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Slimming of Obese Sprague Dawley Male Albino Rats by Garcinia Fruit as Enhanced with Citrus Fruit Peels

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Abstract:

The effects of *Garcinia fruit*, *Garcinia fruit with lemon peels* 5% & 7.5%, *orange peels* 5% & 7.5%, and *grapefruit peels* 5% & 7.5% powders on some biological, biochemical and histological factors of obese rats were studied. Fifty five adult male rats were distributed into eleven groups, the eleven groups were fed on high fat diet for induction of obesity. One of these groups was kept as positive control while the left nine groups were given daily *Garcinia fruit* 5% & 7.5%, *Garcinia fruit with lemon peels* 5% & 7.5%, *orange peels* 5% & 7.5%, and *grapefruit peels* 5% & 7.5%, for 28 days. Results showed that body weight gain was markedly lower especially in the fruit powder at the level 7.5% compared to high fat diet control group. Non significant difference revealed of among group 3-11. Administration of fruits and peels at 5% and 7.5% lowered concentrations of total cholesterol, triglycerides, LDL-c, VLDL-c and decreased activity of AST, ALT and ALP enzymes and lowered creatinine, urea and uric acid of serum while HDL-c concentrations were significantly increased. Histopathological examination showed amelioration of histopathological lesions seen in liver and kidney of obese rats when received the *Garcinia* and citrus peels. So, this study concluded that intake of *Garcinia* and citrus peels at 5%, 7.5% can be useful for coping obesity.

Key words: Obese rats- *Garcinia* - lemon peels - orange peels - grapefruit peels - serum lipids - histopathology studies

Introduction:

Obesity is a major public health problem in the United States. Data on measured heights and weights indicates that the prevalence of obesity has significantly increased among the US population over the past 30 years. Data collected from 1999 to 2002 Y. estimates that nearly 1/3 of adults are obese (27.6% of men and 33.2% of women) and one in six children and adolescents is overweight. Increased prevalence of excessive weight is noted among all age, gender and racial/ethnic groups; however, disparities exist. There is a need for further research to better understand why these increases have occurred, why the observed disparities exist and how to reverse these trends (**Baskin, 2005**). The fruit of the tree *Garcinia cambogia.*, belonging to the family Clusiaceae, is unique in possessing a constituent called (-) hydroxycitric acid [HCA] in its rinds, which is known to exist at the highest known percentage reported thus far. This component of the fruit rind is gaining importance as an anti-obesity factor in addition to several medicinal properties such as, anti-inflammatory, anti-tumour, hypoglycemic and hypolipidemic properties (**Chandu and Chairy, 2009**). *Garcinia cambogia*, a which is tropical fruit also known as the Malabar tamarind, is a popular weight-loss supplement. People say it blocks your body's ability to make fat and it puts the brakes on your appetite. It could help keep blood sugar and cholesterol levels in check, too. It may be found in bottles on the shelf at the store as well as mixed with other ingredients in diet products (**Schaefer, 2015**).

In view of the above, there is a need to explore safer alternative and complementary therapy to combat obesity. Plant based remedies offer a natural choice due to a number of factors including safety, efficacy and affordability. Consequently, the recent years have witnessed an influx of studies exploring plants for their lipid lowering or controlling effect. Plants have a wide variety of natural chemical compounds having diverse structural features making many of them potentially compatible with pancreatic lipase modulating mechanisms. Citrus peels and citrus juices and factories waste by-products are valuable functional food. The activity evaluation of citrus peels powders fortified biscuits as anti hyper lipidemic in induced hyperlipidemic rats carried out. Effect of studied groups on body weight (BW), cholesterol fractions, and triglycerides was assessed. Data recorded positive effect on BW gain in all studied groups. Data showed that HLD+10% Diabetic fed basal diet (DFBD) reduced cholesterol, (28.8%), LDL (33.3%), and triglycerides (49.9%), and raised HDL (28.8%) of rats serum recommending it for obese, and hyperlipidemic persons diets **(Youssef *et al.*, 2014)**.

Citrus fruit extracts also inhibited the advanced glycation end product and H₂O₂-induced oxidative stress in human adipocytes. In a randomized clinical study, fresh grapefruit extracts reduced body weight and improved insulin resistance in obese patients **(Kang *et al.*, 2013 and Park *et al.*, 2013)**.

Materials and Methods

Garcinica (*Garcinia gummi-gutta*); orange peels (*Citrus sinensis*); lemon peels (*Citrus limon*); grapefruit peels (*Citrus paradisi*) fruits were obtained from the local market, Cairo, Egypt. All chemicals and diagnostic kits were purchased from El-Gomhoria Co., Cairo, Egypt.

Preparation of the tested material: The tested fruits and citrus peels were sun-dried at 40 °C for three days and ground into fine powder by using a mill and kept in dark, stoppered glass bottles in a cool and dry location till use so as to reduce oxidation of their contents.

Experimental animals: This study was carried out on fifty five adult male Sprague Dawley albino rats weighing 120 ± 10 g live body weight. The rats were obtained from Laboratory Animal Colony, Helwan Farm, Egypt. Before their use in the experiment, the rats were kept for one week for acclimatization to the laboratory conditions. They were fed on basal diet and provided with water and feed ad libitum.

Preparation of experimental diets and induction of obesity: Basal diet was prepared AIN-1993 according to Reeves *et al.*, (1993). The salt mixture was prepared according to (Hegsted *et al.*, 1941) and the vitamin mixture was prepared according to (Camebell, and McLaughlan 1969) High Fat Diet (HFD) was used in which at least 45% of its energy comes from fat as reported by Negm (2002). Basal diet was modified to contain 40 g corn oil + 200 g ghee/kg diet and the amount of added saturated fat was substituted from the amount of corn starch.

Experimental procedure: Rats were divided into eleven groups consisting of five rats each. Ten groups were fed on HFD during the experimental period. After 28 days that was required to induce obesity as stated by Negm, (2002), the first group was left as a control positive, while the rest were given Garcinia powder supplement fruit with peels powders at 5&7.5% . During the experiment period,(28days) the feed intake and body weight were weighed daily and twice a week, respectively. Body Weight Gain (BWG) and Feed Efficiency Ratio (FER) were calculated at the end of the experimental period according to the following equations:

$BWG (g) = \text{final weight (g)} - \text{initial weight (g)}$

$FER = \text{weight gain (g)}/\text{feed intake (g)}$

Collection of blood samples and Internal organs (liver, kidney and heart) were also weighted:

At the end of the experimental period, rats were sacrificed following a 12 h fast. The rats were lightly anaesthetized by ether and about 7 ml of blood was withdrawn from the hepatic portal vein into dry centrifuge plastic tubes. Blood samples were centrifuged for 20 min at 3000 rpm to separate the serum samples which were kept in tube at -20 °C till biochemical analysis. In addition, livers and kidney of the sacrificed rats were moved for histopathological study.

Biochemical analysis: Serum total cholesterol was calorimetrically determined according to **Allain, (1974)** and triglyceride was determined calorimetrically according to **Fossati and Principe (1982)**. High Density Lipoprotein cholesterol (HDL-c) was determined calorimetrically according to **Burstein (1970)**. Low Density Lipoprotein cholesterol (LDL-c) and Very Low Density Lipoprotein cholesterol (VLDL-c) were calculated mathematically according to **Friedwald and Levy, (1972)**

$$\text{LDL-c} = \text{TC} - [\text{HDL-c} + (\text{TG}/5)]$$

$$\text{VLDL-c} = \text{Triglycerides}/5$$

The activity of Aspartate Aminotransferases (AST), Alanine Aminotransferases (ALT) and Alkaline phosphatase enzymes (ALP) were assigned by the method of **Henery (1974) and Yound (1975)**.

Histopathological study: Livers and kidneys of the sacrificed rats were dissected, removed, washed with normal saline and fixed in 10% formalin solution. The fixed specimens were then trimmed, washed and dehydrated in ascending grades of alcohol. The tissue specimens were cleared in xylene, embedded in paraffin, sectioned at 4-6 microns thickness, stained with Hematoxylin and Eosin (H and E) and then examined by light microscope according to **Carleton, (1979)**.

Statistical analysis: Results are expressed as mean values with the standard deviation of the mean. Statistical differences between groups were evaluated using one-way ANOVA followed by Duncan post hoc test using SPSS version 11.0 for Windows (SPSS, Chicago, IL, USA). Differences were considered significant at ($p < 0.05$) according to **Steel and Torri, (1980)**.

Results and Discussion

From results of table (1) it is evidence that due to obesity control (+) group revealed more BWG, F and FER in comparison with that of the control (-) feeding on *Garcinia* without or with *citrus peels* BWG markedly reduced and native values were encountered ranged . FI ranged +18 to 24.3g daily. FER however revealed also Negative values which were less that control (+) and control (-).

Anyhow, results of table (1) showed that obesity was an revealed based on FER was the of *Garcinia+ lemon peels* 7.5%.

Table(1): show values of body weight gain.(BWG%), feed efficiency ratio (FER) and feed intake(FI)for control positive group ,control negative group and different obese rats groups fed on. *Garcinia fruit* alone, *Garcinia fruit with lemon peels, orange peels, grapefruit peels* and mixture of all plants7.5%.

Groups Parameter	(1) Negative Control C(-)	(2) Positive Control C(+)	<i>Garcinia fruit</i>		<i>Garcinia fruit + orange peels</i>		<i>Garcinia fruit + lemon peels</i>		<i>Garcinia fruit + grape fruit peels</i>		(11) Mixture of peels powder	L.S.D P≤0.05
			(3) 5%	(4) 7.5%	(5) 5%	(6) 7.5%	(7) 5%	(8) 7.5%	(9) 5%	(10) 7.5%		
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	
BWG (rat/day)	.714b ± 0.01	1.142 a ± 0.01	-1.68i ± 0.01	-1.75j ± 0.01	-1.5 e ± 0.01	- 1.535f ±0.01	-1.392c ± 0.01	-1.571 g ± 0.01	1.428d ± 0.01	-1.607 h ± 0.01	-1.428 d ± 0.01	0.0143
FI (mg/dl)	22.5 c ± 1.1	23 b ± 1	21.02f ± 1.2	22.5c ± 1.1	20.5g ± 1.3	22.2d ± 1.2	21.3e ± 1.2	24.3a ± 1.1	18i ± 1.3	23b ± 1.2	19h ± 1.1	0.157
FER (mg/dl)	0.031 b ± 0.001	0.0496 a ± 0.002	- 0.0799e ± 0.001	- 0.0778de ± 0.003	- 0.0732cde ± 0.001	- 0.0691 cd ± 0.001	- 0.0653c ± 0.002	- 0.0646c ± 0.001	- 0.0793 e ± 0.001	- 0.0698cd ± 0.003	- 0.0751de ± 0.001	0.0061

Table(1) show values of body weight gain. (BWG%), feed efficiency ratio (FER) and feed intake(FI)for control positive group ,control negative group and different obese rats groups fed on *Garcinia fruit* alone, *Garcinia fruit with orange peels, lemon peels, grapefruit peels* and mixture of all plants7.5%, It could be observed that the mean value of control (+) group was higher than control (-) group, it was being 1.142 ±0.1 and .714± 0.01% which revealed significant difference with percent of decrease -37.48% of control(-) group as compared to control (+) group. The best BWG% was recorded for groups 8 (obese rats fed on *Garcinia fruit* 5% *lemon peels* when compared to control (+) group.

Srivastava (2012) results indicated that feed intake, body weight and lipid profile, were decreased as a result of *Garcinia cambogia* fruits

containing Hydroxyl citric acid (HCA) supplementation at various levels to rat diet.

Moreover, **Han et al., 2015** showed that (-)-HCA treatment reduced body weight gain; **Liu et al., 2015** showed that *Garcinia cambogia* extracts could significantly reduce body weight gain; **Jena et al., 2002** showed that consumption of hydroxycitric acid reduces appetite, inhibits fat synthesis, lipogenesis, decreases feed intake and reduces body weight).

In relation to **feed intake (FI)** (table 1), it could be observed that the mean value of control (+) group was more than control (-) group, it was being 23 ± 1 and 22.5 ± 1.1 respectively, which revealed significant difference with percent of decreases 2.17% of control (-) group as compared to control (+) group. The best FI was recorded for groups 8 (obese rats fed on *Garcinia fruit with lemon peels 7.5%*) when compared to control (+) group.

Srivastava (2012) indicated that feed intake, body weight and lipid profile, were decreased as a result of *Garcinia cambogia* fruits containing HCA supplementation at various levels to rat diet.

As for feed efficiency ratio (FER)

In the same table (1) it could be observed that the mean value of control (+) group was less than control (-) group, it was being 0.0496 ± 0.002 and 0.0319 ± 0.001 respectively, which revealed significant difference with percent of decrease -35.68% of control (-) group as compared to control (+) group. The best FER was recorded for groups 8 (obese rats fed on *Garcinia fruit with lemon peels 7.5%*).

Organs weight:

Table (2), data presented in show the effect of *Garcinia fruit* powder alone, *garcinia fruit with orange peels, lemon peels, grapefruit peels* and mixture of all plants 7.5% of diet for 4 weeks on organs weights.

Table (2): External organs weight of obese rates fed on *Garcinia* with *citrus peels* diets.

Groups Parameter	(1) Negative Control C(-)	(2) Positive Control C(+)	<i>Garcinia fruit</i>		<i>Garcinia fruit + orange peels</i>		<i>Garcinia fruit + lemon peels</i>		<i>Garcinia fruit + grape fruit peels</i>		(11) Mixture of peels powder	L.S.D P≤0.05	
			(3) 5%	(4) 7.5%	(5) 5%	(6) 7.5%	(7) 5%	(8) 7.5%	(9) 5%	(10) 7.5%			
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD		
Liver (g)	2.25 ^f ±0.205	5.51 ^a ±0.170	2.89 ^{bcd} ±0.11	2.95 ^{bc} ±0.15	2.75 ^e ±0.151	2.74 ^e ±0.11	2.99 ^b ±0.115	2.84 ^{cde} ±0.155	2.96 ^{bc} ±0.165	2.84 ^{cde} ±0.185	2.83 ^{de} ±0.3	0.086	
Heart(g)	0.342 ^f ±0.1	1.06 ^a ±0.1	0.451 ^{de} ±0.1	0.491 ^{cd} ±0.1	0.451 ^{de} ±0.1	0.53 ^{bcd} ±0.1	.55 ^{bc} ±0.1	0.50 ^{bcd} ±0.1	0.40 ^e ±0.1	0.58 ^b ±0.1	0.52 ^{bcd} ±0.1	0.056	
Kidney(g)	0.68 ^e ±0.02	1.07 ^a ±0.03	0.89 ^d ±0.01	0.87 ^d ±0.02	0.93 ^c ±0.03	0.88 ^d ±0.01	0.92 ^c ±0.02	0.796 ^f ±0.02	0.93c±0.01		0.85 ^e ±0.02	0.96 ^b ±0.01	0.019

1- liver Weight (g):

Table (2) showed the effect of *garcinia* fruit alone, *garcinia fruit with orange peels*, *lemon peels*, *grapefruit peels* and mixture of all plants 7.5%, on Liver weight of obese rats. It could be observed that the mean value of control (+) was higher than control (-), it was being 5.51 ±0.170 and 2.25±0.205g, respectively which revealed significant difference with percent of decrease -59.17 % of control (-) group as compared to control (+) group. The best liver weight (g) was recorded for groups 5,6 (obese rats fed on *Garcinia fruit + orange peels* diets 5%,7.5%) when compared to control (+) group.

2- Heart Weight (g):

Table (2) results illustrated the mean value (g) of heart weight of rats fed on various diets. It could be observed that the mean value of control (+) group was higher than control (-) group, it was being 1.06±0.01 and 0.342±0.1, respectively which revealed significant difference with percent of decrease -67.74 % of control (-) group as compared to control (+) group. The best heart weight was recorded for group 9 (obese rats fed on *Garcinia fruit + grape fruit peels* 5% when compared to control (+) group).

3- Kidneys Weight (g):

Date of table (2) indicated the mean value (g) of kidneys of weight rats fed on various diets. It could be observed that the mean value of control (+) group was higher than control (-) group, it was being 1.07±0.011 and 0.68±0.2g, respectively, which revealed significant difference with percent of decrease -36.4% of control (-) group as compared to control (+) group. The best kidneys weight was revealed for

group 8 (obese rats fed on *Garcinia fruit + lemon peels* 7.5% when compared to control (+) group.

Serum lipids parameters

Table (3): The effect *Garcinia fruit* alone, *Garcinia fruit* with *orange peels* 5% & 7.5%, *lemon peels* 5% & 7.5% , *grapefruit peels* 5% & 7.5% and mixture of all plants on serum lipids parameters (mg/dl) in obese rats

Groups Parameter	(1) Negative Control C(-)	(2) Positive Control C(+)	<i>Garcinia fruit</i>		<i>Garcinia fruit + orange peels</i>		<i>Garcinia fruit + lemon peels</i>		<i>Garcinia fruit + grape fruit peels</i>		(11) Mixture of peels powder	L.S.D P<0.05
			(3) 5%	(4) 7.5%	(5) 5%	(6) 7.5%	(7) 5%	(8) 7.5%	(9) 5%	(10) 7.5%		
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	
TC (mg/dl)	66 ^f ±1	110 ^a ±1	75 ^e ±2	62 ^g ±1	92 ^b ±1	83 ^c ±1	84 ^c ±1	60 ^h ±1	79 ^d ±1	75 ^d ±1	82 ^c ±1	1.98
TG (mg/dl)	36 ^f ±1.1	45 ^a ±1	41 ^b ±1.2	38 ^d ±1.1	39 ^c ±1.5	37 ^e ±1.3	37 ^e ±1.2	36 ^f ±1.1	41 ^b ±1.3	38 ^d ±1.2	36 ^f ±1.1	0.37
HDL (mg/dl)	30 ^a ±1.1	20 ^h ±1	25 ^f ±1.2	24 ^g ±1.1	26 ^a ±1.3	27 ^d ±1.2	28 ^c ±1.2	29 ^b ±1.1	27 ^d ±1.3	28 ^c ±1.2	26 ^e ±1.1	0.60
VLDL (mg/dl)	7.2 ^e ±1.1	9 ^a ±1	8.2 ^b ±1.2	7.6 ^d ±1.1	7.8 ^c ±1.3	7.4 ^{de} ±1.3	7.4 ^{de} ±1.2	7.2 ^e ±1.1	8.2 ^b ±1.3	7.6 ^d ±1.3	7.2 ^e ±1.1	0.157
LDL (mg/dl)	28.8 ^g ±1.1	81 ^g ±1	41.8 ^e ±1.2	30.4 ^f ±1.62	58.2 ^b ±1.3	48.6 ^c ±1.2	48.6 ^c ±1.2	23.8 ^h ±1.1	43.8 ^d ±1.3	39.4 ^e ±1.4	48.8 ^c ±1.1	1.25

The effect of experimental diets on serum lipids:

As for total cholesterol (T.C), the results revealed that control (+) group was higher than control (-) group, it was being 110±1 and 66±1 mg\dl , respectively, showing significant difference with percent of decrease -40% of control (-) group as compared to control (+) group. the better serum (T.C) was showed for group 8 (obese rats fed on *Garcinia fruit + lemon peels* 7.5%) when compared to control (+) group.

Concerning triglycerides (T.G), it could be noticed that the mean value of TG of control (+) group was higher than control (-) group, it was being 45±1 and 36±1.1 mg\dl, respectively, showing significant difference with percent of decrease -20% of control (-) group as compared to control (+) group, All obese rats fed on various diets showed significant differences in mean values as compared to control (+) group. The best serum (T.G.) was recorded for group8,11 (obese rats fed on *Garcinia fruit and lemon peels* 7.5% and Mixture of peels powder when compared to control (+) group.

As for low density lipoprotein (LDL), it could be revealed that the mean value were 81 ± 1 and 28.8 ± 1 mg/dl, respectively showing significant difference with percent of decrease -64.44% of control (-) group as compared to control (+) group, The best (LDLc) was recorded for group 8 (obese rats fed on *Garcinia fruit* and *lemon peels* 7.5%) when compared to control (+) group.

Concerning very low density lipoprotein (VLDL), of serum of obese rats fed on various diets. It could be observed that the mean value of VLDLc of control (+) group was higher than control (-) group being 9 ± 1 mg/dl and 7.2 ± 1.1 mg/dl, respectively, showing significant difference with percent of decrease -20% of control (-) group as compared to control (+) group. The best treatment was recorded for group 8 and 11 (obese rats fed on *Garcinia fruit* and *lemon peels* 7.5% and Mixture of peels powder when) compared to control (+) group.

Rakesh, 2013 reported that the crude extract or constituents from the plant also exerted hypolipidaemic because it plays a key role in fatty acid, cholesterol and triglycerides syntheses. **Deepak, (2012)** found that hydroxy citric acid (HCA), of *Garcinia cambogia* had an effect on serum lipid profile. **Liu et al., 2015** demonstrated that *Garcinia cambogia* extract reduced serum triglyceride in rats under high fat diet.

Liver function makers:

Table (4): The effect *Garcinia fruit* alone, *Garcinia fruit* with *lemon peels* 5% & 7.5%, *orange peels* 5% & 7.5%, *grapefruit peels* 5% & 7.5% and mixture of all plants on liver function (mg/dl) in obese rats.

Parameter	Groups		<i>Garcinia fruit</i>		<i>Garcinia fruit + orange peels</i>		<i>Garcinia fruit + lemon peels</i>		<i>Garcinia fruit + grape fruit peels</i>		(11) Mixture of peels powder	L.S.D P≤0.05
	(1) Negative Control C(-)	(2) Positive Control C(+)	(3) 5%	(4) 7.5%	(5) 5%	(6) 7.5%	(7) 5%	(8) 7.5%	(9) 5%	(10) 7.5%		
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD		
ALP u/l	122 j ± 2	355 a ± 1	310 c ± 1.5	365 e ± 2	271 d ± 1.04	335 b ± 2	194 h ± 1.5	225 f ± 2	184 i ± 2	220 g ± 2	352 a ± 2	3.002
ALT u/l	48g ± 1	79 a ± 1	64 d ± 1	57.4 e ± 1	69.9 c ± 1.04	52.4 f ± 1	54 f ± 1	54.2 f ± 0.5	69 c ± 1	75 b ± 1	64.2 d ± 1	1.64
AST u/l	104 l ± 0.5	225 a ± 0.5	151 h ± 0.95	153 g ± 1.10	166.8 d ± 0.5	167d ± 0.5	221b ± 0.5	194 c ± 0.5	221 b ± 0.5	163.7 f ± 1	165.2 e ± 1	1.43

As for (GOT),(AST) the mean value of serum (GOT) (U/L) of obese rats fed on various diets. It could be noticed that the mean value of

(GOT) of control (+) group was higher than control (-) group, it was being 225 ± 0.5 and 104 ± 0.5 u/l respectively showing significant difference with percent of decrease 53.78% of control (-) group as compared to control (+) group. The best (GOT) was recorded for group 3, 4 (obese rats fed on *Garcinia fruit 5 %* when compared to control (+) group.

Concerning (GPT)(ALT) the mean value of serum (GPT) (U/L) of obese rats fed on various diets. It could be noticed that mean value of (GPT) of control (+) group was higher than control (-) group, being 79 ± 1 and 48 ± 1 u/l respectively, showing significant difference with percent of decrease 39.24% of control (-) group as compared to control (+) group. The best treatment was observed group 6 (obese rats fed on *Garcinia fruit and orange peels 5 %*) when compared to control (+) group.

As for (ALP), illustrate the mean value of serum (ALP) (U/L) of obese rats fed on various diets. It could be noticed that the mean value of (ALP) of control (+) group was higher than control (-) group, it was being 355 ± 1 and 122 ± 2 respectively, showing a significant difference with percent of decrease 65.63% of control (-) group as compared to control (+) group. The best (ALP) was recorded for group 9 (obese rats fed on *Garcinia fruit and grape fruit peels 5%* when compared to control (+) group. **Seham (2011)** suggested that evaluated the beverages prepared from the citrus orange peel lower AST,ALT in the serum of rats fed on high cholesterol diet and this may be due to the natural phytochemicals present in these fruit or vegetable wastes that have antioxidant properties succeeded to protect against oxidative free radicals and in turn prevent chronic diseases. **Erukainure et al. (2012)** indicated that the orange peel decreased ALT and increased AST levels in rats.

Chen et al., 2013 demonstrated that water extracts of sweet orange peels and its biological compound, hesperidin had a significant protective effect of lowering the levels of AST,ALT in rat serum.

Kidneys function makers:

Table(5): kidney function parameters of in obese rats fed on Garcinia fruit with cittrus peels

Parameter	Groups	(1) Negative Control C(-)	(2) Positive Control C(+)	Garcinia fruit		Garcinia fruit + orange peels		Garcinia fruit + lemon peels		Garcinia fruit + grape fruit peels		(11) Mixture of peels powder	L.S.D P≤0.05
				(3) 5%	(4) 7.5%	(5) 5%	(6) 7.5%	(7) 5%	(8) 7.5%	(9) 5%	(10) 7.5%		
				Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD		
Creat (mg/dl)		0.5 B ±0.01	0.63 a ±0.085	0.60 ab ±0.04	0.50b ±0.03	0.52b ±0.072	0.58ab ±0.32	0.56ab ±0.07	0.52b ±0.04	0.56ab ±0.02	0.52b ±0.06b	0.60ab ±0.05b	0.088%
Uric acid (mg/dl)		1.3d ±0.1	2.1a±0.1	1.6bcd±0.2	1.3d±0.1	1.4cd±0.2	1.9ab±0.1	1.6bcd±0.2	1.3d±0.2	1.5cd ±0.2	1.4cd ±0.2	1.7bc ±0.2	0.22
BUN (mg/dl)		11e ±1	29a ± 1	23.2c ±1	16.4d ±1	15.6d ±1	22.6c ±1	21.8c ±1	23.2c ±1.5	16d ±1.5	17.4a ±1	27b ±0.5	1.82%

A) Serum urea nitrogen BUN:

Table (5) results the effect of *Garcinia fruit* alone, *Garcinia fruit* with *lemon peels* 5% & 7.5%, *orange peels* 5% & 7.5% , *grapefruit peels* 5% & 7.5% and mixture of all plants on Urea in obese rats group (+) mean values could be observed that the urea of control (+) group was markedly higher when compared with control (-) group it was being 29±1 and 11±1 mg/dl which revealed significant difference with percent of decrease 62.06% of control (-) group as compared to control (+) group. All groups 3-11 revealed preconized decreased of BUN, especially groups (4&5) when compared to control (+) group.

B) Serum Creatinine:

It could be observed that the mean value of control (+) group was higher than control (-) group, it was being 0.63±0.085 and 0.5±0.01 mg/dl , respectively which revealed significant difference with percent of decrease 20.64% of control (-) group as compared to control (+) group. Group 3,6,7,9 and 11 revealed non significant difference between them.

c) Serum uric acid:

It could be observed that the mean value of control (+) group was higher than control (-) group, it was being 2.1±0.1 and 1.3 ±0.1 mg/dl , respectively, which revealed significant difference with percent of decrease -38.09 % of control (-) group as compared to control (+) group. Group 4 (obese rats fed on *Garcinia fruit* and 7.5% was the best when compared to control (+) group. **Amin et al., 2011** reported that *Garcinia* ameliorated the damaging effects of the HFD or HSD and decreased the serum level of creatinine and urea in rats . This may be

due to hydroxy citric acid (the main component of *Garcinia cambogia*) which attenuated increase oxidative stress biomarker through reducing lipid peroxidation (MDA) and declining lipid profiles and level of oxidized LDL which generally improved kidney function. (Asghar *et al.*, 2007).

Eman *et al.*, 2012 suggested that treatment with orange peel extract 200 improved renal functions and significantly prevented the increase in creatinine, urea and blood urea nitrogen levels.

Table (6):The effect of experimental diets on glucose level in serum:

As for **glucose**, the mean value of glucose mmol\dl. of obese rats fed on various diets. It could be noticed that the mean value of glucose mmol\dl of control (+) group was lower than control (-) group, it was being 118±1.04 and 60±0.5, respectively, showing significant difference with percent of decrease -49.15% of control (-) group as compared to control (+) group .The better serum glucose was observed for group 8 (obese rats fed on *Garcinia* fruit and lemon peels 7.5% when compared to control (+) group .

King and Loeken, 2004 found that extract of the *Garcinia* rind (100 mg/kg and 200 mg/kg) for a period of 4 weeks to streptozotocin-induced type 2 diabetic rats is shown to be effective in decreasing both fasting and postprandial blood glucose. Rakesh, 2013 suggested that *Garcinia* extract had anti diabetic effect .Liu *et al.*, 2015 reported that *Garcinia Cambogia* extracts could significantly reduce serum glucose in rats under high-fat diet.

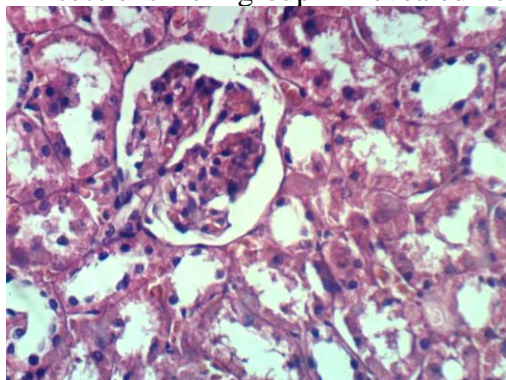
Parameter	Groups		Garcinia fruit		Garcinia fruit + orange peels		Garcinia fruit + lemon peels		Garcinia fruit + grape fruit peels		(11) Mixture of peels powder	L.S.D P≤0.05
	(1) Negative Control C(-)	(2) Positive Control C(+)	(3) 5%	(4) 7.5%	(5) 5%	(6) 7.5%	(7) 5%	(8) 7.5%	(9) 5%	(10) 7.5%		
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD		
Glucose mmol\dl	60j ± 0.5	118 a ± 1.04	104d ± 0.5	98F ± 1	108C ± 0.5	84g ± 0.5	108c ± 0.5	26i ± 0.5	101e ± 1	66h ± 1	113b ± 1.52	0.157

The above presented results indicated that addition of citrus fruit peels with *Garcinia* mostly improved the studied parameters moreover the mixed diet results revealed no synergism. Also the best group was not the same for all plants, although suggested diets were beneficial.

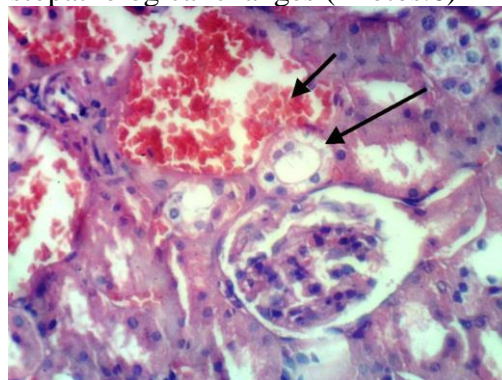
Histopathological examination of kidneys:

Microscopically, Kidney of rat from group 1 revealed the normal histological structure of renal parenchyma (Photo. 1). Meanwhile,

kidneys of rats from group 2 revealed congestion of renal blood vessel (Photo. 2), Moreover, kidneys of rats from groups 3 & 6 revealed no histopathological changes (Photos.3,4), whereas, other sections from this group revealed no histopathological changes. (Photos.5) and some sections from group 11 revealed no histopathological changes (Photos.6)



Photo(1): Kidney of rat from group 1 showing the normal histological structure of renal parenchyma (H & E X 400).



Photo(2): Kidney of rat from group 2 showing congestion of renal blood vessel and cytoplasmic vacuolization of renal tubular epithelium (H & E X 400).

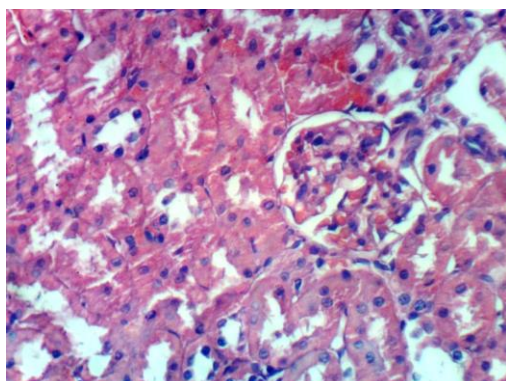


Photo (3): Kidney of rat from group 3 showing no histopathological changes (H & E X 400).

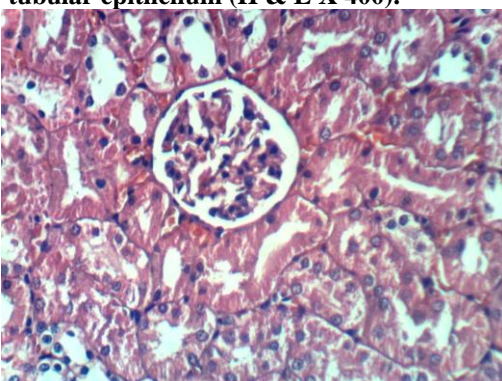


Photo (4): Kidney of rat from group 6 showing no histopathological changes (H & E X 400).

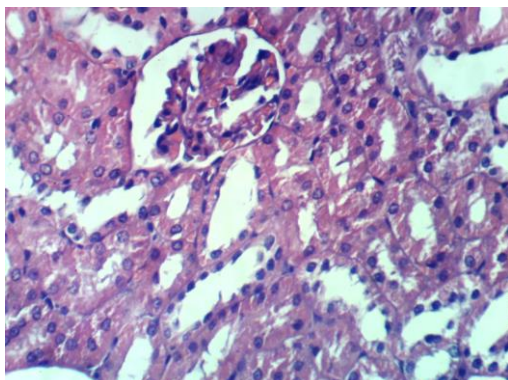


Photo (5): Kidney of rat from group 7 showing no histopathological changes (H & E X 400).

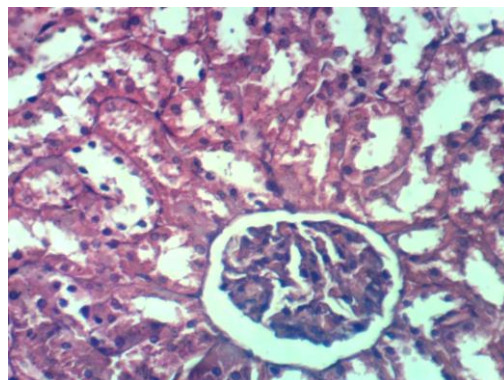
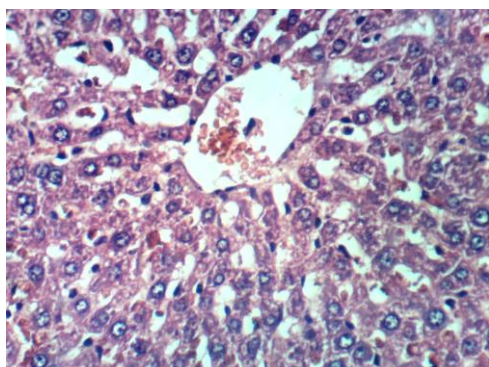
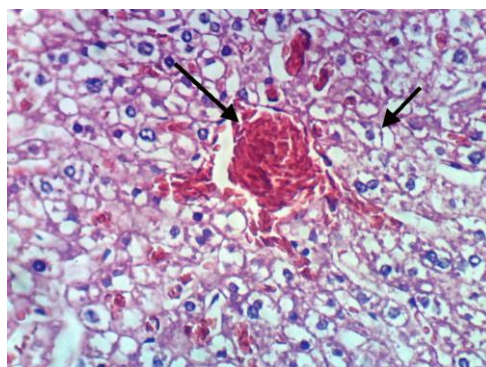


Photo (6): Kidney of rat from group 11 showing no histopathological changes (H & E X 400).



Photo(7): Liver of rat from group 1 showing the normal histological structure of hepatic lobule (H & E X 400).



Photo(8): Liver of rat from group 2 showing cytoplasmic vacuolization of hepatocytes and congestion of central vein and hepatic sinusoids (H & E X 400).

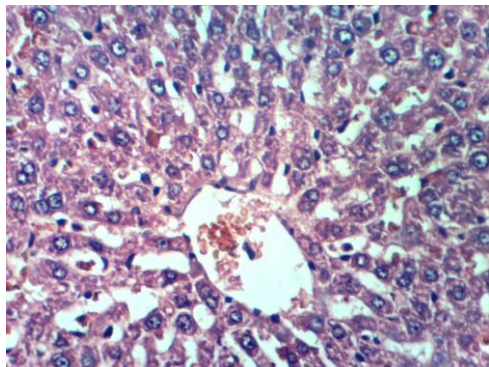


Photo (12): Liver of rat from group 3 showing no histopathological changes (H & E X 400).

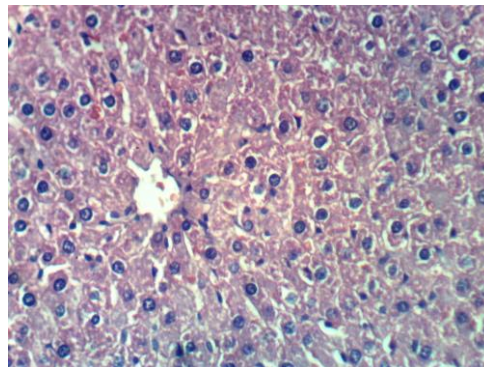


Photo (9): Liver of rat from group 4 showing apparent normal hepatocytes (H & E X 400).

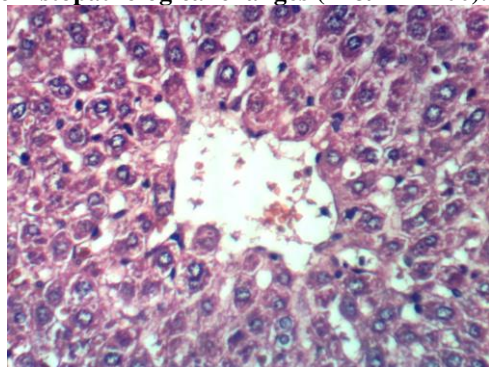


Photo (10): Liver of rat from group 7 showing no histopathological changes (H & E X 400).

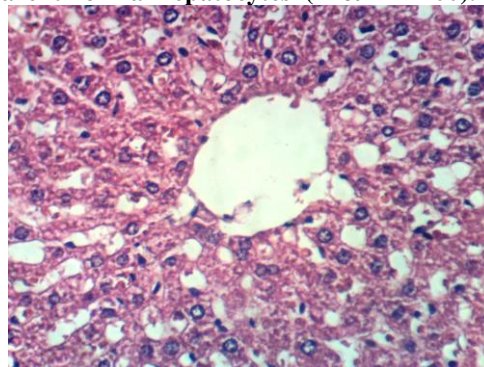


Photo (11): Liver of rat from group 11 showing no histopathological changes (H & E X 400).

Histopathological changes conferred by biological & biochemical changes

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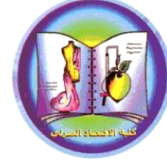
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خفض سمنة ذكور الفئران البيضاء باستخدام فاكهة الجارسينيا المعززة بقشور فاكهة الحمضيات

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الملخص العربي:

تم إجراء الدراسة الحالية لمعرفة تأثير مسحوق فاكهة الجارسينيا المعززة بمساحيق قشور فاكهة الحمضيات على الفئران المصابة بالسمنة. تم استخدام ٥٥ فأر ألبينو بالغ متوسط وزنها (120 ± 10) جم والعمر (3 أشهر). وتم تقسيمهم إلى 11 مجموعات متساوية وتم تغذية جميع الفئران على الوجبة الأساسية لمدة ثلاثة أيام للتكيف مع المكان ثم تغذية 10 مجموعات على وجبات مرتفعة السعرات مع الدهون المشبعة لإصابتهم بالسمنة. و تقسيمهم إلى كل المجموعات التالية:

- المجموعة "١": المجموعة الضابطة السالبة حيث تغذت الفئران الطبيعية على غذاء أساسي لمدة 4 أسابيع
- المجموعة "٢": تغذت الفئران المصابة بالسمنة على الوجبة الأساسية كمجموعة ضابطة موجبة
- المجموعة "٣": تغذت الفئران المصابة بالسمنة على الوجبة الأساسية + مسحوق فاكهة جارسينا ٥٪
- المجموعة "٤": تغذت الفئران المصابة بالسمنة على الوجبة الأساسية + مسحوق فاكهة جارسينا ٥,٧٪
- المجموعة "٥": تغذت الفئران المصابة بالسمنة على الوجبة الأساسية + مسحوق فاكهة جارسينا معزز بمسحوق قشور البرتقال ٥٪
- المجموعة "٦": تغذت الفئران المصابة بالسمنة على الوجبة الأساسية + مسحوق فاكهة جارسينا معزز بمسحوق قشور البرتقال ٥,٧٪
- المجموعة "٧": تغذت الفئران المصابة بالسمنة على الوجبة الأساسية + مسحوق فاكهة جارسينا معزز بمسحوق قشور الليمون ٥٪
- المجموعة "٨": تغذت الفئران المصابة بالسمنة على الوجبة الأساسية + مسحوق فاكهة جارسينا معزز بمسحوق قشور الليمون ٥,٧٪

- **المجموعة "٩":** تغذت الفئران المصابة بالسمنة على الوجبة الأساسية + مسحوق فاكهه جارسينا معزز بقشور الجريب فروت ٥٪.
- **المجموعة "١٠":** تغذت الفئران المصابة بالسمنة على الوجبة الأساسية + مسحوق فاكهه جارسينا معزز بمسحوق قشور الجريب فروت ٧.٥٪.
- **المجموعة "١١":** تغذت الفئران المصابة بالسمنة على الوجبة الأساسية + يحتوى على خليط مسحوق مكون من نسب متساوية من هذه النباتات [جميعا ثم استمرت التجربة ٢٨ يوم وفى نهاية التجربة تم وزن الفئران ثم ذبحهم وتجميع عينات الدم بعد صيام ١٢ ساعة وتم قياس دهون الدم (الكوليسترول الكلي ، الدهون الثلاثية ، ، الليبوبروتين عالي الكثافة (HDL-c) وحساب كلا من الليبوبروتين منخفض الكثافة (LDL-c), الليبوبروتين المنخفض جدا فى الكثافة (VLDL-c)، وتم قياس انزيمات الكبد (ALP, ALT, AST) وحساب كلا من (BWG,FI,FER) كما تم فصل الأعضاء الداخلية (الكبد والكلى والقلب) ووزنها وتم حفظ الكبد والكلى في فورمالين ١٠% متعادل لإجراء الفحوص الهستوباثولوجية. وقد أظهرت نتائج هذه الدراسة أن تناول فاكهه الجارسينيا المعززة بقشور فاكهه الحمضيات نتج عنه إنقاص الوزن. وانخفاض مستوى دهون الدم الضارة وارتفاع نسبة الدهون النافعة وتحسن وظائف الكلى و الكبد بالمقارنة بمجموعه المقارنه الموجبه.

الكلمات المفتاحية: السمنة - مسحوق الجارسينيا- مسحوق قشر البرتقال- مسحوق قشر الليمون - مسحوق قشر الجريب فروت-دهون الدم -وظائف الكلى والكبد- الفحوص الهستوباثولوجية.