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Effect of Pumpkin (Cucurbita Moschata) and Pineapple (Ananas Comosus Linn) on Obese Hyperlipidemic Rats

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Abstract: The present study was carried out to investigate the improvement role of Pumpkin (*Cucurbita moschata*) and Pineapple (*Ananas comosus Linn*) on body weight and biochemical parameters of obese hyperlipidemic rats. Male albino rats Sprague Dawley Strain (36 rats) weighing (150±10 gm.) were fed on basal diet for one week for adaptation. After this week, the rats were divided into two main groups as following: The first main group (6 rats) fed on basal diet (as a control negative group). The second main group (30 rats) was fed on high fat diet (for four weeks) to induce obesity and hyperlipidemia. Then, rats were divided into five groups (six rats each) as following: Group (2) was fed on high fat diet (as a control positive group), Groups (3 and 4): were fed on high fat diet containing dried pumpkin5% and 7.5%. Groups (5 and6): were fed on high fat diet containing dried Pineapple5% and 7.5% respectively. The obtained results revealed that: feeding obese hyperlipidemic rats on diet supplemented with dried pumpkin and dried Pineapple causing significant increase in the mean value of serum HDL-c and significant decrease in the mean value of both BWG %, serum TG, Tch, LDL-c, VLDL-c, ALT, urea nitrogen, glucose and leptin as compared to group of obese hyperlipidemic rats. Therefore, this study recommends that intake of Pumpkin and Pineapple may be beneficial for patients who suffer from hyperlipidemia due to their nutritional and restorative properties.

Key words: High fat diet · Cucurbita moschata · Ananas comosus Linn · Obesity · Hyperlipidemia · Rats

INTRODUCTION

Hyperlipidemia is one of important risk factors involved in the development of cardiovascular disease [1]. Treatment of hyperlipidemia involves diet control, exercise and the use of lipid-lowering drugs. However, some patients cannot tolerate the adverse effects from these oral drugs. Consequently, there continues to be a high demand for new oral antihyperlipidemic drugs [2]. Management of hyperlipidemia without any side effects is still a challenge to the medical system. Plant products are frequently considered less toxic and freer from side effects than synthetic ones. Plants play a major role in the introduction of new therapeutic agents and have received much attention as sources of biologically active substances including antioxidants, hypoglycemics and hypolipidemics [3].

Obesity is a complex disorder involving an excessive amount of body fat. Obesity is not just a cosmetic concern. It increases risk of diseases and health problems, such as heart disease, Type 2 diabetes, high blood pressure, metabolic syndrome, Cancer and Stroke [4]. Regular consumption of dietary antioxidants may reduce the risk of several serious diseases [5]. Antioxidant compounds found in fruits and vegetables such as vitamin C, carotenoids and flavonoids might influence the risk of CVD by preventing the oxidation of cholesterol in arteries [6]. *Ananas comosus* is one of the most popular tropical and subtropical fruits with nutritional value, some folk medicinal uses have been found. In Thailand, *A. comosus* was used as an indigenous medicinal plant for the treatment of dysuria [7]. In China, *A. comosus* cortexes served as alexipharmic, antitussive and antidiarrheal agents; and *A. comosus* leaves were usually used as an antidyspepsia or antidiarrheal agent in Chinese Traditional Medicine [8]. Pumpkin is one of the well-known edible plants and has substantial medicinal properties due to the presence of unique natural edible substances. It contains several phyto-constituents belonging to the categories of alkaloids, flavonoids and

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palmitic, oleic and linoleic acids. Various important medicinal properties including anti-diabetic, antioxidant, anti-carcinogenic, anti-inflammatory and others have been well documented [9].

Aim of work: The present study was carried out to investigate the improvement role of Pumpkin (Cucurbita moschata) and Pineapple (Ananas comosus Linn) on body weight and biochemical parameters of obese hyperlipidemic rats.

MATERIAL AND METHODS

Materials: Casein, vitamin mixture, salt mixture, cellulose powder and choline bitartrate were obtained from Elgomhoria Company, Cairo, Egypt. Fats, sugar, corn oil and cornstarch Pumpkin and pineapple were obtained from local market in Elgharbia Governorate. Thirty-six male albino rats of Sprague Dawley Strain were obtained from the laboratory animal colony, Ministry of Health and Population, Helwan, Cairo, Egypt.

Methods: Preparation of plant materials: Pumpkin and pineapple were dried according to the method described by Alibas [10].

Biological Investigation: Male albino rats Sprague Dawley Strain (36 rats) weighing (150±10 g.) were housed in well aerated cages under hygienic condition and fed on basal diet for one week for adaptation in the animal house of faculty of Home economics, Al Azhar University. The basal diet (casein – basal diet) was composed of 20% casein (< 80% protein), 4g corn oil (4% fat), 3.5g minerals (3.5% salt mixture), 1g vitamins mixture (1% vitamin mixture), 5g cellulose (5% fiber), choline chloride 0.25% and corn starch up to 100g according to Reeves *et al*. [11]. the salt mixture, which used in this experiment was as recommended by Hegsted *et al*. [12] and the vitamin mixture as recommended by Muller [13].

After this week, the rats were divided into two main groups as following: The first main group (6 rats) was fed on basal diet (as a control negative group). The second main group (30 rats) was fed on high fat diet (for four weeks) to induce obesity and hyperlipidemia [14]. After feeding on high fat diet blood samples were obtained by retro orbital method to estimate blood lipids for making sure of hyperlipidemia. Then one sub group (6 rats) was left as control (+),while the other 4 sub- groups were fed on high fat diet supplemented by dried pumpkin 5%, dried pumpkin7.5%, dried Pineapple5% and dried Pineapple7.5% respectively. Feeding trail was continued for four weeks.

Table A: The composition of vitamin mixture

Compound	Amount
Vitamin. A	60 (mg)
Vitamin. D	2.5(µg)
Vitamin. E	10 (mg)
Vitamin. K_3	0.50 (IU)
Vitamin. C	20.0 (mg)
Vitamin. B_{12}	2.00 (mg)
B1, HCl	50 (mg)
B2	1 (mg)
B_6, HCl	0.40 (mg)
Calcium Pantothonate	4.00 (mg)
Nicotinic acid	0.2 (mg)
Coline chloride	200 (mg)
Folic acid	0.2 (mg)
Inistol	25 (mg)
p-Amino -Benzoic acid	10.0 (mg)
Biotine	0.02 (mg)
Corn starch	Up to 100 g

According to Muller [13].

Biological Evaluation: Body weight gain (BWG) and organs weight relative to body weight (%) were calculated according to Chapman *et al*. [15].

Biochemical Analysis: At the end of the experiment, rats were fasted over night and anesthetized with diethyl ether. Blood samples were collected in clean dry centrifuge tubes from hepatic portal vein and left for 10 minutes to clot at room temperature, then centrifuged for 15 minutes at 3000 rpm to separate the serum. Serum was carefully separated and transferred in to dry clean Eppendorf tubes and kept frozen at – 20°C until analysis. The serum was separated to estimate some biochemical parameters, i.e. total cholesterol by Allian *et al*. [16], Triglycerides by Fossati and Prancipl [17], Very Low Density Lipoprotein Cholesterol (VLDL – c) according to the equation of Friedewald *et al*. [18], HDL cholesterol was determined according to the method described by Burstein [19], the concentration of LDL was estimated according to the equation of Friedewald *et al*. [18], serum aspartate aminotransferase (AST) and Serum alanine aminotransferase (ALT) were determined according to Reitman and Frankel [20], Serum urea was determined as mg/dl according to the method described by Malhotra [21], Serum uric acid was determined as mg/dl according to fossatti *et al* [22], Serum glucose was determined according to the method described by Trinder [23] and Serum leptin was determined as ng/ml according to Liefers *et al*. [24].

Histopathological Examination: Specimens from liver were collected after kept in formalin then embedded in paraffin; 4-6 thick sections were prepared and stained with hematoxylin and eosin according to Carleton [25].

Statistical Analysis: Data were presented as means±standard deviation (SD). Values were statistically analyzed by one-way analysis of variance (ANOVA test) according to Sendecor and Cochran [26] using SPSS 10.1 software package. Differences were considered significant at P values #0.05.

RESULTS AND DISCUSSION

Biological Evaluation

Feed intake (g/d) and BWG%: As shown in Table (1). It could be noticed that, rats treated with Pumpkin and Pineapple demonstrated no significant difference P>0.05 in the mean value of feed intake as compared to control negative and control positive group. Control positive group cleared significant increase in BWG% comparing to control negative and other treated groups, on the other hand treatment of obese hyperlipidemic rats with Pumpkin and Pineapple cleared significant decrease in BWG% comparing to the control positive group. Feeding obese hyperlipidemic rats on Pumpkin demonstrated significant decrease of the mean value of BWG% than the group of rats, which fed on Pineapple. When obese hyperlipidemic rats treated with 7.5% dried pumpkin illustrated significant decrease in BWG% than other treated rats. There were no significant difference between rats treated with 7.5% dried Pineapple and rats treated with 5% dried Pineapple. Our results indicated that, Pumpkin and Pineapple succeeded in decreasing BWG%. These findings are in agreement with Al-Sowyan [27] who demonstrated that consumption of high fat diet significantly increased body weight and adipose tissue weight. Kumar *et al*. [28] found that oral feeding of HFD (20 g/day) for a period of 28 days resulted in a significant increase in body mass index. On the other hand, our results dis agree with Liu *et al*. [29] as they concluded that Pumpkin polysaccharides could increase the weight, in diabetic rats and have some good effects to diabetes and diabetes complications. The role of Pumpkin and Pineapple in decreasing BWG% may be attributed to its phytochemical constituents. One of these is bromelain that claims to have therapeutic benefits on many diseases.

Table 1: Mean values±SD of feed intake (g/d) and BWG% of control rats and treated groups (n= 36)

Groups	Feed Intake (g/d)	BWG%
Control -ve	15.46±1 [a]	13.67±10.84 [bc]
Control +ve	14.27±1 [a]	33.05±18.09 [a]
Pumpkin 5%	14.39±2 [a]	-14.28±5.81[e]
Pumpkin 7.5%	14.98±0.57 [a]	-20.66±9.21[f]
Pineapple 5%	14.25±0.58 [a]	-3.51±5.02[d]
Pineapple 7.5%	14.46±1 [a]	-7.67±4.40[d]

Table 2: Mean values±SD of organs weight / body weight %of control rats and treated groups (n= 36)

Groups	liver	kidney	spleen
Control -ve	3.28±0.49 [ab]	1.29±0.22 [a]	0.40±0.07 [a]
Control +ve	2.68±0.40 [b]	1.03±0.22 [ab]	0.34±0.15 [a]
Pumpkin 5%	3.33±0.44 [a]	0.78±0.16 [b]	0.39±0.18 [a]
Pumpkin 7.5%	3.18±0.54 [ab]	1.03±0.32 [ab]	0.54±0.24 [a]
Pineapple 5%	3.17±0.38 [ab]	0.94±0.18 [b]	0.40±0.16 [a]
Pineapple 7.5%	3.56±0.59 [a]	0.93±0.22 [b]	0.49±0.17 [a]

Organs Weight / Body Weight %: As shown in Table (2), the mean value of liver weight / body weight % of all treated groups had no significant differences P > 0.05 as compared to the mean value of the control – ve group. The lowest mean value of liver weight / body weight % was recorded for the control +ve, while the highest mean value was recorded for group of rats, which treated with Pineapple 7.5%. Rats treated with 5% dried pumpkin and 7.5% dried Pineapple illustrated significant increase in liver weight / body weight % compared to the control +ve group. As for the mean value of kidney weight / body weight % the lowest mean value was recorded for rats treated with 5% dried pumpkin while highest mean value was recorded for the control – ve group. Rats treated with 5% dried pumpkin, Pineapple 5% and Pineapple 7.5% significantly decreased in the mean value of kidney weight / body weight % compared to Control -ve group. Regarding spleen weight / body weight % all treated group had no significant differences P > 0.05 as compared to the mean value of the control – ve and Control +ve group. The lowest mean value of spleen weight / body weight % was recorded for the control +ve, while the highest mean value was recorded for group of rats, which treated with Pumpkin 7.5%. Our results agree with Hasanin [30], she demonstrated that feeding on hyperlipidemic hypercholesterolemic diet increase the relative weights of both liver and kidney significantly compared with rats fed on standard diet. Rick [31] reported that extremely high values of triglycerides in the blood seen usually in hyperlipidemic patients cause pain, enlargement or swelling (inflammation) of organs such as the liver, spleen and kidney. Also Kumar *et al*. [28] found that oral feeding of HFD (20 g/day) for a period of 28 days resulted in a significant increase in body organ weights.

Table 3: Mean values±SD of serum cholesterol and triglycerides of control rats and treated groups (n= 36)

Groups	Serum T. ch	Serum T.G
Control -ve	91.83±2.79 c	70.67±9.20 c
Control +ve	118.17±8.68 a	112.83±28.05 a
Pumpkin 5%	99.67±6.41 bc	74.50±11.43 bc
Pumpkin 7.5%	105.83±10.44 b	78.83±9.02 bc
Pineapple 5%	103.00±9.88 b	76.83±4.88 bc
Pineapple 7.5%	104.83±6.68 b	89.83±12.61 b

Table 4: Mean values±SD of serum lipoproteins of control rats and treated groups (n= 36)

Groups	HDL -c	LDL -c	VLDL -c
Control -ve	56.50±7.42 b	37.97±16.64 b	14.134±1.84 b
Control +ve	39.67±20.23 c	52.53±16.28 a	22.566±5.61 a
Pumpkin 5%	74.17±8.21 a	17.43±5.87 c	14.9±2.28 bc
Pumpkin 7.5%	82.50±10.82 a	25.07±9.61 bc	15.766±1.81 bc
Pineapple 5%	76.00±9.88 a	19.08±6.83 c	15.366±0.98 bc
Pineapple 7.5%	69.17±6.01 ab	27.03±4.16 bc	17.966±2.98 b

Biochemical Analysis:

Serum Cholesterol and Triglycerides: As shown in Table (3) the mean value of serum (cholesterol and triglycerides) for the –ve control group decreased significantly as compared to the control +ve and other treated groups. Regarding the mean value±SD of serum cholesterol and triglycerides it could be observed that, all treated groups not reached to the mean value of cholesterol and triglycerides for the control-ve group. On the other side, all treated groups showed significant decrease P> 0.05, than the control +ve group. There were no significant differences P>0.05, in the mean value of serum (cholesterol and triglycerides) among treated groups. The best results of the mean values±SD of cholesterol were recorded for the following groups with arranging, Pumpkin 5%, Pineapple 5%, Pineapple 7.5% and Pumpkin 7.5%., on the other side, the best results of the mean value±SD of triglycerides was for the following groups with arrange, Pumpkin 5%, Pineapple 5%, Pumpkin 7.5% and Pineapple 7.5%.Our results agreed with Rick, [31],who reported that extremely high values of triglycerides in the blood are usually seen in hyperlipidemic patients. On the other hand, El Rabey *et al*. [32] mentioned that feeding rats on 1% cholesterol significantly increased serum total cholesterol, triglyceride and lipid peroxide, whereas catalase and glutathione-S-transferase were decreased. El-Tantawy *et al*. [33] remembered that the high-cholesterol diet caused a significant increase in total lipids, total cholesterol (TC) and total triglycerides (TG). Corresponding to polyphenols in general and flavonoids in particular, many studies investigated their effect on lipid profiles for example; Kollar *et al.* [34] found that flavonoids significantly reduce the value of total cholesterol in the serum of hypercholesterolemic rats. Our results are in line with Weidong *et al*. [35], they studied the hypolipidemic mechanism of pineapple and its activities in lipid metabolism enzymes in mice. Results led to the conclusion that *Ananas comosus* inhibited the synthesis of endogenous cholesterol and the activity of HMGCoA reductase, which might be due to the flavonoids present on it since flavonoids are believed to inhibit HMGCoA reductase activity. The study also suggested that the plant might play a role in inhibiting endogenous triglyceride synthesis. Mohammed *et al*. [36] concluded that administration of three different doses of Ananas comosus leaves extract decreased serum cholesterol level and serum triglycerides level. The cumulative results clearly indicate Ananas comosus possesses potent hypocholesterolaemic effect. Xin-Hua *et al*. [37] reported that oral administration of Pumpkin polysaccharides could significantly decrease the levels of plasma triacylglycerol (TG), total cholesterol (TC) and plasma low-density lipoprotein cholesterol. Therefore, results suggest that Pumpkin polysaccharides had a high hypolipidemic activity and could be explored as a possible agent for hyperlipidemia.

Serum Lipoproteins: As shown in Table (4). Regarding the mean value±SD of serum HDL-c it could be noticed that Control +ve group significantly deceased P < 0.05, as compared to control –ve and other treated groups but in contrast the same group increased significantly P < 0.05, in the mean value±SD of LDL-c and VLDL-c, as compared to control –ve and other treated groups, on the other hand there were no significant differences P< 0.05, among all treated groups P < 0.05 in the mean value±SD of serum HDL-c. The best result was recorded for rats fed on Pumpkin 7.5%. Concerning the mean value±SD of LDL-c it could be observed that Control +ve group significantly increased P < 0.05, as compared to control –ve and other treated groups. There were no significant differences P < 0.05, among all treated groups. More improvement was observed of the mean value±SD in case of feeding rats on Pumpkin 5% than other treated groups. It could be observed that the best results of the mean value±SD of LDL-c were recorded for the following groups with arranging, Pumpkin 5%, Pineapple 5%, Pumpkin 7.5% and Pineapple 7.5%. Feeding rats' high fat diet resulted in significant increase in the mean value±SD of serum VLDL-c at P < 0.05, comparing to other treated groups and control-ve group. There was no significant difference P < 0.05, in the mean value±SD of serum VLDL-c among

Table 5: Mean values±SD of liver enzymes of control rats and treated groups (n= 36)

Groups	AST	ALT	ALP
Control -ve	119.33±3.45 [ab]	18.17±4.02 [c]	145.33±24.46 [a]
Control +ve	133.83±37.30 [a]	31.67±2.34 [a]	172.67±64.71 [a]
Pumpkin 5%	77±14.37 [b]	25.50±2.35 [b]	183.33±62.61[a]
Pumpkin 7.5%	91.50±57.34 [ab]	23.67±1.75 [b]	221.33±19.24 [a]
Pineapple 5%	91±20.18 [ab]	24.67±2.42 [b]	202±18.02 [a]
Pineapple 7.5%	114±43.23 [ab]	23.83±3.13 [b]	198.83±47.17 [a]

Table 6: Mean values±SD of kidney functions of control rats and treated groups (n= 36)

Groups	Urea nitrogen	Creatinine
Control -ve	41.67±11.78 [ab]	0.73±0.19 [a]
Control +ve	54.50±15.54 [a]	0.80±0.33 [a]
Pumpkin 5%	27.67±7.17 [b]	0.55±0.05 [a]
Pumpkin 7.5%	48.50±17.03 [a]	0.78±0.32 [a]
Pineapple 5%	32.83±4.54 [b]	0.58±0.04 [a]
Pineapple 7.5%	41.33±8.17 [ab]	0.68±0.08 [a]

groups treated with Pumpkin and Pineapple. From the obtained data in Table (4) it could be noticed that the best results of the mean value±SD of VLDL-c were recorded for the following groups with arranging, Pumpkin 5%, Pineapple 5%, Pumpkin 7.5% and Pineapple 7.5%. These findings are in agreement with El Rabey *et al*. [32], they mentioned that feeding rats on 1% cholesterol significantly increased low-density lipoprotein and very low-density lipoprotein and decreased serum high-density lipoprotein. El-Tantawy *et al*. [33] remembered that the high-cholesterol diet caused a significant increase in low-density lipoprotein cholesterol (LDL-C) and the atherogenic index, whereas the level of high-density lipoprotein cholesterol (HDL-C) was significantly decreased. It was indicated that polyphenols have the effect of improving blood lipid status via increasing HDL-c forming and cholesterol excretion [38]. More over our results are in agreement with Weidong *et al.* [35]; they studied the hypolipidemic mechanism of pineapple and its activities in lipid metabolism enzymes in mice. Results led to the conclusion that Ananas comosus inhibited the synthesis of endogenous cholesterol and the activity of HMGCoA reductase, which might be due to the flavonoids present on it since flavonoids are believed to inhibit HMGCoA reductase activity. The study also suggested that the plant might play a role in inhibiting endogenous triglyceride synthesis. Xie *et al.* [39] indicated the potential of *A. comosus* as a natural product for hyperlipidemic treatment with mechanisms similar to those of statins. Mohammed *et al*. [36] concluded that administration of three different doses of Ananas comosus extract decreased serum LDL level. Serum HDL level was not affected significantly. The cumulative results clearly indicate *Ananas comosus* possesses potent hypocholesterolaemic effect. Fouad [40] revealed that hypercholesterolemic hamsters supplemented with β carotene showed a significant reduction in the mean values of both serum LDL-c and liver malondialdehyde. Xin-Hua *et al.* [37] reported that oral administration of Pumpkin polysaccharides could significantly increase the levels of plasma high-density lipoprotein cholesterol. Therefore, results suggest that Pumpkin polysaccharides had a high hypolipidemic activity and could be explored as a possible agent for hyperlipidemia.

Liver Enzymes: As shown in Table (5) it could be noticed that the mean values±SD of ALT for control – ve group significantly decreased $P > 0.05$, as compared to all treated groups. Group of control +ve significantly increased $P > 0.05$, as compared to other treated groups. There were no significant differences $P > 0.05$, among all treated groups. Regarding the mean value±SD of AST It could be noticed that group of rats, which treated with Pumpkin 5% significantly, decreased $P > 0.05$, as compared to control – ve, control +ve and other treated groups. There were no significant differences $P > 0.05$, among all groups except group of rats treated with Pumpkin 5%. In addition, there was no significant difference $P > 0.05$ in the mean value±SD of ALP, among all treated groups. Our results indicated that, Pumpkin and Pineapple had no significant effect on AST and ALP and affected significantly on ALT. These results are in line with Assy *et al*. [41], they reported that the most common enzyme abnormalities in hyperlipidemic patients with fatty infiltration of liver were elevated activities of serum ALT and ALP. In addition, Fouad, [40], found that hyperlipidemic hamsters exhibited a significant increase in both serum ALT and AST activities above the normal control values by 15% and 31%.

Kidney Functions : As shown in Table (6) regarding the mean value±SD of urea nitrogen (mg/dl) it could be noticed that, there were no significant differences $P > 0.05$ among group of rats treated with Pumpkin 5%, group of rats treated with Pineapple 5% and group of rats treated with Pineapple 7.5%. There was no significant difference $P > 0.05$ between group of rats treated with Pumpkin 7.5% and group of rats treated with Pineapple 7.5%.Concern the mean value±SD of creatinine (mg/dl) all treated groups revealed no significant difference $P > 0.05$, as compared to the healthy group and control +ve group. Our results indicated that, Pumpkin and Pineapple had no significant

Table 7: Mean values±SD of Serum glucose and leptin of control rats and treated groups (n= 36)

Groups	Glucose(mg/ dl)	Leptin (ng/ ml)
Control -ve	107.67±10.84 [ab]	6.32±0.037 [cd]
Control +ve	132.33±41.94 [a]	6.08±0.019 [b]
Pumpkin 5%	98.17±40.77 [ab]	6.49±0.018 [d]
Pumpkin 7.5%	106.50±24.73 [ab]	5.78±0.018 [a]
Pineapple 5%	93.83±19.34 [b]	6.11±0.074 [bc]
Pineapple 7.5%	84.67±8.29 [b]	6.75±0.055 [e]

effect on creatinine and affected significantly on urea nitrogen. El Rabey *et al*. [32] mentioned that kidney functions parameters in the cholesterol-supplemented group were elevated compared with the negative control.

Serum Glucose and Leptin: As shown in Table (7) regarding the mean value±SD of Glucose (mg / dl), it could be noticed that, all the treated groups revealed no significant difference $P > 0.05$, as compared to control - ve group. Group of rats treated with Pineapple 5% and group of rats treated with Pineapple 7.5% significantly decreased $P > 0.05$ in the mean value±SD of Glucose (mg / dl), as compared to control +ve group.

Concern the mean value±SD of Leptin (ng/ ml) group of rats treated with Pineapple 7.5% significantly increased $P > 0.05$ in the mean value±SD of Leptin (ng/ ml), as compared to control +ve group, control - ve group and other treated groups. On the other hand group of rats treated with Pumpkin 7.5% significantly decreased $P > 0.05$ in the mean value±SD of Leptin (ng/ ml), as compared to control +ve group, control - ve group and other treated groups. There was no significant difference between groups of rats treated with Pineapple 5% and control - ve group. There was no significant difference between groups of rats treated with Pumpkin 5% and control - ve group. Kumar *et al.* [28] mentioned that obesity plays a central role in the insulin resistance syndrome, which is associated with hyperinsulinemia, hypertension, hyperlipidemia, type 2 diabetes mellitus and an increased risk of atherosclerotic cardiovascular disease also, they reported that oral feeding of HFD (20 g/day) for a period of 28 days resulted in a significant increase in serum leptin antioxidant enzymes levels were significantly decreased. ZHU Hong *et al*. [42] concluded that Pumpkin polysaccharides could decrease the level of blood glucose of the diabetic rats.

Histopathological Results: Liver sections obtained from normal rats as control negative(Untreated) and rats pretreated with high fat diet then treated with high fat diet supplemented with dried pumpkin and Pineapple were

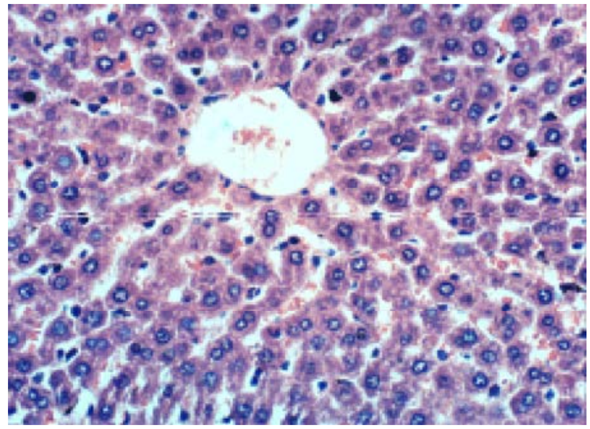

Photo 1: Liver of rat from control Negative group (healthy group) Showing the normal histopathological Structure of hepatic lobule. (H & E × 400).

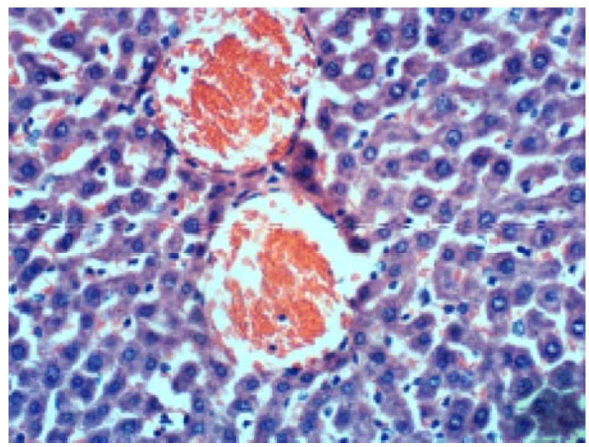

Photo 2: Liver of rat from group 2 (rats pretreated high fat diet) showing congestion of central veins and kepffer cells activation. (H & E × 400).

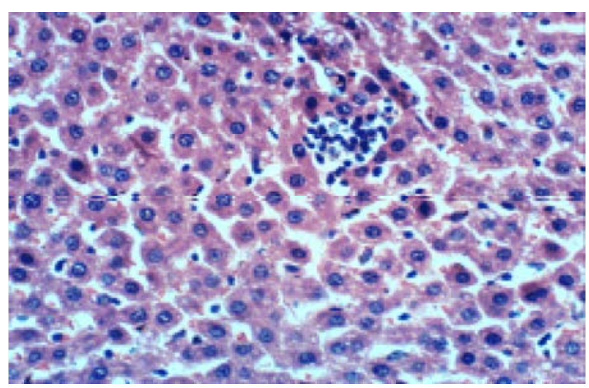

Photo 3: Liver of rat from group 3 (hyperlipidemic rats treated with Pumpkin 5%) showing focal hepatic necrosis replaced by mononuclear cells. (H & E × 400).

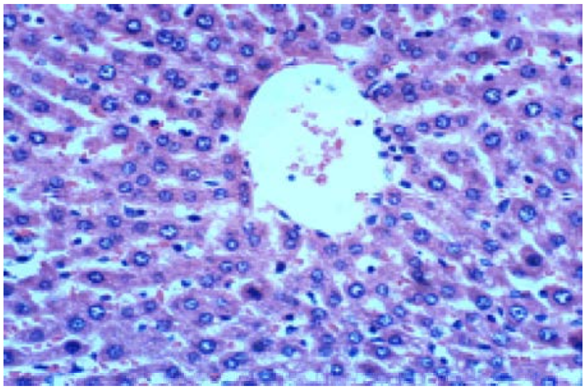

Photo 4: Liver of rat from group 4 (hyperlipidemic rats treated with Pumpkin 7.5%) showing slight kepffer cells activation. (H & E × 400).

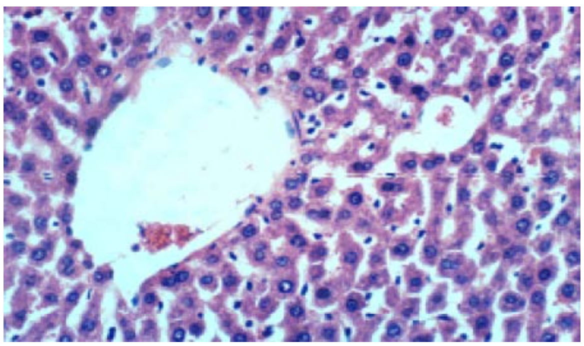

Photo 5: Liver of rat from group 5 (hyperlipidemic rats treated with pineapple 5%) showing slight kepffer cells activation. (H & E × 400).

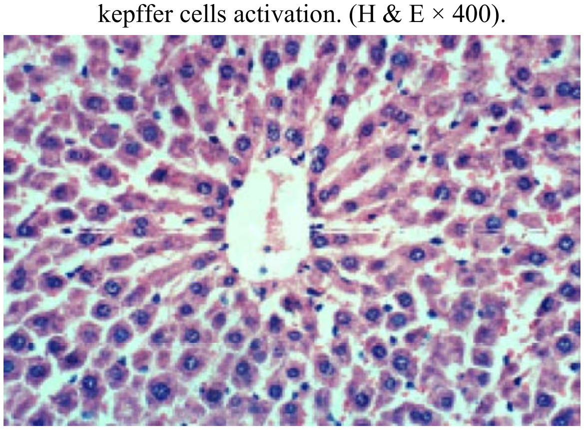

Photo 6: Liver of rat from group 6 (hyperlipidemic rats treated with pineapple 7.5%) showing no histopathological changes. (H & E × 400).

studied histopathologically to confirm the biochemical results and to observe histopathological alternations after treatment of pumpkin and Pineapple on histopathological structure of liver.

Sies and Stahl [43] explained that the higher damage of liver in hyperlipidemic rats could be due to excessive storage of fat, which in turn effects liver functions, increases the activity of liver enzymes and increase the susceptibility to free radical attack. El Rabey *et al*. [32] mentioned that Feeding rats on 1% cholesterol caused histological alteration in kidney, liver, heart and testes compared with the negative control.

CONCLUSIONS AND RECOMMENDATIONS

Because of the positive effect of Pumpkin and Pineapple on the tested parameters, an increase in consumption of Pumpkin and Pineapple in the diet is recommended. Nutritional education programs should be encouraged to inform the public of the importance of Pumpkin and Pineapple in decreasing the risk of hyperlipidemia.

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