymes (Reddy and Lokesh 1994). The decrease in hepatic triacylgly-cerol as proposed by Asai and Miyazawa (2001) is that curcuminor curcuminoids affect fatty acid catabolism rather than *de novo* synthesis through multiple induction of intra- and extra cellular fatty acid catabolism and utilization pathways e. g. induction of fatty acid β-oxidation and triacylglycerol hydrolysis with metabolites of absorbed curcuminoids serving as ligands that can activate PPARs (peroxisome proliferator-activated receptors) which regulate gene expression of ACO (acetyl CoA oxidase) which perform the first catalytic steps enzyme of peroxisomal fatty acid β-oxidation (Pan *et al.* 1999; Ramirez-Tortosa *et al.* 1999; Asai and Miyazawa 2000; Ireson *et al.*2001).

Conclusion

The use of curcum, curcumin, and mixture of curcumin and piperine may be useful in the management of cardiovascular disease. Using the lower level (0.5%) is better than using 2.0%. Piperine enhances the bioavailabilty of curcumin.

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تاثير نبات الكركوم والكركومين وخليط من الكركومين مع البيبرين... على صوره ليبيدات الدم في فئران التجارب البيضاء والمصابه بارتفاع ليبيدات الدم

غادة زغلول عباس سليمان

زميل كيمياء حيوية قسم الكيمياء الحيوية – المعهد القومي للتغذية –ألقاهره

الكركومين ماده صفراء اللون يتم الحصول عليه من ريزومات الكركم وهو من المواد عديدة الفينولات ويستخدم أيضا كماده غذائية ملونه وكذلك في الغذاء كتوابل وفى بعض الاستخدامات ألعلاجيه.

ويهدف هذا العمل لتقييم تاثير الكركوم والكركومين وخليط من الكركومين مع البيبرين... على صوره ليبيدات في بلازما الفئران الطبيعية والمصابه بارتفاع الليبيدات وقد تم استخدام 270 فار قسمت إلى 27 مجموعه

مج 1 ، 1 مجموعه ضابطه

مج 2، 11 فئران طبيعية تم تغذيتهم بغذاء مضاف إليه نسب مختليفه من الكركومين ، والكركم (مج 2 –6 .1% ، 25.% ،.5% ،1% ،2 % على التوالي)

(مج 7– 11 1.67 % ، 4.167 % ، 8.34 % , 16.65 % ، 33.34 %)

مج 12 – 26 في البدايه تم تغذيتها بغذاء مضاف اليه 2 % كوليسترول ثم مج 13 – 17 – 21– 25 – تم تغذيتها بغذاء مضاف اليه نسب مختلفه من الكركم والكركمين

(نفس مستوى مج 2–11 ، مج 18–20 تم تغذيتها بغذاء مضاف اليه كركومين (1. %، 25. % .5، %) وبيبرين (20 مجم / كجم من وزن الجسم)

مج 12 تم ذبحها في البدايه

مج 26 تم تغذيتها بغذاء طبيعي

تم قياس صوره الليبيدات الجلسريدات الثلاثية والفسفوليبيدات " البلازما والأعضاء مثل القلب والكبد ولوحظ ارتفاع الكوليسترول (الكلى) ، الليبوبروتينات ذات الكثافه المنخفضة ، الليبوبروتينات ذات الكثافه المنخفضة جدا) ، الجليسريدات الثلاثية والفوسفوليبيدات فى الفئران التي تخذن الغذاء المضاف اليه كوليسترول. فبما لوحظ انخفاض الليبوبروتينات ذات الكثافه العاليه.

ان الكركم والكركومين له تاثير مخضض (مثبط) للكوليسترول على كل من الفئران السليمه والمصابه ولكن تأثيره اكثر فى الفئران المصابين بارتفاع الكوليسترول يخفض الكركومين الكوليسترول عن طريق تداخله مع امتصاص الأمعاء للكوليسترول مزيلا تحول الكوليسترول الى الأملاح الصفراء وكذلك زياده اخراج الاملاح الصفراء.

استخدام الكركومين والبيرين افضل من استخدام الكركومين لوحده كل الجرعات لها نفس التاثير تقريبا ولكن استخدام .5% افضل من استخدام 2% لوحظ ارتفاع الكوليسترول، الجليسريدات الثلاثية ، الفوسفوليبيدات فى كبد وقلب الفئران المصابه بارتفاع فى الكوليسترولوجدان الكركومين له تاثير مضاد (مخفض) لهذه التأثيرات يضاف البيرين الى الكركومين ليحسن من فاعليته عن طريق زياده امتصاصه وتقليل التمثيل فى الكبد وهكذا يمكن القول ان استخدام الكركومين ، الكركم ، خليط من الكركومين والبيرين مفيد فى التحكم فى اراضى القلب واستخدام التركيز الأقل .5% افضل من استخدام 2% ويحسن البيرين من فاعليه الكركومين.