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Using of Celery (*Apium graveolens* L) for Lowering Obesity of Experimental Rats

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ABSTRACT

Effect of using celery (*Apium graveolens L*) for lowering obesity of experimental rats was performed through feeding study using normal and obese rats. Meals used were replaced with 2.5 and 5% celery leaves and seeds powder. The received results showed that: final weight and the efficiency of using feed of the infected rats (positive control) fed on meals replaced with celery leaves and seeds powder were higher than those of the obese ones and rats fed on standard meal (negative control). In addition, significant differences in weight of liver, kidney, pancreas, heart and spleen to body weight in obese rats fed on meals replaced with celery powder were recorded. Furthermore, the triglycerides found in the bloodstream of rats infected with obesity and fed on meals replaced with celery leaves and seeds powder at 5% level was lower than that of (control positive) at the beginning of the experiment period. There was a significant increase in the level of high-density lipoprotein cholesterol(HDL) for groups of rats fed on meals replaced with celery leaves and seeds powder at the level of 2.5% and 5% compared with positive control, where significant decrease was recorded in (LDL) level in obese rats fed on meals replaced with celery leaves and seeds powder at the levels of 2.5% and 5% compared to positive control. Obese rats fed on meals replaced with 2.5% and 5% of celery powder were characterized by a high improvement in the level of liver enzymes activity (ALT, AST) compared to the control groups. The greatest increment in insulin was found in the group of rat infected with obese which fed on meals replaced with 2.5% and 5% celery powder compared to the control one (positive infected).

INTRODUCTION

Celery *(Apium graveolens Linn., Apiaceae)* can be classified as a biennial vegetable (meaning it has a normal life cycle of two years) that belongs to the Umbelliferae family, its leaves, roots and seeds are used as a food and seasoning as well as a natural medicinal remedy (Herbst, 2001). It has been used in traditional medicine primarily as a diuretic and treats bronchitis, asthma, liver and spleen diseases (Singh and Handa, 1995). In addition, celery seed is considered one of the very common western herbal medicine. It has been used for thousand of year (Fazal and Singla, 2012). Moreover, celery seeds can be used as arthritic pain relief, for treating rheumatic conditions and gout. Apart from the role in rheumatism, celery seeds proved its use in asthma, bronchitis and inflammatory conditions (Fazal and Singla 2012 and Satyanand *et al.,* 2013).

Wesam *et al*. (2014) concluded that, Hydro-alcoholic extract of celery significantly decreased cholesterol and Low-Density Lipoproteins (LDL) at ($P \leq 0.05$). So probably celery consumption due to the antioxidant properties leads to appropriate changes in serum lipid profiles and reduces them. Moreover, celery can regulate heart function. It can also stimulate pancreas to secrete insulin hence, reduce blood glucose levels, so that it can be used to reduce or treat diabetes complications. Hamza and Amin (2007) and Taher *et al*. (2007) showed that the ingredients of celery stabilizes liver cell membranes and reduce release of AST and ALT enzymes into the blood. kooti *et al*. (2014) evaluated the effects of celery on serum lipids of mice fed on a high-fat meals, where the data showed that the plant causes a significant decrease in LDL and cholesterol, but not on very low Density Lipoprotein (VLDL) and high-density lipoprotein (HDL). Teng *et al.* (1985) examined the attributes of anti-hyperlipidemia of the celery in the rat, a significant reduction was observed in the concentration of serum total cholesterol, triglyceride levels and hepatic lipase triacyl glycerol in the treated groups, (kooti *et al*., 2014). In addition, eating 10% of celery alone lowers liver enzyme levels and blood fats (Tsi *et al*., 1995).

Because obesity has been identified as a major health issue, treating obesity is an important goal. However, weight loss management has proved notoriously difficult. It is well documented that reduced energy intake and increased energy expenditure may reduce body weight in the short term, but obesity in the long term is anticipated (Kissler and Settmacher, 2013).

Obesity is characterized by increased body fat mass, arising from the prolonged imbalance between energy intake and energy expenditure which results from both increased fat cell number and size, and may lead to a variety of diseases, such as cardiovascular disease, nonalcoholic fatty liver disease and hormonal imbalances in women, leading to sterility (Lois and Kumar, 2009).

Therefore, this study was designed to investigate the anti-obesity activity of celery *(Apium graveolens*) along with its mechanism of action in experimental rats.

MATERIALS AND METHODS

1.Materials:

1. **Celery *(Apium graveolens L.*) leaves and seeds:** were obtained from the Laboratory of Sciences, National Research Centre, Giza, Egypt, during the year of (2015).
2. **Casein, Cellulose and Minerals mixture:** were bought from Edwic Co., Egypt,
3. **Vitamins mixture:** were obtained from Hoffman La Roch Vitamins and Fine Chemicals Company (USA).
4. **Fat sheep:** was purchased from the local market of Kafrelsheikh , Egypt.
5. **Kits of (Total lipids, triglycerides, total cholesterol, HDL, AST, ALT, ALP, glucose, creatinine, uric acid, urea, glutathione reduced, MDA, SOD, glutathione peroxidase (GSH-Px), catalase, antioxidants standard):** were obtained from Biodiagnostic Co., Dokki, Giza, Egypt.

6. Animals

Female albino rats wister strain (40 rats) were obtained from Experimental Animal House of Food

Technology, Research Institute ,Agric. Research. Center, Giza, Egypt. The male rats (initial body weight (160-170 gm) were approximately of the same age.

2. Methods:

1. Preparation of samples:

leaves and seeds of celery *(Apium graveolens* L.*)* were cleaned from dust, washed using tape water and freezedried, then they were crumbled, well ground, using electric mill, then sieve to pass through 100 mesh metal screen sieve to receive final of fine powder. The final powder was mixed well and stored in polyethylene pages, then kept at room temperature until used.

2.Biological experiments:

1.Experimental animals:

Female albino rats wister strain (40 rats) of (initial body weight (160-170 gm) were approximately of the same age, and housed in galvanized iron cages measuring 40 ×24×20^{cm} (6 rats per each cage). After feeding on basal diet for ten days, rats were divided into two groups. The first group (8 rats) was fed on basal diet for another 8 weeks and was considered as positive control group (control A). The second was divided into five subgroups (5 rats each). The first one of the five subgroup was continued to feed on a high-fat diet (HFD) and considered as a negative control group (control B). Other subgroups were fed on different diets. **The different groups of rats can be clarified as follows:**

- Group 1: was fed on the basal diet (negative control- A).
- Group2: was fed on the high- fat diet (positive control-B).
- Group 3: was fed on the high-fat diet replaced with 2.5% celery leaves powder.
- Group 4: was fed on the high-fat diet replaced with 5% celery leaves powder.
- Group 5: was fed on the high-fat diet replaced with 2.5% celery seeds.
- Group 6: was fed on the high-fat diet replaced with 5% celery seeds.

2. Experimental diet:

The composition of experimental diets was prepared and mixed according to (Lane-Peter and pearson, 1971) procedure.

Composition of salt mixture (g/kg mixture) was prepared as described in the A.O.A.C (1995).

Composition of vitamin mixture: The vitamin mixture was prepared as given in the A.O.A.C (2000).

3. Bioassay determination:

1. Determination of body weight and food intake:

Body weights and food intake were measured every two days during six week of the test period according to the method given by Ennouri *et al.* (2006).

2. Determination of the food efficiency ratio :

The food efficiency ratio (FER) was determined as outlined by Ennouri *et al.* (2006)

4.Biochemical analysis:

1. Blood sampling:

In all mentioned groups, blood samples were taken from rats at the end of the experiment. The blood samples were collected after 12 hours fasting from scarified rats, then put into dry clean centrifuge tubes. The blood was centrifuged for 10 minutes at 3500 rpm to separate the serum which was carefully use pirated and transferred into clean quite plastic tubes and kept at -18 ºC until biochemical analysis as described by (El-Khamissy, 2005).

2. Determination of blood glucose;

Blood glucose was measured according to the method outlined by Alles *et al*. (1999) using blood glucose meter (Gluco star 2).

3. Determination of cholesterol and triglycerides :

The concentration of total cholesterol, high density lipoprotein (HDL-cholesterol) and triglycerides in the serum were determined by using enzymatic colorimetric methods with commercially available kit#276-64909; , High-density lipoprotein kit # 278-67409 and Triglycerides, kit# 274-69 807 (Oska, japan) following Kim and Shin *et al.* (1998) procedures.

4. Determination of low-density lipoprotein LDL-cholesterol:

Low-density lipoprotein (LDL- cholesterol) concentration was calculated as the difference between total cholesterol and HDL- cholesterol according to the method of Skottova *et al.*(1998).

5. Determination of HDL-cholesterol:

Serum HDL-cholesterol was determined by the method of Lopes-Virella *et al.* (1977).

6. Determination of very low density lipoprotein cholesterol (VLDL-C):

The serum level of very low density lipoprotein cholesterol (VLDL-C) was determined according to the method of Wallach (1992) using the following equation:

Serum VLDL (mg/dl) = TG/5

where: TG =Triglycerides (mg/dl)

7. Determination of serum glutamic oxalacetic transaminase (S. GOT) and serum glutamic pyruvic transaminase (S. GPT):

The activity of serum aspartate-aminotransferase (S.AST, commonly known as Glutamic Oxalacetic Transaminase (S.GOT) and serum Alanine Amino - transferase (S.ALT), commonly known as Glutamic Pyruvic Transaminase (S. GPT), were estimated according to the method reported by Varley *et al.* (1980) .

8. Determination of kidney functions:

a) Determination of serum uric acid: Uric acid was estimated according to the method of Trinder (1969).

b) Determination of urea: Urea was determined by using the method described by Barham and Trinder (1972).

c) Determination of creatinine: Creatinine was determined by using the method outlined by Schirmeister (1964).

9. Determination of Insulin

Insulin was measured according to the method of Hellman *et al.*(2007) using Insulin meter (TOSOH AIA-360).

10. Determination of cortisol and insulin in serum :

Serum cortisol and insulin of different groups of rats were performed using the methods described by (Ursula *et al.,* 2013). SPECIMEN COLLECTION AND PREPARATION Either human serum or plasma may be used. The anticoagulants citrate, EDTA and heparin have been tested and used with this assay.

5. Statistical analysis:

The data were analyzed by (SPSS) statistical package as outlined by (Armitage *et al*., 2002).

Differences at P values ≤ 0.01 were considered to be statistically significant.

RESULTS AND DISCUSSION

1. Biological study:

1. Effect of celery leaves and seeds powders on food intake, body weight gain and relative organ weights of obese rats:

Effect of feeding on high fat diet for 70 successive days with or without replacing with celery leaves and seeds powder on body weight gain of rats and the results were summarized in Table (1). Data indicated that initial body weights have significantly differ among the groups and at the end of the experiment, regardless of the diets variation. There was significant differences among all of the tested rat groups except in case of (Groups 1 and 4) which had the lowest increase (14.05 and 14.77 g) as food intake / day after 3 weeks feeding and also increasing weigh of feed intake for rats fed on high fat diet (group 2) after 6 weeks of experiment (16.04g) followed by Groups (6, 5,4, and 3) comparing to control group A (rat fed on basal diet) (14.51g). Meanwhile, high fat diet replaced with different levels of celery powder helped to increase food intake / day comparing to high fat diet control group.

These results are in agreement with those of (Rezq and Abeer, 2011). These results may be attributed to the higher caloric content of high fat diet as compared to normal basal diet. The high fat content of the diet are responsible for satiety and increased total calories. This result agreed with Nehal (2011) who demonstrated that high fat diet, which is used to induce obesiety, leads to lower ingestion by the animals and induces malnutrition.

Table 1. Effect of experimental diet on body weight gain (BWG),food intake and food efficiency ratio(FER).

Groups	Weight gain after the first period of fertilization	Weight after 3 weeks	BWG (g) After 3 weeks	BWG (%) after 3 weeks	Final weight 6 weeks	Final BWG G	Final BWG (%)	Feed intake after 3 weeks(g)	Final feed intake(g) after6 weeks	FER after 3 weeks	Final FER after 6 weeks
G1Control(A+)	196.76^{D}	198.2^{B}	1.53	0.79	200.33^{B}	3.76^{B}	1.86^{B}	14.05^{C}	14.51^{C}	0.10^{B}	0.25^{B}
G2Control (B)	191.33^{E}	200.76^{A}	9.33	4.94	207.3^{A}	15.96^{A}	8.46^{A}	15.11^{A}	16.04^{A}	0.61^{A}	1^{A}
Group(3) Celery leaves powder 2.5%	199.33^{BC}	192.33^{D}	-7	-3.51	189.33^{D}	-10^{D}	-5.02^{D}	15.15^{A}	15.1^{BC}	-0.56^{C}	-0.76^{E}
Group(4) Celery seeds powder 2. 5%	201^{B}	197.33^{B}	-3.76	-1.83	187.33^{D}	-13.76^{E}	-6.81^{E}	14.77^{BC}	15.13^{B}	-0.24^{C}	-0.90^{F}
Group(5) Celery leaves powder 5%	198.83^{CD}	194.5^{C}	-4.33	-2.22	194^{F}	-483^{F}	-2.56^{F}	14.92^{B}	15.17^{B}	-0.29^{C}	-0.32^{C}
Group(6) Celery seeds powder 5%	205.26^{A}	199.33^{A}	-5.83	-2.95	198.5^{C}	-6.76^{F}	-3.26^{F}	15.02^{B}	15.26^{B}	0.38^{D}	-0.43^{C}

***Means with different superscripts (capital letters in the same row) are significantly different at (P≤ 0.01).**

2. Effect of Experimental diets on relative percent of liver, kidney, pancreas, heart and spleen weights to obese rats :

Data given in Table (2) showed that the variances in weights of experimental rat organs are also monitored for indirect feed high-fat diet diagnosis and it was reported that the weights of the liver, kidney, heart and spleen were increased in rats fed on high-fat diet comparing to those of non- high fat diet control group. On contrary, there were no significant differences were found in liver, kidney, heart, spleen and pancreas on their relative weight (%) of rats except that rats fed on high-fat diet (positive and Treated) groups. The obtained data are in agreements with those of Norazmir and Ayub (2010).

These results might be explained based on the accumulation of fat in the liver and heart cells. These results were in accordance with the results of Nehal (2011) who reported that the increase in liver weight could be a consequence of their higher fat content. In addition, Puskas *et al.* (2004) showed that intracellular lipid accumulation in cardiomyocytes was a response to cholesterol increase of diet.

Table 2. Effect of experimental diet on relative percent of (liver, kidney, pancreas, heart and spleen) body weight (B.W) .

Rat Groups	Final Body Weight (g)(B.W)	Liver		Kidney		Pancreas		Heart		Spleen	
		Weight (g)	Liver B.W%	Weight (g)	Kidney B.W%	Weight (g)	Pancreas B.W%	Weight (g)	Heart B.W%	Weight (g)	Spleen B.W%
G1	200.3^{B}	5.42^{A}	0.72	1.33^{A}	0.66	0.27^{A}	0.13	0.56^{A}	0.28	0.59^{A}	0.29
G2	207.3^{A}	6.36^{A}	3.06	1.35^{A}	0.65	0.2^{A}	0.1	0.82^{A}	0.40	0.57^{A}	0.27
G3	189.3^{D}	6.46^{A}	3.41	1.38^{A}	0.73	0.35^{A}	0.18	0.78^{A}	0.41	0.51^{A}	0.27
G4	187.3^{D}	5.99^{A}	3.19	1.47^{A}	0.78	0.3^{A}	0.16	0.79^{A}	0.42	0.57^{A}	0.30
G5	194^{B}	5.99^{A}	0.83	1.26^{A}	0.65	0.39^{A}	0.12	0.77^{A}	0.40	0.54^{A}	0.29
G6	198.5^{C}	5.98^{A}	3.01	1.29^{A}	0.65	0.36^{A}	0.18	0.67^{A}	0.34	0.57^{A}	0.29

***Means with different superscripts (capital letters in the same row) are significantly different at (P≤ 0.01).**

3. Effect of celery leaves and seeds powder on blood glucose levels and lipid profile of obese by high fat diet (HFD rats :

1. Serum glucose:

The serum glucose values of rats fed on different diets under investigation during feeding period (10 weeks) are presented in Table (3) the experiment was carried out at three interval periods.

The data showed that, serum glucose in negative control group ranged between (120.33 and 130.76 mg/dl) as in the beginning of the experiment period their significantly different while, replacement with celery seeds at the level of 5% has the lowest value (114.33 mg/dl). The middle of the experiment showed significant differences, so treatment with celery at the level of 5% leaves powder has the lowest value (102.33 mg/dl) and the results did not significantly differ throughout the feeding periods with mean value of 130.76 mg/dl at the end of the experimental period.

Apparent also from the same Table that a significant differences in serum total glucose in positive control group was occurred when compared with negative control one. However a significant decrease in serum or total glucose for groups of rats fed on test diets were recorded when compared with positive control one at the end of experimental period (10 weeks).

It could be noticed also from the same Table that, the lowest values of serum glucose were found in group fed on 5% celery seeds powder at the end of experimental period. These results were in agreement with those of Khalid Niaz *et al*. (2013).

2. Triglycerides:

Data in Table (3) indicated that triglycerides levels in blood serum showed significant differences between the different investigated groups. The highest recorded value was found in rats fed on high fat diet (control positive), science its value was 120.33 mg/dl, Followed by groups of rats fed on high fat diet replaced with 5% celery leaves (G5). While the lowest value was recorded in group of rat fed on basal diet (control negative) and its values was 80.76mg/dl. Triglycerides levels found in groups of rats fed on high fat diet replaced with different levels of celery leaves and seeds were decreased as a function of prolonging the experimental period.

Data presented in the same table, showed that rats fed on diet formulated with celery leaves and seeds at the level of 2.5%, had the low levels of triglycerides compared to group of rat fed on high fat diet (G2) through out the experimental period. These results were in agreement with the results of Pacheco *et al*. (2001) and Dhanapakiam *et al* .(2008).

Table 3. Effect of celery leaves and seeds powder on blood glucose levels (mg/dl) and lipid profile of obese for high fat diet (HFD) rats .

Groups / Parameter	Group (1) Control A+	Obese by high fat diet (HFD) group: Group (2) Control B-	Group (3) Celery leaves powder 2.5%	Group (4) Celery seeds powder 2.5%	Group (5) Celery leaves powder 5%	Group (6) Celery seeds powder 5%
The beginning of the experiment period						
Serum glucose (mg/dl)	85.76^{E}	120.33^{A}	113.33^{D}	118.33^{B}	115.33^{C}	114.33^{D}
Triglyceride (mg/dl)	80.76^{E}	120.33^{A}	115.76^{C}	114.33^{Cd}	117.76^{B}	113.76^{D}
Total cholesterol(mg/dl)	91.76^{E}	119.76^{A}	113.76^{D}	117.76^{B}	115.33^{C}	113.76^{D}
HDL (mg/dl)	50.33^{A}	27.76^{D}	30.33^{C}	28.33^{D}	31.33^{B}	30.76^{C}
LDL (mg/dl)	21.76^{D}	64.2^{B}	60.2^{C}	66.56^{A}	63.98^{B}	60.36^{C}
VLDL (mg/dl)	16.13^{D}	24.16^{A}	23.16^{B}	22.96^{C}	23.53^{B}	22.73^{C}
The middle of the experiment period						
Serum glucose (mg/dl)	85.33^{E}	123^{A}	103.33^{D}	114.76^{B}	102.33^{D}	109.33^{C}
Triglyceride(mg/dl)	81.76^{E}	125^{A}	105.76^{C}	107.33^{B}	100.33^{D}	101.76^{D}
Total cholesterol(mg/dl)	88.33^{E}	122.33^{A}	101.33^{C}	110.76^{B}	97.76^{D}	100.33^{C}
HDL(mg/dl)	50.76^{A}	25.33^{E}	34.76^{C}	30.33^{D}	38.76^{B}	34.33^{C}
LDL(mg/dl)	21.33^{E}	72^{A}	45.53^{C}	58.96^{B}	38.93^{D}	45.76^{C}
VLDL(mg/dl)	16.33^{D}	25^{A}	21.13^{B}	21.56^{B}	20.16^{C}	20.33^{C}
The end of the experiment period						
Serum glucose (mg/dl)	86.33^{F}	130.76^{A}	95.76^{C}	97.33^{B}	90.76^{E}	92^{D}
Triglyceride(mg/dl)	81.76^{E}	135.76^{A}	92.33^{C}	100.33^{B}	89.66^{D}	95.33^{C}
Total cholesterol(mg/dl)	88.33^{E}	124.76^{A}	96.33^{C}	100.33^{B}	91.76^{D}	95.76^{C}
HDL(mg/dl)	50.76^{A}	22.33^{E}	40.33^{C}	36.76^{D}	45^{B}	39.76^{C}
LDL(mg/dl)	21.33^{E}	75.2^{A}	37.53^{C}	43.6^{B}	28.73^{D}	37.93^{C}
VLDL(mg/dl)	16.33^{D}	27.13^{A}	18.56^{C}	20.16^{B}	17.93^{D}	19.16^{C}

***Means with different superscripts (capital letters in the same row) are significantly different at (P≤ 0.01)..**

3. Cholesterol,HDL, LDL and VLDL :

Hypercholesterolemia plays an important role in atherosclerosis and related cardiovascular diseases (CVD The short-chain fatty acids produced through the fermentation of soluble fiber in the large intestine serve to stabilize blood glucose levels, lower Low-Density Lipoproteins (LDL) or" bad" cholesterol in the blood, increase the production of immune cells, the concentrated barley beta-glucan in hypercholesterolemic men and women (Behall *et al*., 2004 and Keenan *et al*., 2007).

Results of serum total cholesterol of rats of negative control groups, positive control group or groups fed on diet formulated with celery laves and seeds powder during 70 days are presented in Table (3). Data indicated that serum total cholesterol was 119.76 mg/dl at zero time or at the beginning of experiment. After feeding on high fat diet to induce the obesity ,

total cholesterol reached to 97.76 mg/dl in 5% celery leaves powder in the middle of the experiment and continue to decrease to (91.76 mg/dl) at the end of experiment period . The replacement of celery leaves and seeds powder as well as treated groups helped to cause a slight decreased in serum total cholesterol level and the significant decrement compared to positive control group. These results were in agreement with those of Momin and Nair (2002); Dhanapakiam *et al.*(2008) and Patel *et al*.(2012).

4. Atherogenic indices

National Cholesterol Education Program (NCEP) recommends target levels for both LDL cholesterol and HDL cholesterol to assess risk for heart disease . The LDL-C/HDL-C ratio provides key information regarding coronary heart disease risk . Several epidemiological and clinical studies have found that the LDL-C/HDL-C ratio is an excellent monitor for effectiveness of lipid lowering therapies. The LDL-C/HDL-C is a better predictor for risk of heart disease than LDL-C alone .The LDL-C/HDL-C reflects the two way traffic of cholesterol entering and leaving the arterial intima (Fernandez and Webb, 2008).

Table (4) showed TC/LDL , TC/HDL and LDL/HDL ratios in different groups under study for the three stages of experimented period .The ratios of TC/HDL were relatively high at the beginning of the experimental period which reflect that the levels of HDL were relatively low for groups of diets replaced with different levels of celery leaves and seeds powder. The ratios were decreased with prolonging the experimental period for the previous mentioned diets. This result clarified that replacing different levels of celery powder in the used diets helped to improve this ratio with prolonging the experimental period which in turn support the previous mentioned results (increasing the HDL levels with prolonging the experimental period Table 3).

It should be noted also from Table (4) that reversible results were recorded in case of TC/LDL ratio. This indicated that using celery powders whether leaves or seeds helped to lower the levels of LDL and cholesterol. In addition, TC/LDL ratios of groups of rats fed on high fat diet decreased significantly upon increasing experimental periods (Table 4). This indicates that feeding on high fat diet only increase the level of LDL that increases the risk of coronary heart diseases. The results of (Tahereh Ebrahimi *et al* ., 2015) support our findings.

Table 4. Atherogenic indices of normal and different groups of obese by high fat diet (HFD) rats fed on diet contained celery leaves and seeds powder for (10) weeks.

Groups	Group (1)	Obese by high fat diet (HFD) group				
Parameter	Control A+	Group(2) Control B-	Group (3) Celery leaves powder 2.5%	Group (4) Celery seeds powder 2.5%	Group (5) Celery leaves powder 5%	Group (6) Celery seeds powder5%
The beginning of the experiment period						
T.C/LDL Ratio	4.217^{B}	5.360^{A}	1.889^{C}	1.718^{E}	1.803^{D}	1.885^{C}
T.C/HDL Ratio	$1.88.3^{E}$	4.314^{A}	3.751^{CD}	4.157^{B}	3.681^{D}	3.698^{D}
LDL/HDL Ratio	2.312^{A}	2.313^{E}	1.985^{C}	2.349^{A}	2.042^{B}	1.962^{C}
The middle of the experiment period						
T.C/LDL Ratio	4.141^{A}	1.699^{E}	2.226^{C}	1.879^{D}	2.511^{B}	2.193C
T.C/HDL Ratio	1.740^{E}	4.829^{A}	2.915^{C}	3.651^{B}	2.522^{D}	2.923^{C}
LDL/HDL Ratio	0.420^{E}	2.842^{A}	1.309^{C}	1.944^{B}	1.004^{D}	1.333^{C}
The end of the experiment period						
T.C/LDL Ratio	4.141^{A}	1.659^{E}	2.567^{C}	2.301^{D}	3.194^{B}	2.525^{C}
T.C/HDL Ratio	1.740^{E}	5.587^{A}	2.389^{C}	2.729^{B}	2.039^{D}	2.408^{C}
LDL/HDL Ratio	0.420^{E}	3.368^{A}	0.931^{C}	1.186^{B}	0.638^{D}	0.954^{C}

***Means with different superscripts (capital letters in the same row) are significantly different at (P≤ 0.01).**

5. Effect of celery leaves and seeds powder on serum alanine aminotransferase (ALT) and asparate aminotransferase (AST) in obese by high fat diet (HFD) rats:

Liver function:

The most common liver function tests (LFTS) include the serum aminotransferases, alkaline phosphatase; bilirubin, albumin and prothrombin (Macfarlane *et al.,* 2000). Aminotransferases such as alanine aminotransferase (ALT) and aspartate aminotrasferase (AST) measure the concentration of intracellular hepatic enzymes that have leaked into the circulation and serve as a maker of hepatocyte. Moreover, ALT and AST levels also act as indicators of liver function and restoration of normal levels of these parameters indicate normal functioning of liver .Therefore, the increase of the activity ALT in serum is mainly due to the leakage of the enzymes from the liver cytosol into the blood stream (Dauqan *et al.,* 2012), which gives an indication on the hepatotoxic effect of obese rats.

Transaminases:

Results given in Table (5) showed that, levels of ALT and AST of rats fed on high fat diet were higher than those fed on basal diet. This could be attributed to the increment of fat in high fat diet. Moreover, value of transaminase (ALT and AST) increased upon prolonging the experimental period of groups of rats fed on high fat diet. Apparent also from the same Table that levels of transaminase of replacing different levels of celery (leaves and seeds) in diets were slightly high at the beginning of the experimental period. Then significant decrements were occurred in these groups of rats as a function of prolonging the experimental period. Generally the levels of alanime amine transforose (ALT) of different groups of rats fed on diet replaced by different levels of celery leaves and seeds were lower than those of asparate amine transferase (AST) of the same groups of

rats so, fed of rats on diet contained celery leaves and seeds powder exhibited improvement in the activity of ALT enzyme. These results agree with those of Ajdari *et al*. (2014) who found that ALT and AST activities in serum were significantly stimulated by feeding on hyperchlosterolamic.

Table 5. Effect of celery leaves and seeds powder on serum alanine amino (ALT) and asparate amino transferase (AST) of obese rats fed on high fat diet (HFD) .

Groups / Parameter	Group (1) Control A+	Obese by high fat diet (HFD) group: Group (2) Control B-	Group (3) Celery leaves powder 2.5%	Group (4) Celery seeds powder 2.5%	Group (5) Celery leaves powder 5%	Group (6) Celery seeds powder 5%
The beginning of the experiment period						
**ALT (IU/L)	42.33^{E}	66.76^{A}	65.76^{Ab}	60^{D}	62^{C}	62^{C}
*AST (IU/L)	76^{D}	94.76^{C}	97.33^{B}	102^{A}	94.33^{C}	101^{A}
AST /ALT Ratio	1.79	1.41	1.48	1.7	1.52	1.63
The middle of the experiment period						
**ALT (IU/L)	44^{D}	69.76^{A}	53.76^{C}	58.33^{B}	57.33^{B}	56.33^{Bc}
*AST (IU/L)	78^{E}	107^{A}	61^{F}	95.76^{B}	85^{D}	92^{C}
AST /ALT Ratio	1.77	1.53	1.13	1.64	1.48	1.63
The end of the experiment period						
**ALT (IU/L)	44.76^{D}	71.76^{A}	48.76^{C}	51.33^{B}	74.33^{C}	53^{B}
*AST (IU/L)	77^{E}	113.33^{A}	86.33^{C}	93^{B}	80.33^{D}	88^{C}
AST /ALT Ratio	1.72	1.58	1.77	1.81	1.08	1.66

***Means with different superscripts (capital letters in the same row) are significantly different at (P≤ 0.01).**
****Alanine aminotransferase * Asparate aminotransferase**

6. Effect of celery leaves and seeds powder on Urea, uric acid and creatinine (mg/dl) in normal and obese rats fed on high fat diet and other groups of diets:

Serum urea:

The data given in Table (6) indicated that rat fed on high fat diet contained the highest levels of urea among all of the different tested diets, where rats fed on the basal diet had the lowest level of urea at the beginning of the experimental period. No significant difference was recorded for rats fed on high fat diet during the experimental period. Apparent also from the same Table that gradual decrease was recorded in urea content of rats fed on diet replaced with different levels of celery leaves and seeds powder as a function of prolonging experimental period. These results were lower than those of Abd El- rahman *et al*. (1997), who reported that serum urea levels was elevated by hypercholostrolenic, but this increment was reduced by feeding on hypocholesterlsmic agents. However, the elevated level of urea in rats fed on high fat dirt is likely due to the increase of amino acid catabolism which imporied kidney function or liver damage (Lietz and Finley, 1983)

The decrease in the urea level of hyper - cholesterolemic rats fed on diet replaced by different levels of celery leaves and seeds reflect the influence of celery leaves and seeds on liver and kidney functions in later stage of experimented period.

Serum uric acid:

The data in Table (6) indicated that, the serum uric acid in rats fed on basal diet (negative control) was 1.5 mg/dl. Also, administration of high cholesterol diet produced significant adverse effects on the uric acid of the rats, which is evidenced by significant decrease elevation (173%) in the activity of uric acid in rats fed on high fat diet compared to that fed on basal diet at the end of the feeding period (70 days). Rats fed on high fat diets replaced with different levels of celery leaves and seeds powder exhibited improvement in the activity of uric acid compared to those fed on high fat diet through out the feeding periods (Table 6).

Kidney function tests help to determine if the kidney are performing their task adequately. Our findings clarified that obesity rats had renal alterations such as accumulation of fat cells,increases in kidney weight, glomerular sclerosis and inflammatory infiltrates, along with elevated blood-glucose levels, reinforce the idea that glycosylation of proteins, the increased release of proinflammatory cytokines, oxidative stress, and the accumulation of lipid peroxidation products may be the cause of kidney damage (Cherney *et al* ., 2008, Palanisamy *et al .,* 2008 and De Castro *et al* ., 2013). However, the presence of polyphenols in celery is effective against renal failure in rats fed on diets replaced with different levels of celery (Suleria *et al.,* 2013).

Serum creatinine:

Creatinine is the major waste product of cretin metabolism by muscle. In the kidney, it is filtered by the glomerulus and actively excreted by the tubules. Moreover, free creatinine appears in the blood serum (Foley *et al.,* 2005, Meyer *et al .,* 2006 and Stevenes *et al* ., 2006).

The finding in Table (6) showed that relative increase in serum creatinine was observed in all groups of rat fed on high fat diets replaced with different levels of celery leaves and seeds powder compared with basal diet group. Significant increase was recorded in serum creatinine of positive control group since the values increased from 1.1 to 1.5 mg/dl at the end of feeding period; on the other hand, no significant differences were recorded in case of rats fed on high fat diet.

It could be noticed also that rats fed on high fat diet that replaced with celery leaves and seeds powders exhibited improvement in the activity of creatinine compared to that fed on high fat diet (G2) at the end of experimental period (70 days). Meanwhile, the highest increase elevation (73.3 %) in the activity of creatinine in diet compared to (control B). The results of (Amin and Nagy, 2009) support our findings.

Table 6. Urea, uric acid and creatinine (mg/dl) content of normal and obese rats fed on high fat diet (HFD) and different diets replaced by different levels of celery leaves and seeds powder for 10 week.

Groups / Parameter	Group (1) Control A+	Obese by high fat diet (HFD) group: Group (2) Control B-	Group (3) Celery leaves powder 2.5%	Group (4) Celery seeds powder 2.5%	Group (5) Celery leaves powder 5%	Group (6) Celery seeds powder 5%
The beginning of the experiment period						
Urea (mg/dl)	27.76^{D}	33.33^{A}	32.33^{B}	30.33^{C}	32.33^{B}	31.2^{C}
Uric acid (mg/dl)	1.5^{D}	1.9^{C}	3.4^{A}	2.4^{B}	2.4^{B}	2.5^{B}
Creatinin (mg/dl)	1.5^{D}	1.9^{C}	3.4^{A}	2.4^{B}	2.4^{B}	2.5^{B}
The middle of the experiment period						
Urea (mg/dl)	26^{E}	33.83^{A}	31^{B}	29.61^{Cd}	31.4^{Bc}	30.31^{C}
Uric acid (mg/dl)	1.55^{E}	2.5^{A}	2.03^{C}	2.03^{C}	1.93^{DE}	2.13^{BC}
Creatinin (mg/dl)	1.11^{D}	1.51^{A}	1.21^{C}	1.31^{B}	1.25^{Bc}	1.34^{B}
The end of the experiment period						
Urea (mg/dl)	28.76^{D}	33^{A}	30.1^{B}	29^{D}	30^{C}	30.36^{BC}
Uric acid (mg/dl)	1.5^{D}	2.6^{A}	1.9^{C}	2^{B}	1.9^{C}	1.10^{E}
Creatinin (mg/dl)	1.11^{D}	1.55^{A}	1.17^{B}	1.14^{C}	1.17^{B}	1.15^{C}

***Means with different superscripts (capital letters in the same row) are significantly different at (P≤ 0.01).**

7. Effect of celery leaves and seeds powder on cortisol and insulin of obese rats fed on high fat diet (HFD) .

Cortisol a glucocrticiod (sterord harmane) is produced from cholesterol in the two adrenal glands located on top of each kidney (Aronson, 2009). Data give in Table (7) showed a significant differences between cortisol content of rats fed on basal diet (0.48 mg/dl) and those fed on high fat diet (2.23 mg/dl).

Table 7. Effect of celery leaves and seeds powder on cortisol and insulin of obese rats fed on high fat diet (HFD).

Tested groups	Cortisol (µ g/dl)	Insulin (µU/ml)
At the end of the experiment period		
Rats fed on basal diet control (A+) group G1	0.48^{F}	0.4^{A}
Rats fed on basal diet and (HFD) control (B-) group G2	2.23^{A}	0.16^{C}
Group (3) Celery leaves powder 2. 5%	1.83^{C}	0.32^{Ab}
Group (4) Celery seeds powder 2. 5%	2.15^{B}	0.3^{Ab}
Group (5) Celery leaves powder 5%	0.96^{E}	0.38^{B}
Group (6) Celery seeds powder 5%	1.41^{D}	0.35^{B}

***Means with different superscripts (capital letters in the same row) are significantly different at (P≤ 0.01).**

This result can be explained by the finding of Aronson (2009), who reported that cortisol aids adiposities development into mature fat cells. This biochemical process has to do with enzyme control (11- hydroxysteriod dehydiogenase) which converts cortisone to cortisol in adipose tissue, which mean greater amounts of cortisol produced at the tissue level. Apparent also from the same Table that cortisol levels of rat fed on high fat diet replaced with different amounts of celery seeds powder were higher than those fed on high fat diets but replaced with different amounts of celery leaves powder.

Results given in Table (7) clarified that there is a reversible relationship between cortisol level and insulin content (the more cortisol found the less insulin present) in all of the different tested diets. These results are in accordance with those of Aronson (2009), who reported that cortisol inhibits insulin production in an attempt to glucose from being started.

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استخدام نبات الكرافس (*Apium graveolens* L) فى تقليل السمنة لفئران التجارب

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أجريت التجربة البيولوجية على الفئران الطبيعية (كنترول سالب) والبدينة (كنترول موجب) بعد تناولها وجبات تحتوي على مسحوق الكرفس من الأوراق والبذور المستبدلة بنسب ٢,٥ و ٥٪، والتي حسنت من الوزن النهائي للجسم وكفاءة الفئران لاستخدام الواجبات مقارنة بالفئران الكنترول البدينة و أظهرت النتائج النهائية ما يلى: الوزن النهائي وكفاءة استخدام الفئران للغذاء المصابة والتي تم الاستبدال فيها بمسحوق أوراق وبذور الكرفس كان اعلى من الوزن النهائي للفئران البدينة و الفئران التي تغذت على وجبة قياسية (الكنترول الأيجابي) بالإضافة إلى ذلك سجلت أختلافات في وزن الكبد والكلية والبنكرياس والقلب والطحال بالمقارنة إلى وزن الجسم في الفئران البدينة التي تغذت على مسحوق أوراق وبذور الكرفس عند مستويات ٢,٥٪ أو ٥٪ . زيادة على ذلك الدهون الثلاثية الموجودة في مجرى الدم للفئران المصابة بالسمنة، والتي تغذي على وجبه تحتوى على مسحوق أوراق الكرفس والبذور عند مستوى ٥٪ كانت أقل من (الكنترول الإيجابي) في بداية فترة التجربة. و كان هناك زيادة معنوية في مستوى كوليسترول البروتين الدهني عالي الكثافة(HDL) لمجموعات الفئران التي تغذت على وجبات تحتوي على مسحوق أوراق وبذور الكرفس عند مستوى ٢,٥٪ و ٥٪ مقارنة مع الكنترول الإيجابية على السمنة، بينما كان هناك انخفاض معنوي في مستوى البروتين الدهنى منخفض الكثافة (LDL) في الفئران البدناء المغذاة على وجبات تحتوي على مسحوق أوراق الكرفس والبذور بنسب ٢,٥٪ و ٥٪ مقارنة بالكنترول لإيجابي. وقد اتسمت الفئران البدينة التي تغذت على وجبات تحتوى على٢,٥٪ و ٥٪ من مسحوق أوراق الكرفس والبذور بتحسن كبير في مستوى نشاط انزيمات الكبد (ALT, AST) مقارنة مع مجموعات الكنترول الأيجابى من الفئران. في حين لوحظ أن أكبر زيادة في الأنسولين وجدت في مجموعة الفئران المصابة بالسمنة والتي تغذت على وجبات تحتوى على مسحوق أوراق الكرفس والبذور بنسب ٢,٥٪ و ٥٪ مقارنة مع مجموعة الكنترول الأيجابى.