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Research Paper

Effect of Aqueous Extract of Green Tea (*Camellia Sinensis L.*) on Obesity and Liver Status in Experimental Rats

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Abstract: *Obesity is one of the most common disorders encountered in clinical practice. It has been noted as a major public health problem in many countries including Arab countries. It is a major risk factor for many chronic diseases. Green tea is reported to contain thousands of bioactive ingredients which are almost contributed by polyphenols which play a key role in prevention and treatment of many diseases including obesity. Our investigation aimed to study the effect of oral administration of aqueous extracts of green tea (GTE) on obesity and liver status by using experimental rats. Sixteen adult male albino rats (150-160g) was divided into four experimental groups: The first considered as control negative group (C -ve) and fed on normal diet, while other three groups fed on high fat diet for three weeks to induce obesity. Obese rats were divided into three equal groups (n= 4 rats). Second group (obese rats) considered as (C +ve). Third group (obese rat) and fourth group fed on 10% and 20% of green tea extract respectively. At the end the experimental period (28 days), the body weight gain, food intake, feed efficiency ratio, blood sugar, liver enzymes (ALT, AST, ALP), and lipid profile were evaluated. Our results revealed that the consumption of green tea extract produced a significant reduction in body weight in obese rats and enhances liver functions. Conclusion: Green tea could be used as a weight reductions and enhancing liver status for obese.*

Keywords: Obesity, green tea, rats, liver.

Introduction

Obesity has reached pandemic proportions around the world and now poses one of the greatest public health challenges for the 21st century. One billion of the approximately 6.5 billion people in the world are estimated to be overweight [body mass index (BMI) > 25 kg/m2] and, of these, at least 300million are obese (BMI > 30 kg/m2) (WHO, 2009). These numbers are predicted to more than double to 2.3 billion overweight and 700 million obese by 2015 (WHO, 2010).

Obesity is chronic disease prevalent in both developed and developing countries, it is a complex multi-factorial chronic disease that develops from an interaction of genotype and environment (WHO, 2004) Also, related to decreased physical activity and increased energy intake (Westerterp-Plantenga *et al*., 2005) . Obesity has implications for both the individual and society in general. For the individual, obesity is associated with an increased risk of mortality, shortening life. Obesity is also related to increased morbidity (NAO, 2001) and is a major factor in a number of diseases, including coronary heart diseases, hypertension, non—insulin-dependent diabetes, pulmonary dysfunction, osteoarthritis, and certain types of cancer (Westerterp-Plantenga *et al*., 2005).

A rapidly growing therapeutic area is the use of natural herbal supplements. One of these agents is a green tea-caffeine mixture (epigallocatechin gallate plus caffeine), whose claimed anti obesity properties have been ascribed to increased thermogenesis and fat oxidation (Westerterp-Plantenga *et al*., 2005).

Tea is one of the most popular beverages consumed worldwide. Tea, from the plant *Camellia sinensis*, is consumed in different parts of the world as green, black, or oolong tea. Green tea is favored in Japan and China, and initial research on the benefits of green tea was carried out in these countries because of local customs (Jian *et al*., 2004). Green tea has attracted significant attention recently, both in the scientific and in consumer communities for its health benefits for a variety of disorders, ranging from cancer to weight loss (Zaveri, 2006).

Several epidemiological studies have shown beneficial effects of green tea in cancer, cardiovascular, and neurological diseases. The health benefits associated with green tea consumption have also been corroborated in animal studies of cancer chemoprevention, hypercholesterolemia, atherosclerosis, Parkinson's disease, Alzheimer's disease, and other aging related disorders. The beneficial effects of green tea are attributed to the polyphenolic compounds (Zaveri, 2006).

The anti-obesity effects of green tea are being increasingly investigated in cell, animal, and human studies (Wolfram *et al*., 2006). Recent data from human studies indicate that the consumption of green tea and green tea extracts may help reduce body weight, mainly body fat, by increasing postprandial thermogenesis and fat oxidation (Chacko *et al*., 2010). Reduce adipocyte differentiation and proliferation, lipogenesis, fat mass, body weight, fat absorption, plasma levels of triglycerides, free fatty acids, cholesterol, glucose, insulin and leptin (Wolfram *et al*., 2006). Therefore this investigation aimed to study the possible therapy and protection effect of oral doses of green tea water extracts on obesity and liver status.

Materials and Methods

a- Materials:

1- Investigated Samples: Investigated samples were aqueous extracts of green tea (Camellia Sinesis). We bought it from the local market. These natural herbs used after knowing their active constituents and their biological activities.

2- Rats: Sixteen Sprague-Dawley male albino rats, each weighing 150-200 g, were purchased from king Fahd medical Research Center (KFMRC), Jeddah, Saudi Arabia.

b- Methods:

1- Preparation of Plant Extracts: To study the effect of GTE on male reproduction, the doses have been used selected based on the studies conducted earlier (Chandra and De, 2010) & (Sakamoto *et al*., 2001). Briefly, 10 g green tea was added to 100 ml of boiling water and was steeped for 15 min. The infusion was cooled to room temperature and then filtered. Tea leaves were extracted a second time with 100 ml of boiling water and filtered, and two filtrates were combined to obtain a 5% tea aqueous extract (5% tea leaf\100 ml water). Similar procedure was performed with 20 g green tea to prepare 10% aqueous green tea extract (GTE). Both of GTE were orally administered to rats at a dose of 1 ml/100 g body wt, for each of them.

2- Experimental Design: Sixteen Sprague - Dawley male albino rats, each weighing 150-200 g., were housed in special cages under controlled conditions. Every day animals were observed for the external appearance, shape, colour and distribution of hair and physical activity. All rats were fed on the control diet which consisted of casein (12.5%), corn oil (10%), choline chloride (0.2%), vitamin mixture (1%) (Campbell, 1963), cellulose (5%), salt mixture (4%), sucrose (22%) and corn starch (up to 100%) (Hegested *et al.,* 1941) for 7 consecutive days before the beginning of the experiment for adaptation. Diets were presented to rats in special non-scattering feeding cups to avoid loss of food and contamination. Tap water was provided to rats by mean of glass tubes projecting through wire cages from inverted bottles supported to one side of the cage. All the experiment process was done in Umm Al-Qura University. Rats were divided into two main groups (n= 4 rats). The first main group fed on basal diet as a negative control group. The second main Groups received high caloric diet including edible fat at percent of 20% from the diet for three weeks, then divided to three sub groups. One of them left as control positive and the two main groups received the basal diet and oral administration with 10 mg/kg body weight and the other group received oral administration with 20 mg/kg body weight of green tea extract for 30 days.

3- Biological Evaluation: All rats were weighted once weekly. At the end of the experiment, biological evaluation of the different diets was carried out by determination of body weight gain % (BWG %), feed efficiency ratio (FER) according to Chapman *et al.,* (1959).

4- Biochemical Analysis: Enzymatic colorimetric method used to determine blood glucose according to Trinder (1969). Colorimetric method was used for the determination of total cholesterol according to Allain (1974). Determination of HDLc was carried out according to the method of Friedewald (1972) & Gordon and Amer (1977). Enzymatic colorimetric method used to determine triglycerides according to Young and Pestaner (1975). The determinations of VLDLc and LDLc were carried out according to the method of Lee and Nieman (1996) as follows: Very low density lipoprotein (VLDLc) = triglycerides/5 and LDLc = Total cholesterol – HDLc – VLDLc. Colorimetric method used to determine AST and ALT according to Reitman and Frankel (1957); while determination of alkaline phosphates ALP activity according to Haussament (1977).

5- Histopathological Investigation: Liver specimens only were collected from rats of all experimental groups at the end of the experimental period, fixed in 10% neutral buffered formalin (pH=7.0), dehydrated in ethyl alcohol, then cleared in xylol and embedded in paraffin; 4-6 microns thickness sections prepared and stained with heamtoxylin and eosin for examining the liver using light microscope at various magnification (Carleton, 1976).

6-Statistical Analysis: Statistical analysis performed by using computer program statistical package for social science (SPSS, 2008), and values compared with each other using the suitable tests.

Results

1. Biological Evaluation

1.1. Effect of Green Tea at Two Doses on BWG, FI and FER for Obese Rats: Data present in table (1) show the effect of green tea extract at two doses (10 and 20%) on body weight gain (BWG), food intake (FI), and feed efficiency ratio (FER) in obese rats.

Table 1: Effect of GTE at two doses (10 and 20%) on BWG FI and feed FER for obese rats

Parameters Animal group	BWG (g)	FI (g)	FER
Control (-)	13.30±3.47 [d]	15.12±0.56 [c]	0.04±0.003 [b]
Control (+)	59.00±3.47 [a]	56.02±2.56 [a]	0.03±0.002[c]
GTE 10%	25.00±3.71[c]	21.06±0.59 [b]	0.04±0.002[b]
GTE 20%	41.00±3.47[b]	19.98±0.56 [b]	0.07±0.003 [a]

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at $p \leq 0.05$.
Using one way ANOVA test, while those with similar letters are non-significant.

It could be observed from the table that body weight gain for obese rats (C +ve group) was 59.00±3.47 compared to 13.30±3.47 g/28day in (C -ve) normal rats. These results denote that there were significant increase in BWG of obese rats as compared to normal rats. Rats of obesity and administered with green tea extract 10 and 20% showed significant decrease when compared to control positive group. Rats administered with green tea extract 10% showed the highest significant decrease in body weight gain when compared to control positive group.

Concerning food intake (FI), there were significant increase in control positive group compared to control negative ($P<0.05$) which were 56.02±2.56 and 15.12±0.56 g/day, respectively. All experimental groups showed significant decrease in FI when compared to positive group. Rats administered with green tea extract 10% showed non significant change in FI when compared to rats administered with 20%green tea extract.

Regarding feed efficiency ratio (FER) it is clear in (C +ve) group that the mean was 0.03±0.002 but in (C -ve) group was 0.04±0.003. The obtained results showed that there were significant decrease in feed efficiency ratio in control positive as compared to control negative group. Obese rats and administered with green tea extract 10% showed non significant changes when compared to control negative group (Normal rats) showing the most effective dose in FER. Rats administered with green tea extract 20% showed the highest significant increase in FER when compared to control positive group.

1.2. Effect of Green Tea at Two Doses on Organs Weight: Data present in table (2) show the effect of green tea extract at two doses (10 and 20%) on organs weight (Liver, Lung, Heart, Spleen and Kidneys) in obese rats. The weights of liver, lung, heart, spleen and kidneys determined at the end of feeding rats of the diets containing green tea extract. All weight of organs (liver, lung, heart, spleen and kidneys) was remarkably increased by 5.50±0.004, 0.89±0.007, 1.61±0.009, 0.93±0.007 and 2.74±0.006 g., respectively in obese rats (C +ve group) when compared to normal rats (C -ve) which were 3.79±0.003, 0.63±0.006, 1.22±0.007, 0.47±0.005 and 1.83±0.004 g., respectively**.** All experimental groups showed significant decrease in weight of organs (liver, lung, heart, spleen and kidneys) when compared to positive group. Rats administered with green tea extract 10% showed significant decrease in organs weight compared to rats administered with green tea extract 20%.

Table 2: Effect of green tea extract at two doses (10 and 20%) on weight organs (Liver, Lung, Heart, Spleen and Kidneys) in obese rats

Parameters Animal group	Liver	Lung	Heart	Spleen	Kidneys
Control (-)	3.79±0.003[d]	0.63±0.006[d]	1.22±0.007[d]	0.47±0.005[d]	1.83±0.004 [d]
Control (+)	5.50±0.004[a]	0.89±0.007[a]	1.61±0.009[a]	0.93±0.007[a]	2.74±0.006 [a]
GTE 10%	4.19±0.005[c]	0.73±0.008[c]	1.31±0.008[c]	0.63±0.006[c]	2.11±0.005 [c]
GTE 20%	5.10±0.004[b]	0.79±0.007[b]	1.49±0.007[b]	0.79±0.005[b]	2.53±0.004 [b]

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at p≤0.05.
Using one way ANOVA test, while those with similar letters are non-significant.

2. Biochemical Analysis

2.1. Effect of Green Tea Extract at Two Doses on Lipids Profile for Obese Rats: Data illustrated in table (3) show the effect of green tea on cholesterol, triglyceride, HDL, LDL and VLDL in obese rats. Apparently from the table that there were significant increase (p≤0.05) in serum of total cholesterol, LDL, HDL, VLDL and T.G levels in obese rats (C+ve) when compared to normal groups (C-ve). Obese rats and administered with green tea extract10 and 20% showed significant decrease in all lipid profiles when compared to control positive group. Rats administered with green tea extract 10% showed the highest significant decrease in the LDL, VLDL and T.G levels while rats administered with green tea extract 20% showed the highest significant decrease in the level of total cholesterol when compared to control negative groups.

Regarding high density lipoprotein (HDL) it was showed a high significant decrease in the obese group compared to normal. Rats of obesity and orally administered with green tea extract 10 and 20% showed significant increase when compared to control positive group. Rats received 10% showed significant increase in the level of total cholesterol and HDL as compared with rats received 20% aqueous extract.

Table 3: Effect of green tea extract at two doses (10 and 20%) on lipids profile for obese rats

Parameters Animal group	T.G Mg/dl	T.C. Mg/dl	HDL Mg/dl	LDL Mg/dl	VLDL Mg/dl
Control (-)	70.12±1.70[d]	52.00±1.19[c]	28.00±1.68[a]	10.00±0.79[d]	14.00±0.14[d]
Control (+)	104.13±3.17[a]	85.80±2.21[a]	19.00±1.18[d]	46.00±0.39[a]	20.80±0.24[a]
GTE10%	78.3±1.82[c]	56.61±1.29[b]	26.00±1.26[b]	15.00±0.81[c]	15.61±0.36[c]
GTE 20%	82.25±1.01[b]	56.45±1.51[b]	23.00±1.37[c]	17.00±0.19[b]	16.45±0.39[b]

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at p≤0.05.
Using one way ANOVA test, while those with similar letters are non-significant.

2.2. Effect of Green Tea Extract at Two Doses on Kidney Functions for Obese Rats: Data illustrated in table (4) show the effect of green tea extract on urea, uric acid and creatinine. Findings of our study indicated that obese rats (C +ve) group showed significant increase (p≤0.05) in urea, uric acid and creatinine when compared with (C -ve) group, while showed significant decrease in all experimental groups when compared with (C +ve) group. When compared level of urea between experimental groups there were significant decrease in rat administered with 10% compared to rats administered with 20% of green tea extract even than normal group. Also, rats orally fed with low

dose from green tea 10% showed significant decrease in the uric acid and creatinine more than group orally fed with high dose from green tea 20%.

Unfortunately, the same author showed the best results of serum uric acid, urea nitrogen and creatinine recorded for the group which treated with the high level from green tea (4ml water extract of green tea/rat), that contrast with our results that showed the low doses of green tea 10% showed more significant decrease in the uric acid and creatinine than group fed with high dose of green tea 20%**.**

Table 4: Effect of green tea extract at two doses (10 and 20%) on kidney functions for obese rats

Parameters **Animal group**	Urea Mg/dl	Uric acid Mg/dl	Creatinine Mg/dl
Control (-)	45.00 ± 1.06^{c}	0.81 ± 0.02^{d}	0.30 ± 0.02^{d}
Control (+)	61.00 ± 2.28^{a}	2.42 ± 0.02^{a}	0.49 ± 0.02^{a}
GTE10%	40.00 ± 1.34^{d}	1.13 ± 0.02^{c}	0.33 ± 0.02^{c}
GTE 20%	54.00 ± 1.16^{b}	1.38 ± 0.02^{b}	0.38 ± 0.02^{b}

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at $p \leq 0.05$.
Using one way ANOVA test, while those with similar letters are non-significant.

2.3. Effect of Green Tea Extract at Two Doses on Glucose, AST, ALT and ALP for Obese Rats: Data illustrated in table (5) show the effect of green tea extract on glucose, AST, ALT and ALP in obese rats. It is clear from the table that obese rats (C +ve) group showed significant increase ($p \leq 0.05$) in serum glucose when compared to normal rats which were 136.00±3.68 and 122.00±2.28 mg/dl respectively. All experimental groups showed significant decrease ($p \leq 0.05$) in serum glucose when compared to control positive group. There were no significant changes in the level of serum glucose between two groups which fed green tea extract with its two doses.

Concerning liver enzymes, there were significant increase in control positive group for AST, ALT and ALP compared to normal rats ($P<0.05$)which were 121.33±3.70, 76.38±2.75, 647.80±2.81, 97.03±1.90, 46.23±1.15 and 115.10±2.11U\L, respectively, and showing significant decrease in AST, ALT and ALP in all experimental groups when compared with(C+ve) group. As compared levels of liver enzymes between experimental group we found significant decrease in level of AST and ALP in rats fed with 10% compared to rats administered 20% of green tea extract while significant decrease in the level of ALT showed in group fed with 20% of green tea extract.

Table 5: Effect of green tea extract on glucose, AST, ALT and ALP in obese rats

Parameters Animal group	GLU Mg/dl	AST U/L	ALT U/L	ALP U/L
Control (-)	122.00 ± 2.28^{b}	97.03 ± 1.90^{d}	46.23 ± 1.15^{d}	115.10 ± 2.11^{d}
Control (+)	136.00 ± 3.68^{a}	121.33 ± 3.70^{a}	76.38 ± 2.75^{a}	647.80 ± 2.81^{a}
GTE10%	125.00 ± 2.44^{b}	101.13 ± 2.81^{c}	70.30 ± 1.87^{b}	253.70 ± 3.00^{c}
GTE20%	126.00 ± 2.08^{b}	111.63 ± 1.70^{b}	60.88 ± 1.45^{c}	331.60 ± 2.01^{b}

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at $p \leq 0.05$.
Using one way ANOVA test, while those with similar letters are non-significant.

Discussion

Our results revealed that green tea extract decreased body weight gain and had an anti-obesity potential. These findings are in agreement with Sayama *et al*., (2000) who reported that the addition of green tea powder (GTP) to the diet suppressed fat accumulation and body weight increase. Also, Zheng *et al*., (2004) indicated that caffeine and theanine were responsible for the suppressive effect of GTP on the body weight increase and fatty accumulation. It has been reported that caffeine ingestion elevated the metabolic rate and fat oxidation in vivo through lipolysis in fat cells and the release of catecholamines. Moreover, caffeine enhanced noradrenalin- or adrenaline induced lipolysis in fat cells. They also obtained results which supported the anti-obesity activities of caffeine. Thus, it seems that the anti-obesity effect of caffeine in GTP was due to enhancement of thermogenesis and fat metabolism along with caffeine EGCG, a kind of catechins, significantly reduced or prevented body weight gain with reduction of food intake in lean and obese rats (Kao *et al*., 2000).

Moreover (Zheng *et al*., 2004) it was shown that catechins acted synergistically with caffeine in manifestation of anti-obesity activities. In controlled intervention trials have shown that consumption of GTC (270 mg to 1200 mg/day) may reduce body weight and fat. There are several proposed mechanisms whereby GTC may influence body weight and composition. The predominating hypothesis is that GTC influences sympathetic nervous system (SNS) activity, increasing energy expenditure and promoting the oxidation of fat (Pennington Biomedical Research Center, 2007) Also, inhibiting intestinal lipases, decreasing fat absorption , increasing fat excretion, increasing uncoupling proteins, increasing thermogenesis and decreasing lipogenic enzymes (Rains *et al*., 2011).

On the other hand, theanine also had anti-obesity action. It was reported that theanine could pass through the blood-brain barrier and induced increase of dopamine release and reduction of serotonin concentration in the brain (Zheng *et al*., 2004). In 2005, it was reported that treatment with green tea extract significantly reduced body weight (BW) and body fat in different strains of mice fed a high-fat diet (Klaus *et al*., 2005). In addition to its weight loss effects, there are studies that have suggested that tea consumption may alleviate other metabolic abnormalities related to obesity (Tsuneki *et al*., 2004). Our result showed that green tea decrease body weight gain by decrease food intake that contract with (Klaus *et al*., 2005) who found the decrease in body fat accumulation was observed after an even shorter time (29 days) this decrease occurred without a change in food intake but with a significant reduction in food digestion. In a clinical study Rumpler *et al*., (2001) found greater decreases in weight, BMI, visceral fat area, and waist and hip circumference, as well as improved signs of cardiovascular health. Green tea extracts have also been used to achieve weight maintenance after loss. (Sumiyoshi and Kimura, 2006).

Green tea *catechins* affect lipid metabolism by different pathways. GTE intake decreases the absorption of triglycerides and cholesterol, and these findings are in accordance with the fact that fat excretion increases (Raederstorff *et al.*, 2003). Nevertheless, the mechanism remains to be determined. Some studies report that green tea catechins decrease plasma total cholesterol and blood triglyceride levels, but the effects differ among studies (Murase et *al.*, 2002). Green tea extract reducing activity of cholesterol and lipid oxidation in rats by significant hypolipidemic action of polyphenols and catechins that will be responsible for the observed effects and reducing cholesterol and LDL, and relative increase HDL (Hussein, 2011).Our results agreed with Susana *et al.*, (2006) who stated that green tea has been associated with lower serum levels of cholesterol, triglycerides, and LDL-cholesterol cholesterol but higher serum levels of HDL-cholesterol. Also, these results agreed with Kl *et al.,* (2005) who found that green tea leaves decrease plasma TAG, cholesterol and LDL-cholesterol in rats by decreasing lipogenesis. In this concern, our findings are consistent with Yang and Koo, (2000) who recommended that green tea reduce significantly serum cholesterol and triglycerides and improved plasma lipid profiles and reduced LDL and VLDL oxidation in hamster fed high cholesterol diet. In humans, our results agreed with Sulibursk*a et al.*, (2012) who found green tea extract supplementation resulted in decreases in levels of total cholesterol, low density cholesterol and triglyceride and increase HDL cholesterol.

Our finding contrast with Suzuki *et al*., (2012) who found that GT reduced serum triglycerides (TG) levels in ND and HFD-fed rats but diets containing 1% GT did not affect the serum levels of total cholesterol (T-Cho) and high-density lipoprotein cholesterol (HDL-Cho) significantly, although there was a trend towards an increase in cholesterol levels. When 3% GT was added to the diet, the serum levels of T-Cho and HDL-Cho increased significantly in ND and HFD-fed rats compared to non-GT fed rats. The effect of green tea drinking in lipid profiles have been widely studied in animals and in humans; however, controversial results are reported, although the animal studies offer more consistent data. This controversy may be related to differences in the study design, namely, in dietary and lifestyle habits, and/or in the experimental protocols of the many reported methods for the preparation of tea, temperature, time of infusion and concentration are important. In addition, the time of green tea consumption may also contribute to the controversy (Susana *et al*.., 2006).

Findings of our study indicated that there was significant decrease in rat administered with 10% compared to rats administered with 20% of green tea extract even than normal group. Also, rats orally fed with low dose from green tea 10% showed significant decrease in the uric acid and creatinine more than group orally fed with high dose from green tea 20%. These results were in agreement with Sano *et al.,* (1995) who found that orally administration of green tea extract to rats resulted in an improvement of renal function; therefore, EGCG may be an antioxidant in the kidney. Also, agreed with Dufresne and Farnworth (2001) who found that rats receiving green tea decreased blood levels of urea nitrogen and creatine, and lower urinary levels of protein. In this respect, Choi *et al*. (2004) reported that the catechin in green tea is clearly effective in reducing oxidative stress and inflammatory reactions in kidney tissue. Also , our data confirmed with Hasanein *et al*., (2012) who found the values of serum uric acid, urea nitrogen and creatinine decreased in group which treated with water extract of green tea.

Several human and animal-based studies suggested that green tea and its flavonoids have anti diabetic effects (Wolfram *et a*l., 2006). Along with flavoniods, Several studies reported that the hypoglycemic effect of green tea was attributed to the presence of polyphenols, catechins and water-soluble polysaccharide fractions (Sabu *et al*., 2002).Our results agreed with Suzuki *et al*., (2012) which found that catechin-rich green tea extract reduced serum glucose (Glc) in rats feed high fat diet. Also, our results confirmed with Bose *et al*., (2008) who found that EGCG significantly decreased blood glucose, insulin, and insulin resistance in high-fat fed mice. Furthermore, short-term treatment with EGCG reversed the effects of high-fat diet on blood glucose. Previous studies showed that green tea supplementation increased muscle glucose transporter protein expression in insulin-resistant rats (Wu *et al*., 2004).Some studies conducted that catechins can inhibit digestive enzymes such as salivary amylase, intestinal sucrase and α-glucosidase, suggesting that the reduced digestibility action of catechins may be responsible for lowering blood glucose levels. These mechanisms may be responsible for the anti-hyperglycemic effect of green tea (Liao *et al*., 2001).Other studies reported that green tea epigallocatechin gallate promotes pancreatic β-cells regeneration, has insulin-like and insulinotropic activities, and inhibits gluconeogenesis through inhibition of liver phosphoenol pyruvate kinase synthesis (Chemler *et al*., 2007).

Our results indicated that AST, ALT and ALP in all experimental groups were significant decrease when compared with (C +ve) group. As compared levels of liver enzymes between experimental group we found significant decrease in level of AST and ALP in rats fed with 10% compared to rats administered 20% of green tea extract while significant decrease in the level of ALT showed in group fed with 20% of green tea extract this result agreed with Hussein (2011) who indicate that green tea extract can lowers GOT, GPT during treatment periods. Also, this result agree with Hasanein *et al*., (2012) showed the highest decrease in the mean value of AST, ALT and ALP recorded for the group fed on high fat diet and treated daily with water extract of green tea. The antioxidant property of flavonoidal compounds of GTE contributes to decrease the oxidative stress in liver and increase the levels of antioxidant enzymes, superoxide dismutase, catalase and glutathione (El-Beshbishy, 2005). Epidemiologic studies suggest that green tea consumption reduces serum aminotransferases commonly used markers of liver injury. The hepatoprotective activities of green tea are attributed to its catechins that scavenge ROS/RNS *in vitro* (Hasanein *et al*., 2012).

1.3. Histopathological Evaluation: Microscopically, the liver of rat from control negative group revealed no histopathological changes meanwhile, liver of rat from control positive group showed very occasional foci of lobular inflammation. Moreover, liver from rat which is take GTE 10% show normal hepatic lobule. However, the liver from rat which is tske GTE 20% showed a very occasional foci of lobular inflammation as a control positive group.

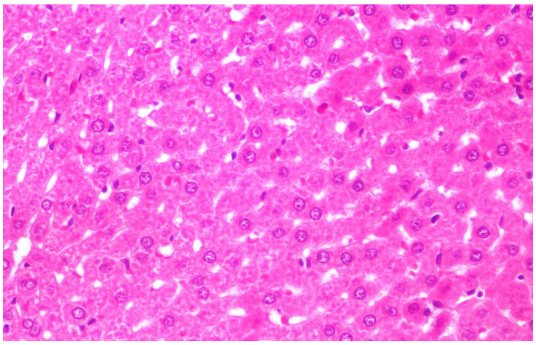

Photo 1: Liver of rat from control negtive group showing no histopathological changes. (H and E × 400)

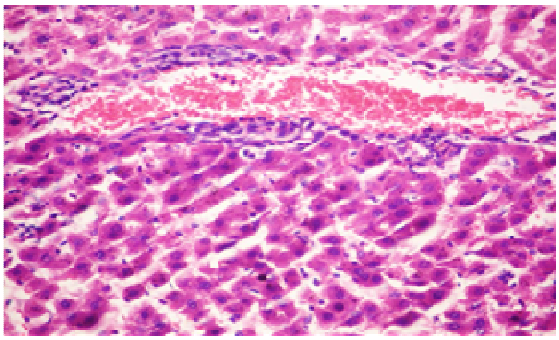

Photo 2: Liver of rat from group 2 showing very occasional foci of lobular inflammation. (H and E × 400)

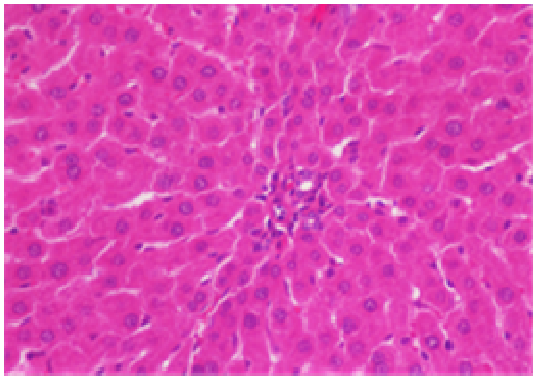

Photo 3: Liver from rat which is take GTE 10% show normal hepatic lobule. (H and E × 400)

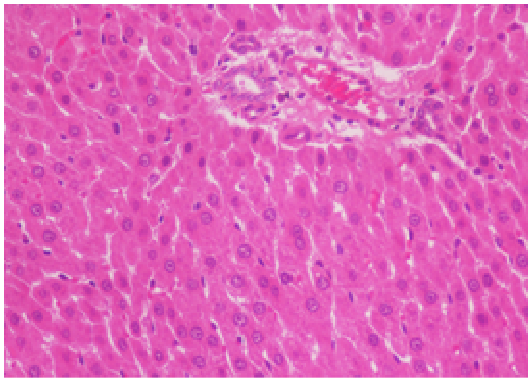

Photo 4: Liver from rat which is take GTE 20% show a very occasional foci of lobular inflammation. (H and E × 400)

Conclusion

Oral administration with tested plant reduced weight gain and enhancing liver status. According to the results, green tea could be used for obese patients.

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