ORIGINAL ARTICLE

Comparative Study of Protective Effect of Tomato Juice and N-Hexane Extract of Tomato on Blood Lipids and Oxidative Stress in Cholesterol-Fed Rats

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ABSTRACT

Background: Hyperlipidemia is a well-established risk factor in pathogenesis of atherosclerosis and atherosclerosis-associated conditions by enhancing oxidative stress. Dietary supplementation of tomato which is enriched with antioxidants especially like lycopene may therefore be effective in reducing oxidative stress during hyperlipidemic condition. The study evaluates and compares the protective effect of tomato juice and n-Hexane extract of tomato on oxidative stress in hyperlipidemic rats.

Methodology: This experimental study was carried out among 42 rats divided in 7 groups. Rats were treated with 0.5% cholesterol (suspension of cholesterol powder in soybean oil) at a dose of 50 mg/ ml once daily through intragastric tube for 8 weeks. In other two groups of rats tomato juice (1 mg/kg) or n-Hexane extract of tomato (1 mg/kg) with 0.5% cholesterol were given orally once daily through intragastric tube for 8 weeks. Serum lipid profile, body weight, plasma malondialdehide (MDA) and erythrocyte reduced glutathione(GSH) levels were measured after 8 weeks in all the groups.

Results: Administration of cholesterol caused significant increase ($p < 0.001$) in serum cholesterol, serum triglyceride (TG), serum low-density lipoprotien cholesterol (LDL-C)and significant decrease ($p < 0.001$) in serum high-density lipoprotein cholesterol (HDL-C) which were associated with significant increment ($p < 0.001$) in plasma MDA levels and depletion($p < 0.001$) in erythrocyte GSH levels. Concomitant treatment of tomato juice or n-Hexane extract of tomato with cholesterol reduced ($p < 0.001$) serum cholesterol, serum LDL-C, body weight and increased serum HDL-C level in cholesterol plus tomato juice treated group ($p < 0.001$) and in cholesterol plus n-Hexane extract of tomato treated group ($p < 0.05$).But serum triglyceride was decreased($p < .05$) only in cholesterol plus tomato juice treated group. Simultaneous treatment of tomato juice or n-Hexane extract of tomato with cholesterol decreased ($p < 0.001$) plasma MDA level and increased ($p < 0.001$) erythrocyte GSH level. However, significant differences were noted between the effect of tomato juice and n-Hexane extract of tomato on serum cholesterol ($p < 0.001$), serum triglyceride ($p < .05$), serum LDL-C ($p < 0.001$), serum HDL-C level($p < 0.01$) and plasma MDA($p < 0.001$) and erythrocyte GSH ($p < 0.001$) levels. But no significant difference was noted on body weight.

Conclusion: It may be concluded that both tomato juice and n-Hexane extract of tomato offered protection against hyperlipidemia and oxidative stress, but the protection afforded by tomato juice was superior to n-Hexane extract of tomato.

Key Words: Tomato juice, n-Hexane extract of tomato, oxidative stress, hyperlipidemia. malondialdehyde, glutathione

Introduction

Hyperlipidemia plays a fundamental role as risk factor for the development and progression of atherosclerosis and atherosclerosis-associated conditions, such as coronary heart disease,ischemic cerebrovascular disease and peripheral vascular disease.[1-7] The excessive generation of free radicals in oxidative stress has emerged as a fundamental process in atherosclerotic diseases[8] and induce imbalance in natural defensive mechanism leading to impaired antioxidant protection.[9] Hypercholesterolaemia increases vascular oxidative stress by enhancing endothelial superoxide production (O_2^-)[10], that facilitates LDL oxidation which induces the generation of ROS in different vascular cell types, and decreases ROS degradation[8], auses induction of endothelial dysfunction, activation of endothelial adhesiveness, monocyte differentiation and adhesion

and smooth muscle cell proliferation[11] leading to lipid peroxidation products which may contribute to endothelial damage, alterations of endothelium-dependent vascular relaxation and atherogenesis.[10] Hypertriglyceridaemia has been shown to cause endothelial dysfunction via enhanced oxidative stress, it also indicates the presence of remnant lipoproteins that cause atherosclerosis.[6] ROS can stimulate vascular smooth muscle cell hypertrophy and hyperplasia., initiate development of a vascular proinflammatory state and are capable of reacting with unsaturated lipids and of initiating the self-perpetuating chain reactions of lipid peroxidation in the membranes. which is thought to be involved in various pathological conditions, such as, , tissue destruction.[12] To demonstrate the occurrence of lipid peroxidation in biological systems, determination of MDA, a known stable product of lipid peroxidation, is the most widely used method and also considered as a relevant and universal indicator.[13,14] Antioxidant status is an important marker of oxidative stress. GSH detoxifies oxygen radicals and therefore prevents cellular damage from oxidative stress. As GSH is rapidly oxidized to GS-SG by radicals and other reactive species and GS-SG is exported from cells, intracellular GSH can provide a valid index of oxidative stress.[15]

Feeding a high saturated-fat diet stimulates free radical production and oxidative DNA damage in the whole body.[16] Diets high in cholesterol play a key role in atherosclerotic disease risk by increasing blood lipids.[7] Epidemiologic studies suggest that tomato and tomato products such as tomato juice presumably might have lipid-lowering and antioxidant effect[17,18], which has attracted substantial interest for experiment. Tomato contains antioxidants such as lycopene, vitamin A,vitamin C, vitamin E, carotenoids, phytochemicals, polyphenols and flavonoids (Campbell et al., 2004) and can act in synergy in oxidative stress mechanism.[19,20] Lycopene, a hydrocarbon carotenoid, by virtue of its acyclic structure, large array of conjugated double bonds, and extreme hydrophobicity, exhibit a potent antioxidant activity by scavenging free radicals and inhibiting the chain propagation effect of ROS.[20,22] It has been suggested that there is a role of lycopene in protecting LDL or phospholipid in LDL from oxidation and in upregulating LDL receptor activity in macrophages 23[and] inhibiting HMG-CoA reductase, a key enzyme in the biosynthesis of cholesterol.[24] n-Hexane extract of tomato has been assumed to contain lycopene, a lipophilic compound, showed antioxidant potential in experimentally induced myocardial infarction in a study.[25]

So the present study aims to evaluate and distinguish the effect of tomato juice from that of n-Hexane extract of tomato on oxidative stress and hyperlipidemia.

Materials and Methods

This interventional experimental study was carried out on 42 rats in the Department of Pharmacology, Bangabandhu Sheikh Mujib Medical University, Shahbagh Dhaka, Bangladesh. (From May 2010 to March 2011)

Chemicals and reagents: Cholesterol powder =99% was procured from E. Merck, Germany.

Cholesterol, triglycerides and HDL cholesterol assay kit were procured from Randox Laboratories, UK. Trichloroacetic acid, disodium hydrogen phosphate, 5,5'-dithio-bis-2-nitrobenzoic acid (DTNB), reduced glutathione (GSH) and thiobarbituric acid were procured from Sigma Aldrich, Germany. All other chemicals used were of analytical grade. n-Hexane extract of tomato (lycopene) and tomato juice prepared in the laboratory of Pharmacology department of BSMMU.

Procedure of obtaining n-Hexane extract of tomato:

n-Hexane extract of tomato dissolved in upto1 ml of soybean oil for each rat which was equivalent to daily lycopene dose of 1 mg/kg body weight 26.Red tomatoes were cleaned properly, cut into small pieces and soaked in n-Hexane in clean amber coloured glass container for 24 hours. After that tomatoes were filtered properly and filtrate was condensed by Rotary vacuum evaporator at 40?c. For this method 1 kg of tomatoes were soaked into 1 liter of n-Hexane. In this way 51.8 mg of n-Hexane extract of tomato was obtained and was kept in amber coloured glass container and preserved at -20µc in deep freezer.[25]

Preparation of tomato juice

Each rat received tomato juice 18 which was equivalent to daily lycopene dose of 1 mg/kg body weight.[27,28] Fresh tomatoes were washed and cut into small pieces and then well homogenized by mechanical process, then slightly heated with little amount (350 μl) of soybean oil to facilitate lycopene absorption by gut.[23]

Animals: The study was carried out on 42 Long Evans Norwegian strains of adult healthy rats of both sexes, 2-3 months aged and weighing between 170-210 g. Rats were housed in standard stainless cages. They were allowed living at room temperature in a clean, well ventilated rodent room where a 12/12 hours light/dark cycle was maintained. They were fed on standard pellets of rat food and allowed to drink ad libitum.

Experimental Design

Experimental animals were divided into seven groups each group containing six rats and were treated orally through intragastric tube daily for 8 weeks accordingly. The rats of Group A were fed standard rat diet, Group B were fed soybean oil at a dose of 1 ml once daily, Group C were fed a 0.5% cholesterol (suspension of cholesterol powder in soybean oil) at a dose of 50 mg/ ml once daily[29,30], Group D were fed 0.5% cholesterol with tomato juice (1 mg/kg body weight) 18, Group E were fed 0.5% cholesterol with n-Hexane extract of tomato (1 mg/kg body weight)[26], Group F were fed tomato juice (1 mg/kg body weight), Group G were fed n-Hexane extract of tomato (1 mg/kg body weight). All the rats were sacrificed under light anesthesia by chloroform and were kept fasting overnight the day before sacrifice.

Body weight measurement: Properly calibrated analogue weight measurement machine was used to measure body weight of rats. Body weight of 42 rats was measured at day 0 and after 8 weeks.

Sample collection: Blood samples were collected by cervical decapitation and were treated with and without heparin in clean and dry test tubes.

Preparation of serum: The serum was separated by ultra-centrifugation (4000 rpm for 5 minutes) from non-heparinised blood and collected by micropipette, transferred to labeled test tubes for biochemical study.

Preparation of erythrocyte hemolysate: Heparinized blood samples were centrifuged at 4,000 rpm for 5 min and the plasma was separated from the top. The packed RBCs were washed three times with five volumes buffered saline (0.9% saline in 10 mM phosphate buffer, pH 7.4) by centrifugation at 4,000 rpm for 5 min. The packed cells were then suspended in an equal volume of the distilled deionized water to lyse RBCs.

Estimation of serum cholesterol: Serum cholesterol was assayed by enzymatic (CHOD-PAP) method[31]. One mL of the cholesterol reagent was added to each of the test tubes containing 10 μL of standard solution, 10 μL of distilled water and 10 μL of serum and the mixtures were mixed properly and incubated at 37°C for 5 min. The absorbance was measured at 500 nm against the reagent blank using UV-Vis spectrophotometer.

Estimation of serum triglyceride: Serum triglyceride was assayed by enzymatic (GPO-PAP) method[32]. One mL of the triglyceride reagent was added to each of the test tubes containing 10 μL of standard solution, 10 μL of distilled water and 10 μL of serum and the mixtures were mixed properly and incubated at 37°C for 5 min. The absorbance was measured at 500 nm against the reagent blank using spectrophotometer.

Estimation of serum HDL cholesterol: Serum HDL cholesterol was assayed by enzymatic (CHOD-PAP) method after precipitation of other lipid component of the sample.[33] One mL of the precipitant reagent was added to 500 μL of the sample. Then the mixture was mixed properly, allowed to stand for 10 min at room temperature and centrifuged at 4,000 rpm for 10 min. After that HDL cholesterol was assayed from the supernatant by enzymatic (CHOD-PAP) method.

Estimation of serum LDL cholesterol: Serum LDL cholesterol was calculated by Friedewald equation.[34] LDL cholesterol = Total cholesterol - HDL cholesterol - Triglycerides/.[5]

Estimation of GSH: GSH level was assayed by Ellman's method.[35] In brief, 1 mL of erythrocytes was added to 1 mL of 5% trichloroacetic acid and

the mixture was vortexed and centrifuged at 4,000 rpm for 5 min. Then 250 μL of supernatant was added to 2 mL Na2HPO4 (4.25%) and 250 μL of DTNB (0.04%). The mixture was allowed to stand for approximately 10 min, and forming a yellow substance. The absorbance was measured at 412 nm using spectrophotometer.

Estimation of Plasma MDA level: Plasma MDA level was estimated by Thiobarbituric acid method[36]. The absorbance was measured using spectrophotometer at 532 nm.

The quantitative variables were expressed as mean±SD. ANOVA (multiple comparisons) was done for statistical analysis. Post hoc analyses of differences were done by Bonferroni test.

Result

Results showed that administration of tomato juice or n-Hexane extract of tomato did not cause any significant change in serum lipid profile, plasma MDA, erythrocyte GSH and body weight when compared with control (Table II).

Table I: Effect of 0 .5%cholesterol, tomato juice, n-Hexane-extract of tomato on body weight of rat

Groups n=6	Body weight(gm) At day o	Mean ±SD After 8 weeks	Percentage reduction
A	193.33±8.16	268.33 ±7.53	
B	185.0±8.37	266.67 ±8.16	
C	188±7.53	301.67 ±7.53	
D	191.67±7.53	275.00 ±8.37	8.84%
E	190.00±6.32	281.67 ±7.53	6.63%
F	188.33±7.53	271.67±7.53	
G	186±8.16	270.00±6.32	

Table II: Effect of 0 .5%cholesterol, tomato juice, n-Hexane-extract of tomato on lipid profile, Plasma MDA, Erythrocyte GSH of rats

Groups (n=6)	Serum cholesterol (mg/dl) Mean ± SD	Serum Triglycerides (mg/dl) Mean ± SD	Serum LDL (mg/dl) Mean ± SD	Serum HDL (mg/dl) Mean ± SD	Plasma MDA (micromol/L) Mean ± SD	Erythrocyte GSH (mg/gmHb) mean±SD
A(control)	68.63 ± 4.22	66.14±6.30	20.81±3.94	34.51±1.86	0.36±0.05	9.96±0.27
B(vehicle)	68.70±2.89	69.19±3.73	20.55±4.16	34.38±2.09	0.37±0.05	9.78±0.34
C(cholesterol)	151.86±4.88	99.87±5.12	107.40±6.36	24.49±2.48	1.78±0.29	4.43±0.29
D(chol+tomato juice)	93.13±3.69	88.71±5.88	38.94±5.62	36.44±3.19	0.53±0.04	7.90±0.27
E(chol+n-H extract)	120.42±4.41	98.81±5.72	70.56±5.99	30.10±2.86	0.98±0.06	6.23± 0.38
F(tomato juice)	68.60±2.74	65.08±3.86	12.64±5.02	42.91±3.19	0.35±0.05	10.02±0.32
G(n-H-extract)	68.85±3.32	66.54±3.56	20.23±5.40	35.39±2.83.	0.36±0.06	9.85±0.38

Serum cholesterol, serum TG, serum LDL, serum HDL level (mean ± SD) were 68.63±4.22 mg/dl , 66.14 ±6.30 mg/dl, 20.81±3.94 mg/dl, 34.51 ±1.86 mg/dl in control respectively and 151.86±4.88 mg/dl, 99.87 ± 5.12 mg/dl , 107.40±6.36 mg/dls, 24.49±2.48 mg/dl in cholesterol-fed rats respectively.Cholesterol feeding produced significant change ($p<0.001$) in serum lipid profile, when compared to control(TableI I). Serum cholesterol, sserum TG, serum LDL, serum HDL level (mean ± SD) were 93.13±3.69 mg/dl, 88.71±5.88 mg/dl, 38.94±5.62 mg/dl, 36.44±3.19 mg/dl respectively in tomato juice with cholesterol treated group and 120.42±4.41 mg/dl, 98.81±5.72 mg/dl, 70.56±5.99 mg/dl, 30.10±2.86 mg/dl respectively in n-Hexane extract of tomato with cholesterol treated group. Concomitant treatment of tomato juice or n-Hexane extract of tomato with cholesterol significantly reduced ($p<0.001$) serum cholesterol, serum LDL-C and increased serum HDL-C level in cholesterol plus tomato juice treated group ($p<0.001$) and in cholesterol plus n-Hexane extract of tomato treated group ($p<0.05$) as compared to only cholesterol treated group.But as compared to cholesterol treated group serum triglyceride was significantly decreased($p<0.05$) only in cholesterol plus tomato juice treated group (TableII). Concomitant treatment of tomato juice or n-Hexane extract of tomato with cholesterol decreased the serum cholesterol level by 38.67% and 21% respectively, serum TG level by 11.17% and 1.06% respectively, serum LDL level by 63.74% and 34.30% respectively and increased serum HDL level by 48.79% and 22.91% respectively (Table III). The change in serum lipid profile when compared between these two groups, the change was significant (Table III).

Table III: Intergroup variation with percentage of increase(↑) or decrease(↓)

Variable	chol+tomato juice	Chol+n -H-extract	Level of significance
Serum cholesterol	38.67% "↓	21%"↓	0.000***
Serum TG	11.17%"↓	1.06%"↓	0.027*
Serum LDL	63.74%"↓	34.30%"↓	0.000***
Serum HDL	48.79%'↑	22.91%'↑	0.005**
Body wt	8.84%"↓	6.63%"↓	1.000 NS
Plasma MDA	70.22"↓	44.94"↓	0.000***
Erythrocyte GSH	78.33'↑	40.63'↑	0.000***

Plasma MDA level in the cholesterol treated rats and control group were 1.78 ± 0.29 μmol/L and $0.36 \pm 0.05\mu$mol/L respectively. The rise in the plasma MDA level was significant ($p < 0.001$) (TableII). Plasma MDA level in tomato juice with cholesterol treated group was 0.53 ± 0.04 μmol/L and in n-Hexane extract of tomato with cholesterol treated group was 0.98 ± 0.06 μmol/L. In the both groups, the decrease in plasma MDA level as compared to only cholesterol treated group was significant ($p < 0.001$). Concomitant treatment of tomato juice or n-Hexane extract of tomato with cholesterol decreased the plasma MDA level by 70.22% and 44.94% respectively (TableIII). The change in plasma MDA level when compared between these two groups, the change was significant (Table III).

The concentration of erythrocyte GSH in cholesterol treated group and control group were 4.43 ± 0.29 mg/gm Hb and $9.96 \pm 0..27$ mg/gm Hb respectively. The reduction in concentration of erythrocyte GSH concentration was significant ($p < 0.001$) (TableII). The concentration of erythrocyte GSH in tomato juice with cholesterol treated group and n-Hexane extract of tomato with cholesterol treated group were 7.90 ± 0.27 and 6.23 ± 0.38 mg/gm Hb respectively. In the both groups, the increase in erythrocyte GSH concentration as compared to only cholesterol treated group was significant ($p < 0.001$). Simultaneous treatment of tomato juice or n-Hexane extract of tomato with cholesterol increased the erythrocyte GSH concentration by 78.33% and 40.63% respectively(TableIII). The change in erythrocyte GSH level when compared between these two groups, the change was significant (Table III).

Body weight of the cholesterol treated rats and control group were 301.67 ± 7.53 gm and $\pm 268.33 \pm 7.53$ gm respectively after 8 weeks. The gain in the body weight was significant ($p < 0.001$). Body weight in tomato juice with cholesterol treated group was 275 ± 8.37 gm and in n-Hexane extract of tomato with cholesterol treated group was 281.67 ± 7.53 gm. In the both groups, the decrease in body weight as compared to only cholesterol treated group was significant ($p < 0.001$) (TableI). Concomitant treatment of tomato juice or n-Hexane extract of tomato with cholesterol decreased the body weight by 8.84% and 6.63% respectively (TableI). The change in body weight when compared between these two groups, the change was not significant (Table III).

Discussion

There is a close relationship between hyperlipidemia and atherosclerosis[2,3] where generation of free radicals and lipid peroxidation ultimately lead to an overall deleterious impact on biological system[8]. Many studies[37,38] have shown that dietary phytochemical antioxidants are capable of removing free radicals. Among them tomato containing lycopene by virtue of its powerful antioxidant property causes neutralization of free radicals, resulting in protection against chronic disease especially coronary heart disease[39,40,41]. The aim of the present study is to evaluate and compare the protective effect of tomato juice or n-Hexane extract of tomato in cholesterol induced oxidative stress in experimental hyperlipidemic rats. The results of this study showed that simultaneous treatment of tomato juice or n-Hexane extract of tomato with cholesterol for 8 weeks afforded protection against hyperlipidemia and oxidative stress as evidenced by significant changei n serum lipid profile and markers of oxidative stress In the present study cholesterol feeding for 8 weeks produced significant rise in serum cholesterol, triglycerides, LDL levels, body weight and decrease in serum HDL in rats. An increase in oxidative stress after cholesterol treatment was revealed by a significant increase in plasma MDA level and a significant decrease in erythrocyte GSH concentration. Couple of researchers, in their study showed that cholesterol feeding produced significant rise in serum cholesterol, triglycerides and LDL levels body weight and reduction in serum HDL level .They also found marked elevation in erythrocyte MDA and significant decrease in activities of endogenous antioxidants such as reduced GSH in rats[29]. Some others demonstrated significant increase in serum cholesterol, triglycerides and LDL levels and reduction in serum HDL cholesterol level and increased concentration of plasma

MDA and decreased level of GSH-Px in cholesterol-fed hamsters after 8 weeks treatment.[17] Plasma MDA level significantly increased in hyperlipidemic animal model were observed by some researchers.[42] The rise in MDA level indicates enhanced lipid peroxidation which is one of the important manifestations of oxidative damage initiated by ROS[13,14]. The lowered erythrocyte GSH in rats could occur as a consequence of the oxidative stress where GSH may be exhausted by excessive production of reactive oxygen species and may be involved in the reduction of hydrogen peroxide radicals. The decreased erythrocyte GSH may be associated with enhanced protective mechanism to oxidative stress in hyperlipidemic condition induced by cholesterol feeding.

There is evidence that links hypercholesterolemia with increased endothelial superoxide (O_2-) production and lipid peroxidation and increased oxidative stress[10]. Feeding a high saturated-fat diet increases nitric oxide synthase (NOS) activity and stimulates free radical production and oxidative DNA damage in the whole body[16]. Dietary manipulation, particularly of fats, result in marked changes in lipid profiles and lipoprotein composition[43]. A number of studies suggested that tomato and tomato products presumably might have lipid-lowering and antioxidant effect[17,18]. In our study coadministration of tomato juice or n-Hexane extract of tomato along with cholesterol significantly reduced serum cholesterol, serum low density lipoprotein (LDL) levels and increased significantly serum high density lipoprotein (HDL) level. But serum triglycerides level did not reduce significantly by n-Hexane extract of tomato. In a study by some researchers showed hypocholesterolemic effect of lyophilized powder of tomato juice, was seen in hyperlipidemic mice[42]. Another group found that serum cholesterol, serum triglycerides, serum LDL levels were reduced and serum HDL level was increased significantly by supplementation with tomato juice in oxidative stress induced rats[18]. In a study researchers showed tomato paste decreased serum cholesterol and LDL levels and increased HDL concentration significantly in hypercholesterolemic hamsters[18]. A chinese study showed lipid lowering effect of lycopene in hyperlipidemic model of rats[44]. The beneficial effects of tomato juice or n-Hexane extract of tomato could be contributed by lycopene by inhibiting HMG-CoA reductase, a key enzyme in the biosynthesis of cholesterol[24]. In our investigation simultaneous administration of tomato juice along with cholesterol reduced serum cholesterol, serum triglycerides, serum LDL levels by 38.67%,11.17%, 63.74% respectively and increased serum HDL level by 48.79% and coadministration of n-Hexane extract of tomato with cholesterol decreased serum cholesterol, serum LDL levels by 21%, 34.30% respectively and increased serum HDL levels by 22.91%. The lipid-lowering effect of tomato juice was superior to n-Hexane extract of tomato. The better effect of tomato juice could be due to the presence of phenolics, fruit matrix, specific fibers such as pectin in tomato juice 19 and absence of those components in n-Hexane extract of tomato.

In this study simultaneous administration of tomato juice or n-Hexane extract of tomato with cholesterol caused a significant reduction in plasma MDA level. Another group of researchers found that lyophilized powder of tomato juice supplementation reduced plasma MDA level in hypercholesterolemic mice[42]. On the other hand, some others[44] showed that consumption of tomato powder increased erythrocyte MDA levels in rats exposed to oxidative stress[37]. Couple of researchers, in their study observed that administration of tomato product decreased plasma MDA level significantly in hyperlipidemic hamsters.[17] Concomitant administration of cholesterol with tomato juice or n-Hexane extract of tomato decreased plasma MDA level by 70.22% and 44.94% respectively. A study showed protective effect of lycopene on coronary heart disease by preventing free radical mediated lipid peroxidation 46. The decreased level of lipid peroxides (MDA) in tissue was found with lycopene treatment in experimental model of myocardial ischaemia reperfusion injury[26]. Administration of n-Hexane extract of tomato prevented the rise in cardiac MDA concentration in experimental myocardial ischaemia[25].

In this study concomitant administration of tomato juice or n-Hexane extract of tomato with cholesterol significantly increased erythrocyte GSH concentration. In a previous study tomato powder increased erythrocyte GSH levels in rats exposed to oxidative stress[37]. An earlier study found that administration of lycopene was able to enhance myocardial GSH content and GSH-Px activity in experimental model of myocardial ischaemia reperfusion injury[26]. Simultaneous administration of cholesterol with tomato juice or n-Hexane extract of tomato increased GSH concentration in erythrocyte by 78.33% and 40.63% respectively. Lycopene, exhibit a potent antioxidant activity by scavenging free radicals and inhibiting the

chain propagation effect of ROS[20,22]. It has been suggested that there is a role of lycopene in protecting LDL or phospholipid in LDL from oxidation and in upregulating LDL receptor activity in macrophages[23]. The preventive effect of tomato juice in ameliorating the oxidative stress is superior to n-Hexane extract of tomato. The superiority could be due to presence of both lipophilic and hydrophilic compounds as well as metabolites and oxidative products of lycopene (lycopenoids) that could act in synergy in ameliorating oxidative stress by removing free radicals[20,21].

Concomitant administration of tomato juice or n-Hexane extract of tomato with cholesterol significantly decreased body weight by 8.84% and by 6.63% This result is in conformity with a study where tomao juice administration restored the body weight gain of hyperlipidemic rats[18]. This effect could be due to hypolipidemic effect of tomato juice and n-Hexane extract containing lycopene, however there was no significant difference in the effect on body weight when these two groups were compared.

Conclusion

It may be concluded that concomitant administration of tomato juice or n-Hexane extract of tomato with cholesterol afforded protection against hyperlipidemia as reflected by a decrease in serum cholesterol, LDL levels and increase in HDL level and against oxidative stress as evidenced by a decrease in plasma MDA level and an increase in erythrocyte GSH level. However, the protective effect of tomato juice was better than n-Hexane extract of tomato with the assumption that synergy of all the phytochemicals beside lycopene might also be involved in preventive effect of tomatoes.

Conflict of Interest: Authors declared that they have no conflict of interest.

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