Journal of Home Economics

Volume 25, Number (4), 2015

http://homeEcon.menofia.edu.eg

Journal of Home Economics

ISSN 1110-2578

Study on obese rats fed on local Egyptian bakery product (Rokaq) supplemented with Saltbush *(Atriplex halimus* , L.)

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Abstract

In the present study, the chemical composition and sensory evaluation of Egyptian bakery Rokaq) product containing saltbush powder (***Atriplex halimus, L.***) at ratio of 5% and 10% was carried out. There were a significant differences between Egyptian bakery product saltbush and control sample in the organoleptic properties. Results showed that Egyptian bakery product containing saltbush had a high content of protein and fiber while it has low carbohydrates. Egyptian bakery product Rokaq containing saltbush could be considered as anti-obesity owing the decreased the body weight of rats. The results of biological experiment indicated the decrease in body weight of rats fed on bakery containing 5% and 10% saltbush . Also, Egyptian bakery product had low values of serum lipid profile to rats, and improving liver and kidney functions and improving the properties histology sections of liver, pancreas and kidney. It could be recommended to add saltbush powder at a ratio of 5 or 10% during the manufacture of Egyptian bakery(Rokaq) product to improve the health and nutritional benefits of this product .

Key words: Biological experiment, organoleptic properties, liver**,** pancreas and kidney tissues.

Introduction

Basic Egyptian nutrition is producing of bakery, the staple food, enjoys a very special place in the diet. It is still made from high extraction wheat flour or wheat mixed with other ingredients. It is the main component

in all meals. Egyptians eat food with bread, and not bread with food. (**Hassan, 2004**).

Egyptian bakery products were previously listed in the category of food preparations not classified elsewhere.

Obesity is a condition where a person has accumulated too much body fat that it may have a negative effect on their health. When parsons body weight is at least 20% higher than it should be, he or she is considered obese. However, obesity is different from being overweight, which means weighting too much. The weight may come from, bone, muscles, fat and or body water. Both terms mean that a person weight is greater than what is considered healthy for her or his height.(**Chiung, *etal*., 2012**).

Rokaq bread is a local bakery product made by some families at home or by small bakery. The people buy this product from local market . Now days, some big bakery produce it. Rokaq bread is consumed especial in Ramadan (fast month for moslium).

Saltbush ***(Atriplex*** spp) is found in many arid and regions of the world particularly in salin , arid soils (**Manousaki and kalogerakis, 2009**).

Atriplex are extremely tolerant of salt content in the ground. Their name derives from the fact that they retain salt in their leaves (**Djerroudi *et al*., 2011**). In Algeria, a great number of plants may be shown to have therapeutic value (**Chikhi *et al*., 2014)**. The Algerian species *Atriplex halimus*, know under the name of Guettaf or El-Gtaf, is autochthonous, grown over a wide range of soil, from 10 coastal areas to mountainous areas at more than 1100 m altitude (**Aouissat *et al*., 2011**). The traditional use in phytotherapy by local populations is mainly as a means of lowering hyperglycaemia and to treat anemia.

Atriplex halimus is an evergreen shrub growing to 3 m, forming tufts up to 1-3 m in diameter.

In absence of grazing, this species can grow up to 4 m in height. It is dense with alternate, ovate or diamond-shaped leaves, to 2-5 cm long, flowers in terminal panicles and reddish seeds (Franclet and Le Houerou, 1971).

Atriplex halimus growing in arid and sub-arid areas, known for its hypoglycemic activity and widely used by the local population as remedy to treat diabetes mellitus (**Zohra , 2015**). *Atriplex* species are used for their important medicinal values and several species evaluated for their antidiabetic effect, such as *Atriplex* halimus (**Rodriguez and Murray, 2010).**

Obesity accompanied with metabolic disorder is often complicated by hepatic regulations of lipid metabolism and lipoprotein recruitment**.(Chiung 2012)**

The aim of this work was to study the chemical properties of local Egyptian bakery product(Rokaq) supplemented with saltbush (***Atriplex halimus***). Also, biological experiment and histopathology were carried out to study the effect of feeding obese rats on local Egyptian bakery product containing saltbush at different percentages for improves liver, pancreas and kidney functions and tissues and adjuvant therapeutics .

Materials and Methods

Materials

Saltbush shrubs naturally grown in Nubaria desert area were cut leaves and dried leaves (40ºC) to get powder. Wheat flour 72 % was obtained from local market ,Zagazig City ,Egypt. Kits (triglyceride, total cholesterol and high -density lipoprotein cholesterol (HDL-c), total protein (ALT, AST, creatinine and urea were purchased from Sigma-Aldrich (MO,IL USA) .Reagents and chemicals used were of the highest purity.

Preparation of local Egyptian bakery product (Rokaq)

Making local Egyptian bakery(Rokaq) prepared by mixing all dry ingredients, wheat flour with salt and water in a mixer (K45SS, Kitchen Aid, St. Joseph, MI) at speed 1 for 30 sec. at (25 ± 2°C) . The dough was mixed well for about 2 min at speed 2 and another1 min at speed 4.Then the dough was allowed to rest in a plastic covered bowl at 25°C for 5 min. After that, the dough was cut manually to small round pieces and flattened for 10 sec using manual equipment, then put the thin slices on a hot plate (using a thick ,ungreased iron or aluminum tortilla griddle) for cooking the bread at 232.2 ± 2.8°C for 10 sec, turned over for 30 sec, and lastly

turned over for 20 sec, giving each side a total of 30 sec of cooking time. Once the outer edges are slightly golden ,the bread was cooked ,so remove it from griddle. Cooked Egyptian bakery product was allowed to cool at room temperature. The cooled Egyptian bakery product was stored in double plastic bags and held for 24 hr before testing and sensory evaluation **(FAO , 1992).**

Chemical composition of *Atriplex halimus* powder and Rokaq

Moisture, crude protein, fat , total ash and crude fiber content were determined according to the methods outlined in **AOAC (2005).** Total carbohydrates were calculated by difference according to the following equation:

Total carbohydrates =100 - (Moisture% + crude protein% + crude fat% + ash% + total crude dietary fibre %).

Sensory evaluation

Rokaq was evaluated organolptically according to **Iwe, (2002)**. Samples of Egyptian bakery(Rokaq), control without saltbush, 5% saltbush and 10% saltbush were coded and presented to fifteen member panel of judges who are familiar with the product for sensory evaluation. The panelists scored the colour, flavor, taste, texture and overall acceptability of the Egyptian bakery(Rokaq) using a nine point hedonic scale, where 9 indicates extremely like and 1 extremely dislike

Biological Experiment

Experimental animals.

The work was carried out in Food Science Department, Faculty of Agriculture, Zagazig University, Egypt. Healthy male albino rats weighting 210 ±5 g, were obtained from Agricultural Research Center, Giza, Egypt.

Experimental design

Male rats have been selected at a random way. The rats were housed in stainless steel cages with screen bottom in a controlled environment with 12 hr., light and 12 hr., dark cycles. All rat groups were fed on the basal diet (20g. daily per rat) for two weeks as adaptation period. The basil pellet diets obtained from the central animal house of the National Research Center ,Dokki, Giza, Egypt. This standard diet consisted of 20 % casein, 5%

fiber (cellulose),10% sucrose, 4.7%corn oil, 0.2% choline chloride, 0.3% methionin, 1% vitamin mixtures, 3.5% salt mixture. The remainder was corn starch. Salt and vitamin mixtures were prepared according to **Hegested *et. al.*,(1941) and Campbell, (1963).**

Water was given *adlibitum*. The experiment lasted for end the adaptation period the animals were divided into 4 groups (6 rats each). Group1 (G1): Rats fed on basal diet and considered to be as negative control. The other three groups (obese animals). Group2 (G2): fed on 5% Egyptian bakery (Rokaq) without (saltbush). Group3 (G3):fed on5% Egyptian bakery (Rokaq) containing 5% saltbush. Group4 (G4): fed on 5% Egyptian bakery (Rokaq) containing 10%saltbush.

Blood and tissue analysis

Blood samples were collected from the scarified rats under diethyl ether after 3 and 6 weeks from the start. The blood samples were collected in tubes and were centrifuged at 3000 rpm for 20 min to obtain serum. The total cholesterol was analyzed according to Young (2001), triglyceride was analyzed according to Stein (1987), (HDL-c) was measured by enzymatic colorimetric method using Randox kits (Gordon, 1977) and the concentration of (LDL-c) cholesterol was calculated by the following equation:

$$LDL\text{-}c = (T.C – HDL) – T.G/5$$

A liver enzyme activates, alanine amino transferase (ALT), aspartate amino transferase (AST) and total protein were analyzed according to **Young (2001).** Kidney functions in serum, creatinine and blood urea nitrogen were determined according to **Young (2001).**

Statistical analyses

The obtained results were analyzed using SD--Duncan's new multiple range test to determine the difference of means, and $P \leq 0.05$ was considered to be statistically significant (Steel and Torrie,1980).

Histopathological examination

Specimens from liver, kidney and pancreas from all groups were examined. Then fixed in 10% neutral formalin and embedded in paraffin. Sections of five microns thickness were prepared, stained by haematoxylin and eosin as mentioned by **Suvarna *et.al.*, (2013)** and were examined microscopically.

Results and dissociation

Chemical composition of saltbush leaves powder and Rokaq.

As shown in Table (1), chemical composition of saltbush leaves powder had higher content of crude protein (20.02 %) and the higher content crude fiber,(15.32%) and lowest content of crude carbohydrates (39.30%) . These results agree with previous studies **Zohra, (2015**). **, Ishihawa *et al.* (2002) and Al-Owaimer *et al.* (2011).** The results of Egyptian bakery (Rokaq) containing of 10% saltbush had higher content of crude protein (19.98%) comparing with the control (9.19%) . (Rokaq) containing of 10% saltbush had the lowest carbohydrates (51.09%).

Table 1. Chemical composition of leaves saltbush powder and Rokaq

Sample	Moisture (%)	Protein (%)	Fat (%)	crude fiber (%)	Ash (%)	Carbohydrates (%)
Saltbush	10.43	20.02	2.19	15.32	12.74	39.30
C	11.37	9.19	1.23	0.90	2.08	75.23
T1	10.80	18.42	0.98	10.22	5.04	54.54
T2	10.73	19.98	0.75	11.63	5.82	51.09

Saltbush *: **Atriplex** halimus* leaves powder C: Egyptian bakery (Rokaq)
T1: Egyptian bakery (Rokaq) containing 5% saltbush T2 : Egyptian bakery (Rokaq) containing 10% saltbush.

Sensory evaluation of Egyptian bakery product (Rokaq).

Results in Table (2) show that Egyptian bakery **(**Rokaq) containing of saltbush treatments at different ratio were acceptable . There was no significant ($p \leq 0.05$) observed of sensory evaluation (aroma, colour, taste, texture and over all acceptability) of Egyptian bakery(Rokaq) except some little decrease at taste, texture and over all acceptability of 10% saltbush treatments that may be due to the high fiber containt in saltbush which affected on it .**Giami *et al.*,(2004)** noticed that high supplementation reduced elastic property of wheat flour dough. **Against Kaur *et al.*, (2013)** reported that to improve the nutritive value of bakery products as well as improving sensory properties.

Table 2. Sensory evaluation of Egyptian bakery product(Rokaq)

Sample	Aroma (9)	Colour (9)	Taste (9)	Texture (9)	Acceptability (9)
C	8.83[a]	8.58[a]	8.00[a]	8.582[a]	8.66[a]
T1	8.50 [a]	8.00[a]	7.08[b]	7.58[b]	8.08[b]
T2	8.16[b]	7.16[b]	6.50[c]	6.91 [c]	7.08[c]
LSD p≤0.05	0.619	0.745	0.286	0.375	0.421

Mean values in each column having different subscript (a, b, c) are significantly different at **p≤0.05**

Influence of Egyptian bakery (Rokaq) containing saltbush on reducing body weight of rats.

After 3 weeks, it was observed that rats fed on Rokaq containing saltbush (G3 and G4 group) showed a decrease in the body weight as compared with the control group. Also, at the end of the experiment, group G3 and group G4 showed more decrease in the body weight as compared with the normal group (Table 3). The lowest weight was observed for G4 group. Egyptian bakery inhibited the body weight gain, and apparently showed the effect after Egyptian bakery feeding for 6 weeks. on the same trended feeding on saltbush improved intake, digestibility, nitrogen balance and utilization (**Salem, *et al.*, 201**5). **Gihad, (1993)** reported that saltbush is characterized by its high ash and crude fiber, moderate crude protein and low crude fat contents.

Table (3): Influence of Egyptian bakery (Rokaq) on reducing body weight of rats.

Treatments		**G1**	**G2**	**G3**	**G4**	**LSD**
At the beginning		**225**				
Weight (g)	**3(weeks)**	252	246	239	230	4.7865
	6(weeks)	275	267	227	220	18.2030

G1(control) : Normal group

G2: Obese group fed on 5% Egyptian bakery Rokaq without saltbush

G3: Obese group fed on 5% Egyptian bakery Rokaq containing (5% saltbush) G4: Obese group fed on 5% Egyptian bakery Rokaq containing *(*10% saltbush)

Influence of Egyptian bakery Rokaq on the serum lipid profile of rats.

From Table (4), it could be observed that at the beginning of the experiment, group fed on basal diet (normal group) had a triglyceride(TG), total cholesterol (TC),low density lipoprotein (LDL-c) and high density lipoprotein (HDL-c) were 125.98, 136.63, 62.47 and 48.97 (mg/dl), respectively. The serum lipid profile indicated that significant differences were observed between all studied groups. Lower level of total cholesterol (TC), triglyceride(TG) and low density lipoprotein (LDL-c)was observed in (G4) followed by (G3). The group (G4) had the lowest values in serum TG, TC, LDL-c and highest value of HDL levels after six weeks. Egyptian bakery lowered TG, TC, and LDL-c with increasing HDL. Egyptian bakery reduced the liver lipids dose-dependently. **Kadan *et al*., (2013**) indicated that saltbush possesses **antioxidant activity**. The results are in line with **Chikhi *et al*. (2014)** who reported that saltbush contain a wide range of bioactive metabolites. Qualitative analysis performed in the aqueous extract demonstrated the presence of phyto-components like tannins, flavonoids, saponins and alkaloids. These substances are potentially useful for the food preservation and prevention against many human diseases.

Table (4) : Serum lipids profile of rats fed on Egyptian bakery(Rokaq).

Feeding period (weeks)	Groups	Triglyceride (mg/dl)	Total cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)
At the beginning		125.98±10.65^{a}	136.63±1.97^{c}	48.97±0.16^{a}	62.46±0.09^{c}
3	**G1**	151.39±3.46^{c}	152.39±1.82^{b}	56.100±0.59^{d}	66.030±0.09^{a}
	G2	160.88±1.16^{b}	146.52±0.27^{e}	50.000±1.01^{ab}	64.34 ±0.09^{a}
	G3	150.30±3.46^{c}	144.24±0.19^{e}	59.075±0.55^{d}	55.11± 3.19^{b}
	G4	148.36± 1.6 ^{c}	135.43±2.78^{c}	65.755±1.95^{b}	40.01± 0.87^{c}
L.S.D p≤0.05		8.8119	3.8179	1.5114	3.3129
6	**G1**	166.36 ±0.62^{b}	164.60±1.52^{b}	52.775±1.84^{f}	78.56±0.32^{a}
	G2	166.14±1.81^{b}	142.28±2.21^{d}	52.865±1.85^{e}	56.19±0.02^{b}
	G3	163.42± 0.70 ^{b}	130.17±1.04^{e}	64.090±1.28^{d}	33.40±0.50^{cd}
	G4	153.90±1.03^{bc}	115.89±0.21^{a}	68.495±1.06^{b}	16.62 ±1.20^{d}
L.S.D p≤0.05		27.563	1.7227	3.6834	1.3545

Mean values in each column having different subscript (a, b, c, d) are significantly different at $p \leq 0.05$

Influence of Egyptian bakery (Rokaq) on the liver functions of rats.

Liver plays an essential role in regulating plasma lipid level through LDL clearance and HDL recruitment, while lipid uptake must affect the hepatic fat composition and thus burden the liver function **(Friis-Liby, *et al.*,2004).**

The levels of total protein ,ALT, and AST are shown in Table (5). The levels of total protein of rats fed on Egyptian bakery containing saltbush were significantly deference. As indicated from results, at the beginning of the experiment group fed on basal diet (normal group) had ALT and AST 72.0 and 67.00 U/L respectively. The results indicated that a significant increase in serum ALT and AST in control group as compared with the other groups and the highest level of ALT was 67.00 U/L, in the G2 (feeding Egyptian bakery without saltbush) after 6 weeks**.** Treatment with each (G3) Egyptian bakery (5%saltbush), and(G4) Egyptian bakery (10% saltbush) for three and six weeks was markedly improved enzyme activities by decreasing the level of ALT and AST activity.

Table (5) : Influence of Egyptian bakery (Rokaq) on serum total protein , alanine amino transferrase (ALT), and alanine amino transferrase (AST),contents of rats.

Feeding period (weeks)	Groups	Total protein (g/dl)	ALT (U/L)	AST (U/L)
At the beginning		**7.2100±0.07^{a}**	72.000±0.7^{ab}	67.000±1.41^{c}
3	**G1**	7.0800±0.07^{b}	60.500± 2.10^{a}	67.000 ±2.12^{a}
	G2	6.7600±0.08^{c}	76.000±0.70^{ab}	76.500 ±2.82^{d}
	G3	6.5350±0.30^{cd}	64.000±2.12^{ab}	52.500 ±2.12^{b}
	G4	6.1250±0.17 ^{e}	61.500±1.41^{b}	52.000 ±3.53^{b}
L.S.D p≤0.05		0.2924	4.6242	1.9252
6	**G1**	6.5300±0.01^{bc}	62.500±2.12^{a}	66.00 ±2.14^{a}
	G2	6.4550±0.31^{c}	67.000±2.11^{ab}	67.00±2.83 ^{d}
	G3	6.1250±0.16 ^{d}	59.500±4.24^{ab}	46.50± 3.67 ^{c}
	G4	5.8600±0.12 ^{d}	52.00±2.12^{bc}	46.00 ±3.48 ^{c}
L.S.D p≤0.05		0.2891	4.7309	5.0967

Mean values in each column having different subscript (a, b, c, d) are significantly different at $p \leq 0.05$

Influence of Egyptian bakery (Rokaq) on the kidney functions of rats.

As shown in Table (6),groups (G3) and (G4) had lower creatinine and urea levels as compared to rats group (G1) fed on basal diet after 3, and 6 weeks . However these changes are not significant for creatinine but significant for urea as comparative with the beginning feed. At the beginning of the experiment group fed on basal diet has a creatinine and urea 1.350, 46.45 mg/dl , respectively. Creatinine and uric acid levels had reported as a factor in lead toxicity**.** This decrease in creatinine and urea , in group G3,G4 may be due to that the diet contain saltbush.

Table (6) : Influence of diet Egyptian bakery on serum creatinine, acid and urea contents of rats.

Feeding period (weeks)	Groups	Creatinine (mg/dl)	Urea (mg/dl)
At the beginning		1.3500±0.014^{a}	44.800±0.62^{ab}
3	**G1**	1.3800±1.07^{a}	46.605±0.55^{a}
	G2	1.4050±0.00^{a}	45.660±0.60^{b}
	G3	1.3750 ±1.07^{a}	42.620±0.55^{c}
	G4	1.3450± 1.07^{a}	40.860 ±0.56^{d}
L.S.D p≤0.05		0.1947	0.9062
6	**G1**	1.3950±1.07^{b}	47.785±1.03^{a}
	G2	1.3950±1.07^{b}	47.615±0.44^{ab}
	G3	1.3300±1.00^{a}	46.300±0.42^{c}
	G4	1.3100±1.00^{b}	44.340±0.69^{d}
L.S.D p≤0.05		0.0169	1.0814

Mean values in each column having different subscript (a, b, c, d) are significantly different at $p \leq 0.05$

Histopathology

The beneficial effects of feeding obese rats were confirmed by histopathological examination of the liver, pancreas and kidney are shown in photos (1-12).

American Diabetes Association,(2010) reported that saltbush(*Atriplex halimus*) is widely used in traditional medicine for its antidiabetic properties. **Diabetes mellitus** is a chronic metabolic disorder characterized by high levels of glucose in the blood, due to the impaired secretion of insulin or insulin insensitivity.

Kabbash and Shoeib (2012) and Zohra, (2015) observed that saltbush *(Atriplex halimus*) had antioxidants properties and therefore, secondary metabolites of this plant present a good source for antioxidants that may be involved in the prevention of human cellular damage, caused by **free radicals.**

Group 1 : Liver of rat was normal . Liver Hepatic tissue of G1 normal control proliferation of bile duct . Hemorrhagic infarct area without inflammation cellular infiltration and no congestion zone on periphery could be seen , **(Photo 1).** Pancreas tissue of control rat . **(Photo 2).** Kidney of normal control rat. In kidney tissue of rats, the proximal and distal convoluted tubules the normal healthy pictures (Photo3).

Group 2 : The liver of obese rat group fed on 5% Egyptian bakery without saltbush showing interstitial lymphocytic aggregations (thick arrow) and apoptotic bodies (thin arrow) beside vacillation (Microsteatosis) of the hepatic cells. Mild congestion and sever acute cell swelling **Photo 4 . P**ancreas of obese rat group fed on 5% Egyptian bakery without saltbush . showing apparently normal endocrine pancreas**.(Photo5).**
Kidney of obese rat group fed on 5% Egyptian bakery without saltbush. The majority of renal parenchyma within the normal except a few renal tubules contained granular or cellular casts. Mild prelobular fibrosis and mild congestion (**Photo 6)**.

Group 3 :it was liver of obese rat fed on 5% Egyptian bakery containing 5%saltbush . Congested blood vessels and sinusoids beside sever acute cell swelling were observed **(Photo7)** Pancreas showed that a few hyperplasic kupffer cells could be seen. Focal necrosis infiltrated with lymphocytes was noticed at **(Photo 8).**. **Kidney** of obese rat showed normal tissue **(Photo 9)**.

Group 4: Liver of obese rat obesity group 5% Egyptian bakery (10%saltbush, G4).was focal replacements of hepatic parenchyma by lymphocytic infiltrated with macrophages together with apoptosis, microsteatosis could be seen**.** Hyperplastic kupffer cells also are noticed. **(Photo10)**. Pancreas of obese rat fed on 5% Egyptian bakery 10%saltbush was normal pancreatic tissues **(Photo11).**
Kidney of obese rat fed on 5% Egyptian bakery 10%saltbush (G4) was normal renal parenchyma **(Photo 12**).

Group 1

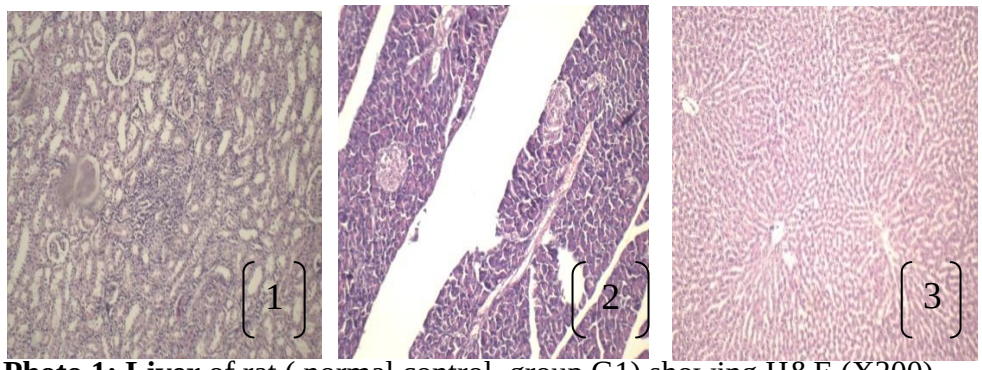

Photo 1: Liver of rat (normal control group G1) showing H&E (X300).
Photo2: pancreas of rat (normal control group G1) showing H&E (X300).
Photo3: Kidney of rat (normal control group G1) showing H&E (X300).

Group 2

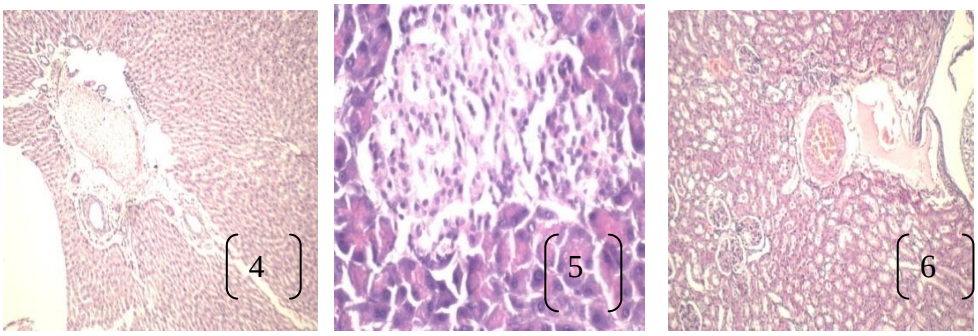

Photo4: Liver of obese rat group fed on 5% Egyptian bakery (rokaq) without saltbush G3) showing H&E (X300)**.**
Photo5: Pancreas of obese rat group fed on 5% Egyptian bakery (rokaq) without saltbush G3) showing H&E (X1200).
Photo 6 :Kidney of obese rat group fed on 5% Egyptian bakery (rokaq) without saltbush G3) showing H&E (X1200).

Group 3

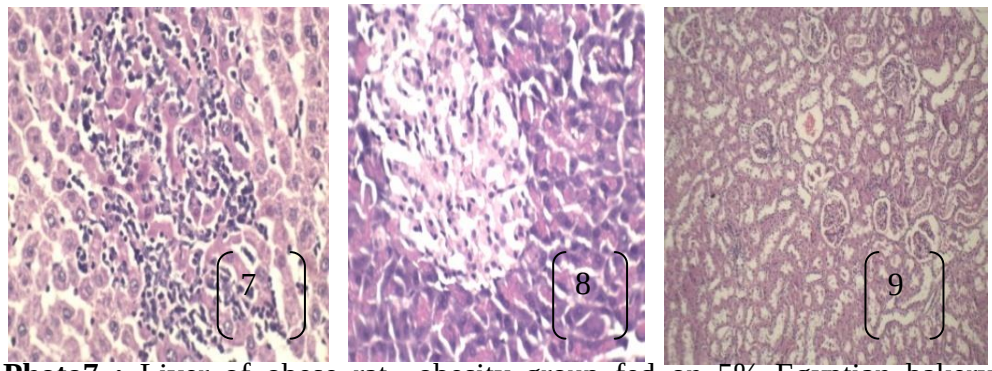

Photo7 : Liver of obese rat obesity group fed on 5% Egyptian bakery (5%saltbush) (G3) showing H&E (X300).

Photo8: Pancreas of obese rat obesity group fed on 5% Egyptian bakery (5%saltbush)(G3) showing H&E (X300).

Photo9 :Kidney of obese rat obesity group fed on 5% Egyptian bakery (5%saltbush (G3) showing H&E (X300).

Group 4

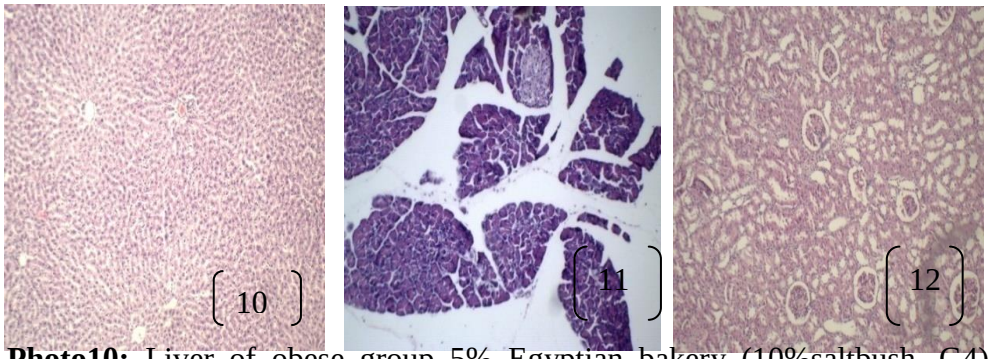

Photo10: Liver of obese group 5% Egyptian bakery (10%saltbush, G4) showing H&E(X300).

Photo11: Pancreas of obese group 5% Egyptian bakery (10%saltbush, G4) showing H&E (X1100)..

Photo 12 :Kidney of obese group 5% Egyptian bakery (10%saltbush, G4) showing H&E (X1200).

Conclusion

The results indicated influence of Egyptian bakery product *(*Rokaq) containing saltbush on the metabolism of blood lipids in the groups of rats and decreased the body weight rats. Also liver serum enzymes-lowering activity and kidney functions and severe hepatic liver, Pancreas and kidney tissues in rats. Therefore, it could be recommended to adding saltbush to local Egyptian bakery product (Rokaq) at a ratio of 5 or 10% during the manufacturing to improve the health and nutritional benefits of this product.

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Journal of Home Economics, Volume 25, Number (4), 2015

دراسة على سمنة الفئران باستخدام منتج مخبوز مصري محلى (رقاق) مدعم بالقطف

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الملخص العربى

أجريت هذه الدراسة لمعرفة التركيب الكيميائي والحسي لمنتج مخبوز مصري (رقاق) محتوى على مسحوق القطف بنسبة ٥ و١٠%. وأوضحت نتائج التحكيم الحسي عدم وجود فروق معنوية بين المنتج المخبوز المصري والكنترول، كما أوضحت النتائج أن المنتج المخبوز المصري المحتوى على القطف سجل أعلى نسب لكل من البروتين والألياف واقل نسبة للكربوهيدرات وكذلك مضاد لنشاط سمنة الفئران كما بينت التجربة البيولوجية خفض وزن الفئران بالمنتج المحتوى على القطف بنسب٥ و١٠%، وحدوث انخفاض في الكولسترول الكلي والجلسريدات الثلاثية واللليبوبروتين منخفض الكثافة إلى جانب ارتفاع مستوي الليبوبروتينات مرتفعة الكثافة. أظهرت النتائج تحسن في وظائف الكبد والبنكرياس والكلي في الدم مقارنة بالفئران التي لم يتم تغذيتها علي المنتج المحتوى على القطف وكذلك حدوث تحسن في كلا من قطاعات الكبد والبنكرياس والكلي وتوصى الدراسة بإضافة ١٠% من بودر القطف أثناء صناعة المنتج المخبوز المصري (الرقاق) للحصول على الفوائد الصحية والغذائية لهذا المنتج.

الكلمات المفتاحية : التجربة البيولوجية – الخواص الحسية – أنسجة البنكرياس والكبد والكلى .