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# PROTECTIVE EFFECT OF CUPCAKE PREPARED BY REPLACING FAT WITH DIFFERENT LEVELS OF BAKED SWEET POTATO ON OBESE RATS

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**ABSTRACT:** ***Nowadays, there is an increase interest in natural products as an alternative to replace fat in different food formulations to meet the nutritional demands of consumers. In this sense, the current study utilized baked sweet potato in different levels, due to its high nutritional value and health-promoting properties, to replace fat in the cupcake and produce healthy value-added product. The potential effects of reduced-fat cupcake containing baked sweet potato on obese rats were evaluated. The results indicated that body weight gain of obese rats fed reduced fat cupcake diets formulated with baked sweet potato was reduced by 43-63% compared to positive control rats. Also, the obese rats fed reduced fat cupcake diets at 40-80% baked sweet potato level for 30 days lead to restoring the normal organs weight of negative control rats. Feeding obese rats with reduced fat cupcake diets prepared with baked sweet potato reduced body weight gain, organs weight, TG, TC, LDL, blood glucose, liver enzymes, and creatinine compared to positive control rats. The non-significant (P>0.05) differences in organ weight, HDL, blood glucose, kidney functions, and liver functions were observed between reduced fat cupcake diets at 5% and 2.5% replacement level. While feeding rats with reduced fat cupcake diets at 5% showed lower (P≤0.05) TG, TC, and LDL and higher (P≤0.05) weight gain than reduced fat cupcake diets at 2.5%. The obtained results proved that baked sweet potato is a suitable natural product which might be incorporated in the production of the cupcake to improve obesity.***

**Key words:** ***Baked sweet potato, cupcake, obese rats, liver and kidney functions, lipoproteins***

## INTRODUCTION

Sweet potato (*Ipomoea batata L.)* is very important crop due to its starchy roots, which can provide energy and nutritive substances that can contribute to enhancing the nutrient status of the consumers (Burri, 2011). Sweet potato is nutritionally good in terms of dietary fiber, certain minerals and vitamin contents which promote different health benefits to the human being (Ji *et al.,* 2015). Dietary fiber has positive effects on diabetes and constipation. Vitamins A, C, and E present in sweet potato are powerful antioxidants which act against certain cancer and the ravages of aging. In addition to the nutritional values of sweet potato, it has been considered as a functional food due to the high levels of various phytochemicals which might have health beneficial effects (Tsuda *et al.,* 1998). Moreover, sweet potato is among the best sources to prevent vitamin A deficiency (van jaarsveld *et al.,* 2015) and contains anti-inflammatory, anti-diabetic, and anticancer properties (Mohanraj and Sivazankar, 2014). Due to the high nutritional value and health-promoting properties of sweet potato, many researches have been conducted

to incorporate sweet potato in baking industry to produce value-added products (Alloush, 2015; Trinidad *et al.,* 2013; Srivastava *et al.,* 2012; Rodriguez *et al.,* 2011). Different forms of sweet potato can be used to supplement wheat flour in bakery products such as steamed, boiled, baked, mashed and flour (Hagenimana *et al.,* 1998).

Recently, there has been increasing interest in the health benefits and an urgent need for safer, lower cost, and more effective bioactive agents to be incorporated in food to produce value-added and functional food products. Therefore, the current study was designed to produce reduced fat cupcake by partial substitution of fat in the formula of the cupcake with different levels of baked sweet potato. Reduced fat cupcake was used to replace the diets of obese rats at 2.5 and 5% levels.

The objective of this study was to evaluate the effect of feeding obese rats with reduced fat cupcake diets prepared with different levels of baked sweet potato on body weight gain, organs weight, lipid profile, blood glucose, kidney functions, and liver functions.

## MATERIALS AND METHODS

### Materials:

Sweet potato tuberous roots, (*Ipomoea batata L.)* Wheat flour (72% extraction), sugar, butter, fresh yeast, and salt were purchased from the local market at Shibin El-Kom, Menoufia, Egypt. Casein, oil, cellulose, choline chloride, Dl-methionine, vitamins mixture, and minerals mixture were obtained from Morgan Co. Cairo, Egypt. Chemical kits for determination total cholesterol, triglyceride, high-density lipoprotein, creatinine, urea, and uric acid, were purchased from El-Gomhoria Company for Chemicals and Drugs El-Ameria, Cairo, Egypt. Adult male albino rats of Sprague Dawley strain (150 g ± 5) were obtained from the Research Institute of Ophthalmology, Animal House Department, Giza, Egypt.

### Methods:

### Technological methods

### Preparation of sweet potato

Sweet potato was carefully washed with tap water. Sweet potato was baked at 160ºC for 40 min in an electric draught oven. Raw and baked sweet potatoes were kept at -10ºC until use.

### Preparation of sweet potato cupcake

Control cupcake was prepared according to Sudha *et al.,* (2007) with some modifications. The formula included 25.84% wheat flour, 25.84% sugar, 31% egg, 16.8% margarine, 0.13% baking powder and 0.39% salt. Cupcake batter was prepared in a Hobart mixer (N-50) using a flour batter method. The flour, margarine, salt and baking powder were creamed together to get a fluffy cream; eggs and sugar were whipped together until semi-firm foam resulted. The sugar-egg foam was mixed with the creamed flour and margarine. For each cupcake variation, twelve 50-g portions of batter were weighed and placed in paper baking cups in an aluminum muffin pan. The cupcakes were baked in a 160°C oven for 45min. Cupcakes were cooled to room temperature before use. To prepare the fat replacer treatments, the margarine in the formula was replaced with 20, 40, 60 and 80 % of baked sweet potato. The same order of mixing described for the control was followed.

### Biological evaluation

### Experimental animals

The work was carried out at Research Institute of Ophthalmology, Animal House Department, Giza, Egypt. Seventy-two male albino rats (150g ±5) were fed a standard diet for 7 days as an adaptation period. The standard diet was formulated

according to AIN-93 guidelines (Reeves *et al.,* 1993) The salt mixture and vitamin mixture were prepared according to Hegested *et al.* (1941) and Campbell (1961), respectively. The rats were housed individually in wire cages under normal laboratory conditions. Every day the rats were observed for the external appearance, shape, color, and distribution of hair and physical activity. The diets were introduced to rats in special food cups to avoid loss of food and contamination. Also, water was provided to rats by glass tube projecting through wire cages from inverted bottles supported to one side of the cage. Food and water provided were checked daily.

## Experimental groups:

Seventy-two rats were randomly divided into two main groups, the first, negative control group (n=6), fed standard and the second group (n=66) fed high-calorie diet (fat is 40% of total calories) for four weeks to achieve obesity according to Kang *et al.,* (2005). The second group (n=66) was divided into 11 subgroups, 6 rats per subgroup. First subgroup is positive control fed standard diet, second subgroup fed standard diet substitution with 2.5% of control cupcake, third subgroup fed standard diet substitution with 2.5% of cupcake contains 20% of baked sweet potato, fourth subgroup fed standard diet substitution with 2.5% of cupcake contains 40% of baked sweet potato, fifth subgroup fed standard diet substitution with 2.5% of cupcake contains 60% of baked sweet potato, sixth fed standard diet substitution with 2.5% of cupcake contains 80% of baked sweet potato, seventh subgroup fed standard diet substitution with 5% of control cupcake, eighth subgroup fed standard diet substitution with 5% of cupcake contains 20% of baked sweet potato, ninth subgroup fed standard diet substitution with 5% of cupcake contains 40% of baked sweet potato, tenth subgroup fed standard diet substitution with 5% of cupcake contains 60% of baked sweet potato, eleventh subgroup fed standard diet substitution with 5% of cupcake contains 80% of baked sweet potato. The dried cupcake was replaced with corn starch in the standard diet at 2.5 and 5% replacement levels.

## Body Weight gain

All rats were weighed at the beginning (initial weight) and the end of the experiment (final weight) to determine body weight gain according to Chapman *et al.,* (1959) using the following formulas:

Body weight gain (g) = final weight – initial weight

## Organ weights

The liver, kidney, and heart were removed from each rat carefully dissection, cleaned from the adhesive matter by a saline solution, dried by filter paper and weighed according to the methods described by Drury and Wallington, (1980).

## Blood sampling and preparation

Blood samples were taken at the beginning and at the end of the experimental period (30 days). The blood samples were collected from orbital plexus venus by means of fine capillary glass tubes according to the method described by Schermer, (1967). The blood samples were placed in dry clean centrifuge tubes and allowed to clot for 1-2 h at room temperature. Serum was then removed by centrifuging at 1500g for 10 min. The clear supernatant serum was kept at - 20°C until analysis.

## Analytical methods:

Serum triglyceride (TG), total cholesterol (TC), and high-density lipoprotein cholesterol (HDL) were determined by using the enzymatic

colorimetric method as described by Fossati and Prencipe, (1982), Allain *et al.,* (1974), and Assmann (1979), respectively. Low-density lipoprotein (LDL) was carried out according to the method of Lee and Nieman, (1996) as follows:

LDL = Total cholesterol - (HDL + VLDL)

Serum glucose was estimated according to Trinder, (1969). Uric acid, urea, and creatinine levels were determined according to the method described by Barham and Trinde, (1972), Gutmann and Bergmeyer , (1974) and Houot, (1985), respectively. Alanine aminotransferase (ALT), aspartate aminotransferase (AST) were determined according to the method of Reitman and Frankel, (1957). Alkaline phosphatase (ALP) was determined according to the method of Hayssement, (1977).

## Statistical Analysis

Data were presented as the mean ± standard deviations. Data were analyzed using a two-way analysis of variance. Comparisons among means were performed using the LSD test. The differences were considered significant at the 5% level ($p \leq 0.05$) using Costat version 6.311 (Copyright 1998-2005, CoHort software).

# RESULTS AND DISCUSSION

## Effect of baked sweet potato cupcake on body weight gain of rats

Obese rats had higher (P≤0.05) initial weights than negative control rats (Table 1). Shin *et al.,* (2013) reported that the body weight of the high-fat diet rats was higher than the normal diet rats. The final weight of rats fed cupcake diets was lower (P≤0.05) than positive control rats. On the other side, final weights of rats fed reduced fat cupcake diets were significantly (P≤0.05) decreased by increasing the replacement level of baked sweet potato in reduced fat cupcake diets as compared with positive control rats and obese rats fed control cupcake diet. This reduction may be due to the beneficial action of baked sweet potato on body weight gain. Shin *et al.*, (2013) reported that rats fed supplemented purple sweet potato extract diet had lower body weight than those fed the high-fat diet during the six weeks of the experiment period.

Positive control rats had higher (P≤0.05) body weight gain than negative control rats and rats fed cupcake diets. Rats fed control cupcake diet had higher (P≤0.05) body weight gain than negative control rats and rats fed reduced fat cupcake diets. Body weight gain of rats fed reduced fat cupcake diets was reduced (P≤0.05) by increasing the replacement level of baked sweet potato in reduced fat cupcake diets as compared with positive control rats and obese rats fed control cupcake diet. Body weight gain was reduced by 43.14-63.03% as compared with positive control rats. There is sufficient evidence that the consumption of sweet potato could play an important role in the prevention and development of body weight gain. Although reduced fat cupcake diets at different replacement level of baked sweet potato reduced body weight gain in the obese rats, their values still higher than negative control rats. This may be due to the short of the trial period.

## Effect of baked sweet potato cupcake on organ weight

Obese rats fed standard diet (positive control rats) and rats fed control cupcake (full-fat cupcake) diet had higher (P≤0.05) organ weight values than normal rats fed standard diet (negative control rats) and obese rats fed reduced fat cupcake diets (Table 2). Kumar *et al.,* (2012) found that feeding rats high-fat diet (20 g/day) for 28 days resulted in a significant increase in organs weight. A non-significant (P>0.05) differences in organ weight values were

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**Table (1): Effect of reduced fat cupcake diets containing different levels of baked sweet potato on weight gain of obese rats**

| | Negative | Obese rats | | | | | | Means[1] |
|---|---|---|---|---|---|---|---|---|
| | | Positive | Reduced fat cupcake diets | | | | | |
| | | | 0% | 20% | 40% | 60% | 80% | |
| **Initial weight (g)** | | | | | | | | |
| 2.5% | 150.0 | 223.0 | 223.2 | 224.0 | 224.8 | 224.8 | 222.6 | $213.2^{a}\pm2.1$ |
| 5% | 150.0 | 223.6 | 221.6 | 224.2 | 225.6 | 226.2 | 224.8 | $213.7^{a}\pm2.2$ |
| Means | $150.0^{b}\pm1.3$ | $223.3^{a}\pm2.2$ | $222.4^{a}\pm2.2$ | $224.1^{a}\pm2.1$ | $225.2^{a}\pm2.3$ | $225.5^{a}\pm2.2$ | $223.7^{a}\pm2.1$ | |
| **Final weight (g)** | | | | | | | | |
| 2.5% | 173.8 | 258.8 | 253.6 | 209.8 | 205.8 | 205.0 | 203.7 | $215.8^{a}\pm2.1$ |
| 5% | 173.8 | 259.2 | 252.4 | 207.6 | 204.4 | 204.8 | 198.8 | $214.4^{a}\pm2.3$ |
| Means[2] | $173.8^{g}\pm1.4$ | $259.0^{a}\pm2.5$ | $253.0^{b}\pm2.3$ | $208.7^{c}\pm2.1$ | $205.1^{d}\pm1.9$ | $204.9^{e}\pm1.8$ | $201.3^{f}\pm1.5$ | |
| **Body weight gain (g)** | | | | | | | | |
| 2.5% | 23.8 | 35.8 | 30.4 | 14.2 | 19.0 | 19.8 | 18.9 | $23.1^{b}\pm1.1$ |
| 5% | 23.8 | 35.6 | 30.8 | 16.6 | 21.2 | 21.4 | 26.0 | $25.1^{a}\pm1.1$ |
| Means[2] | $23.8^{c}\pm1.1$ | $35.7^{a}\pm1.5$ | $30.6^{b}\pm1.4$ | $-15.4^{g}\pm0.8$ | $-20.1^{f}\pm0.7$ | $-20.6^{e}\pm0.9$ | $-22.5^{d}\pm1.1$ | |

[1]Means ± SD, means in the same column with different letters are significantly different (P ≤ 0.05).
[2]Means ± SD, means in the same raw with different letters are significantly different (P ≤ 0.05).

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**Table (2): Effect of reduced fat cupcake diets containing different levels of baked sweet potato on organ weight of obese rats**

| | Negative | Obese rats | | | | | Means[1] |
|---|---|---|---|---|---|---|---|
| | | Positive | Reduced fat cupcake diets | | | | |
| | | | 0% | 20% | 40% | 60% | 80% | |
| **liver** | | | | | | | | |
| 2.5% | 2.7 | 3.6 | 3.5 | 3.3 | 2.8 | 2.6 | 2.5 | $3.0^{a}\pm0.1$ |
| 5% | 2.7 | 3.6 | 3.5 | 3.1 | 2.6 | 2.6 | 2.7 | $2.97^{a}\pm0.1$ |
| Means | $2.7^{c}\pm0.1$ | $3.6^{a}\pm0.2$ | $3.5^{a}\pm0.2$ | $3.2^{b}\pm0.1$ | $2.7^{c}\pm0.1$ | $2.6^{c}\pm0.1$ | $2.6^{c}\pm0.07$ | |
| **kidney** | | | | | | | | |
| 2.5% | 0.90 | 1.2 | 1.1 | 0.95 | 0.94 | 0.92 | 0.90 | $0.99^{a}\pm0.01$ |
| 5% | 0.90 | 1.2 | 1.1 | 0.93 | 0.92 | 0.92 | 0.90 | $0.99^{a}\pm0.01$ |
| Means[2] | $0.90^{b}\pm0.03$ | $1.2^{a}\pm0.1$ | $1.1^{a}\pm0.09$ | $0.94^{b}\pm0.01$ | $0.92^{b}\pm0.01$ | $0.91^{b}\pm0.01$ | $0.90^{b}\pm0.01$ | |
| **Heart** | | | | | | | | |
| 2.5% | 0.20 | 0.40 | 0.36 | 0.32 | 0.25 | 0.23 | 0.20 | $0.28^{a}\pm0.01$ |
| 5% | 0.20 | 0.40 | 0.36 | 0.28 | 0.23 | 0.23 | 0.20 | $0.27^{a}\pm0.01$ |
| Means[2] | $0.20^{c}\pm0.01$ | $0.40^{a}\pm0.02$ | $0.36^{a}\pm0.02$ | $0.30^{b}\pm0.01$ | $0.24^{c}\pm0.01$ | $0.23^{c}\pm0.01$ | $0.20^{c}\pm0.01$ | |

[1]Means ± SD, means in the same column with different letter are significantly different ($P \leq 0.05$).
[2]Means ± SD, means in the same raw with different letter are significantly different ($P \leq 0.05$).

observed between positive control rats and rats fed control cupcake diet. However, organ weight values were significantly (P≤0.05) decreased by the replacement level of baked sweet potato in reduced fat cupcake diets as compared with positive control rats and obese rats fed control cupcake diet. Shin *et al.,* (2013) reported that rats fed supplemented purple sweet potato extract diet had lower liver weight than those fed the high-fat diet.

The obese rats fed reduced fat cupcake diets from 40 to 80% replacement levels for 30 days lead to restore the normal liver and heart weights of negative control rats. However, obese rats fed reduced fat cupcake diets at any replacement levels for 30 days lead to restore the normal kidney of negative rats. Data showed the beneficial role of baked sweet potato in restoring the normal liver, kidney and heart weights of negative control rats. The non-significant (P>0.05) differences in organ weights were observed between reduced fat cupcake diets at 2.5% and 5% replacement level.

## Effect of baked sweet potato cupcake on lipids profile

Positive control rats and rats fed control cupcake diet had higher (P≤0.05) triglyceride (TG), total cholesterol (TC), and low-density lipoprotein (LDL) values than negative control rats and obese rats fed reduced fat cupcake diets Table (3). However, high-density lipoprotein (HDL) had an opposite trend. The high lipid levels in plasma may be due to increased uptake of exogenous lipid and decreased lipid catabolism. The similar results were reported by Walatara *et al.* (2014) who found that obese male and female rats had higher TC and LDL as well as lower HDL values than non-obese males and females. Sunarti, *et al.,* (2016) showed that the administration of a high-fat diet for 25 days increases cholesterol and reduces HDL.

The non-significant (P>0.05) differences in TG, TC, LDL and HDL values were observed between positive control rats and rats fed control cupcake diet. However, TG, TC, and LDL values were significantly (P≤0.05) decreased by increasing the replacement level of baked sweet potato in reduced fat cupcake diets as compared with positive control rats and obese rats fed control cupcake diet. However, HDL values had an opposite trend. The reduction in triglycerides and lipoproteins may be due to the high content of bioactive compounds in sweet potatoes such as carotenoids, anthocyanin, phenolic acids, and flavonoids. These findings are in accordance with those reported by Shin *et al.,* (2013) who reported that feeding obese mice with sweet potato enhanced the decreases of serum triglyceride, total cholesterol, and LDL cholesterol. Kan *et al.,* (2014) found that sweet potato reduced serum triglyceride, total cholesterol, and LDL concentration and increased serum HDL concentration in treated rats.

Reduced fat cupcake diets at 5% replacement level were more effective (P≤0.05) in reducing TG, TC and LDL values than reduced fat cupcake diets at 2.5% replacement level. However, a non-significant (P>0.05) difference in HDL values was observed between reduced fat cupcake diets at 2.5% and 5% replacement level. Reduced fat cupcake at 80% replacement level of baked sweet potato was more effective (P≤0.05) in reducing TG, TC, and LDL values and increasing HDL values than other replacement levels of baked sweet potato. The reduction in TG, TC and LDL values and increase in HDL values of the rats fed reduced fat cupcake at 80% replacement level of baked sweet potato diets was 25.80, 37.08, and 51.91% and

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**Table (3): Effect of reduced fat cupcake diets containing different levels of baked sweet potato on the lipid profile of obese rats**

| (mg/dl) | Negative | Obese rats | | | | | | Means[1] |
|---|---|---|---|---|---|---|---|---|
| | | Positive | Reduced fat cupcake diets | | | | | |
| | | | 0 | 20% | 40% | 60% | 80% | |
| **TG** | | | | | | | | |
| 2.5% | 100.6 | 143.0 | 140.6 | 135.8 | 130.2 | 125.0 | 109.4 | 126.4 $^{a}$±2.1 |
| 5% | 100.6 | 143.0 | 140.8 | 130.2 | 126.0 | 118.8 | 102.8 | 123.2$^{b}$±3.1 |
| Means[2] | 100.6$^{f}$±1.1 | 143.0$^{a}$±2.0 | 140.7$^{a}$±1.7 | 133.0$^{b}$±3.1 | 128.1 $^{c}$±1.7 | 121.9$^{d}$±2.5 | 106.1$^{e}$±2.6 | |
| **TC** | | | | | | | | |
| 2.5% | 118.6 | 196.6 | 198.4 | 192.4 | 183.0 | 158.2 | 125.3 | 167.5 $^{a}$±2.7 |
| 5% | 118.6 | 196.6 | 197.0 | 189.2 | 175.4 | 146.2 | 122.0 | 163.6 $^{b}$±2.1 |
| Means | 118.6 $^{f}$±1.1 | 196.6 $^{a}$±2.4 | 197.7 $^{a}$±2.4 | 190.8 $^{b}$±1.9 | 179.2 $^{c}$±2.3 | 152.2 $^{d}$±1.3 | 123.7 $^{e}$±2.6 | |
| **LDL** | | | | | | | | |
| 2.5% | 39.1 | 131.2 | 131.8 | 130.5 | 114.9 | 86.2 | 71.1 | 100.7$^{a}$±3.7 |
| 5% | 39.1 | 131.2 | 130.4 | 124.5 | 105.0 | 73.4 | 55.04 | 94.1$^{b}$±2.4 |
| Means | 39.1$^{f}$±2.4 | 131.2$^{a}$±2.6 | 131.1$^{a}$±3.9 | 127.5$^{b}$±1.1 | 110.0 $^{c}$±2.5 | 79.8$^{d}$±1.4 | 63.1$^{e}$±3.8 | |
| **HDL** | | | | | | | | |
| 2.5% | 59.4 | 36.8 | 36.4 | 38.2 | 41.4 | 47.0 | 49.4 | 44.1$^{a}$±1.5 |
| 5% | 59.4 | 36.8 | 35.8 | 37.2 | 44.0 | 49.0 | 51.4 | 44.8 $^{a}$±1.3 |
| Means[2] | 59.4$^{a}$±1.5 | 36.8$^{f}$±1.5 | 36.1$^{f}$±2.9 | 37.7$^{e}$±1.6 | 42.7$^{d}$±2.5 | 48.0$^{c}$±1.2 | 50.4$^{b}$±1.9 | |

[1]Means ± SD, means in the same column with different letter are significantly different (P ≤ 0.05).
[2]Means ± SD, means in the same raw with different letter are significantly different (P ≤ 0.05).
TG: Triglyceride, TC: Total Cholesterol, LDL: Low-density lipoprotein, HDL: High-density lipoprotein.

36.96.%, respectively as compared with positive control rats. Srijita, (2015) showed that consumption 4 grams daily of sweet potato extract for three months resulted in reducing the levels of TC and LDL by 30 and 13%, respectively. Although reduced fat cupcake at different replacement levels of sweet potato decreased TG, TC and LDL and increased HDL values in the obese rats, their values were still higher and lower, respectively than negative control rats. This may be due to the short trial period.

## Effect of baked sweet potato cupcake on blood glucose

Positive control rats and rats fed control cupcake diet had higher (P≤0.05) blood glucose levels than negative control rats and obese rats fed reduced fat cupcake diets Table (4). Obesity adds pressure on rat body ability to use insulin to properly control blood sugar levels. A non-significant (P>0.05) difference in blood glucose level was observed between positive control rats and rats fed control cupcake diet. However, blood glucose level was significantly (P≤0.05) decreased by increasing the replacement level of baked sweet potato in reduced fat cupcake diets as compared with positive control rats and obese rats fed control cupcake diet. Sweet potato may be beneficial for diabetes because it helps in stabilizing blood sugar levels and lower insulin resistance (Milind and Monika, 2015). Srijita, (2015) found that sweet potato is high in fiber and have a low glycemic index which can help diabetics control their blood sugar. Moch *et al.,* (2010) showed that administration of an extract of sweet potato at a dose of 200 mg/kg for two weeks caused a significant reduction in blood glucose.

A non-significant (P>0.05) difference in blood glucose level was observed between reduced fat cupcake diets at 2.5% and 5% replacement level. Reduced fat cupcake at 80% replacement level of baked sweet potato was more effective (P≤0.05) in reducing blood glucose levels than other replacement levels of baked sweet potato. The reduction in blood glucose level of the rats fed reduced fat cupcake at 80% replacement level of baked sweet potato diets was 15.98% as compared with positive control rats. Although reduced fat cupcake at different replacement levels decreased blood glucose levels in the obese rats, their values were still higher than negative control rats. This may be due to the short of the trial period.

Table (4): Effect of reduced fat cupcake diets containing different levels of baked sweet potato on blood glucose of obese rats

| (mg/dl) | Negative | Obese rats | | | | | | Means[1] |
|---|---|---|---|---|---|---|---|---|
| | | Positive | Reduced fat cupcake diets | | | | | |
| | | | 0% | 20% | 40% | 60% | 80% | |
| 2.5% | 83.0 | 102.6 | 102.4 | 97.6 | 94.0 | 90.2 | 86.8 | 93.8 $^{a}$±2.9 |
| 5% | 83.0 | 102.6 | 102.2 | 96.6 | 92.8 | 89.4 | 85.6 | 93.2 $^{a}$±2.6 |
| Means[2] | 83.0$^{f}$±1.5 | 102.6 $^{a}$±3.9 | 102.3$^{a}$±1.6 | 97.$^{b}$±2.3 | 93.4$^{c}$±1.6 | 89.8$^{d}$±1.3 | 86.2$^{e}$±1.7 | |

[1]Means ± SD, means in the same column with different letter are significantly different (P ≤ 0.05).
[2]Means ± SD, means in the same raw with different letter are significantly different (P ≤ 0.05).

## Effect of baked sweet potato cupcake on kidney functions

Kidney removes metabolic wastes such as urea, uric acid, and creatinine. The concentrations of the metabolites increase in blood during renal diseases or renal damage may due to high activities of xanthine oxidase, lipid peroxidation, and increased triacylglycerol and cholesterol levels (Anwar and Meki, 2003). Positive control rats and rats fed control cupcake diet had higher (P≤0.05) blood urea, serum uric acid, and serum creatinine values than the negative control (Table 5). Obesity causes increased blood pressure which produces unfavorable effects and such a change in kidney resulting in increased tubular secretions leading to increased blood urea and creatinine and uric acid level (Kovesdy *et al.,* 2017). Blood urea and serum uric acid were not affected (P>0.05) by baked sweet potato at any replacement level. However, serum creatinine was significantly (P≤0.05) decreased by increasing the replacement level of baked sweet potato in reduced fat cupcake diets as compared with positive control rats and obese rats fed control cupcake diet. Salmean *et al.* (2013) conclude that increasing fiber intake in chronic kidney disease patients may reduce serum creatinine level.

A non-significant (P>0.05) difference in serum creatinine was observed between reduced fat cupcake diets at 2.5% and 5% replacement level. Reduced fat cupcake at 80% replacement level of baked sweet potato was more effective (P≤0.05) in reducing serum creatinine than other replacement levels of baked sweet potato. The reduction in serum creatinine of the rats fed reduced fat cupcake at 80% replacement level of baked sweet potato diets was 14.04% as compared with positive control rats. A non-significant (P>0.05) difference in serum creatinine was observed between negative control rats and rats fed reduced fat cupcake at 80% replacement level of baked sweet potato. Data indicate that feeding obese rats with a reduced fat cupcake at 80% replacement level of baked sweet potato for 30 days led to restore the normal serum creatinine of negative control rats.

## Effect of baked sweet potato cupcake on liver functions

Several hepatic enzymes in serum were used for the biochemical markers to understand the early hepatic injury, such as alkaline phosphatase (ALP), alanine aminotransferase (ALT), and aspartate aminotransferase (AST) (Giannini *et al.,* 2005). Positive control rats and rats fed control cupcake diet had higher (P≤0.05) ALP, ALT and AST enzymes than the negative control rats (Table 6). Marchesini *et al.* (2008) reported that the presence of obesity increases the risk of elevated liver enzymes. The ALP, ALT, and AST enzymes were significantly (P≤0.05) decreased by the replacement levels of baked sweet potato in reduced fat cupcake diets as compared with positive control rats and obese rats fed control cupcake diet. A non-significant (P>0.05) difference in ALP enzyme was observed among the replacement levels of baked sweet potato in reduced fat cupcake diets.

Rats fed 40 to 80% replacement levels of baked sweet potato in reduced fat cupcake diets had lower (P≤0.05) ALT enzyme than those fed 20% replacement level of baked sweet potato in reduced fat cupcake diet. However, non-significant (P>0.05) difference in ALT enzyme was observed among 40, 60 and 80% replacement levels of baked sweet potato in reduced fat cupcake diets. Jung *et al.,* (2015) showed that pretreatment with extract of sweet potato decreased ALT and AST serum levels in hepatic rats.

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**Table (5): Effect of reduced fat cupcake diets containing different levels of baked sweet potato on kidney functions of obese rats**

| (mg/dl) | Negative | Obese rats | | | | | | Means[1] |
|---|---|---|---|---|---|---|---|---|
| | | Positive | Reduced fat cupcake diets | | | | | |
| | | | 0% | 20% | 40% | 60% | 80% | |
| **Urea** | | | | | | | | |
| 2.5% | 48.4 | 50.8 | 51. 2 | 51.0 | 51.4 | 50.8 | 51.2 | $50.7^{a}\pm0.8$ |
| 5% | 48.4 | 50.8 | 50.8 | 51.0 | 50.6 | 50.6 | 50.8 | $50.5^{a}\pm0.8$ |
| Means[2] | $48.4^{b}\pm1.1$ | $50.8^{a}\pm0.8$ | $51.0^{a}\pm0.8$ | $51.0^{a}\pm1.0$ | $51.0^{a}\pm0.8$ | $50.7^{a}\pm0.8$ | $51.0^{a}\pm0.8$ | |
| **Uric Acid** | | | | | | | | |
| 2.5% | 3.9 | 4.3 | 4.2 | 4.3 | 4.2 | 4.2 | 4.1 | $4.2^{a}\pm0.1$ |
| 5% | 3.9 | 4.3 | 4.3 | 4.3 | 4.3 | 4.2 | 4.2 | $4.2^{a}\pm0.1$ |
| Means[2] | $3.9^{b}\pm0.3$ | $4.3^{a}\pm0.1$ | $4.25^{a}\pm0.1$ | $4.3^{a}\pm0.1$ | $4.25^{a}\pm0.1$ | $4.2^{a}\pm0.1$ | $4.15^{a}\pm0.1$ | |
| **Creatinine** | | | | | | | | |
| 2.5% | 0.49 | 0.57 | 0.57 | 0.55 | 0.53 | 0.51 | 0.49 | $0.53^{a}\pm0.7$ |
| 5% | 0.49 | 0.57 | 0.57 | 0.55 | 0.53 | 0.51 | 0.49 | $0.53^{a}\pm0.7$ |
| Means[2] | $0.49^{e}\pm0.1$ | $0.57^{a}\pm0.8$ | $0.57^{a}\pm0.7$ | $0.55^{b}\pm0.8$ | $0.53^{c}\pm0.1$ | $0.51^{d}\pm0.1$ | $0.49^{e}\pm0.2$ | |

[1]Means ± SD, means in the same column with different letter are significantly different (P ≤ 0.05).
[2]Means ± SD, means in the same raw with different letter are significantly different (P ≤ 0.05).

**Table (6): Effect of reduced fat cupcake diets containing different levels of baked sweet potato on liver functions of obese rats**

| (u/l) | Negative | Obese rats | | | | | Means[1] |
|---|---|---|---|---|---|---|---|
| | | Positive | Reduced fat cupcake diets | | | | |
| | | | 0% | 20% | 40% | 60% | 80% | |
| **ALP** | | | | | | | | |
| 2.5% | 69.0 | 73.4 | 73.5 | 72.6 | 72.0 | 71.6 | 71.5 | $71.8^{a}\pm1.5$ |
| 5% | 69.0 | 74.4 | 74.1 | 72.4 | 72.4 | 72.0 | 71.9 | $72.1^{a}\pm1.5$ |
| Means[2] | $69^{c}\pm1.0$ | $73.9^{a}\pm1.5$ | $73.8^{a}\pm1.6$ | $72.5^{b}\pm1.5$ | $72.2^{b}\pm1.5$ | $71.8^{b}\pm1.1$ | $71.7^{b}\pm1.2$ | |
| **ALT** | | | | | | | | |
| 2.5% | 16.2 | 20.8 | 20.6 | 18.0 | 17.2 | 17.2 | 17.0 | $18.5^{a}\pm0.8$ |
| 5% | 16.2 | 20.8 | 20.8 | 18.2 | 17.2 | 17.2 | 17.2 | $18.4^{a}\pm0.6$ |
| Means[2] | $16.2^{d}\pm0.8$ | $20.8^{a}\pm0.8$ | $20.7^{a}\pm0.7$ | $18.1^{b}\pm0.8$ | $17.2^{c}\pm0.5$ | $17.2^{c}\pm0.6$ | $17.1^{c}\pm0.5$ | |
| **AST** | | | | | | | | |
| 2.5% | 61.2 | 66.8 | 66.2 | 65.6 | 64.4 | 63.2 | 62.8 | $64.3^{a}\pm0.8$ |
| 5% | 61.2 | 66.8 | 66.2 | 65.2 | 64.6 | 63.4 | 62.6 | $64.3^{a}\pm0.8$ |
| Means[2] | $61.2^{e}\pm1.3$ | $66.8^{a}\pm0.8$ | $66.2^{a}\pm1.1$ | $65.4^{b}\pm0.9$ | $64.5^{c}\pm0.8$ | $63.3^{d}\pm0.7$ | $62.7^{de}\pm0.8$ | |

[1]Means ± SD, means in the same column with different letter are significantly different ($P \leq 0.05$).
[2]Means ± SD, means in the same raw with different letter are significantly different ($P \leq 0.05$).

Shin *et al.,* (2013) showed that sweet potato extract lowered ALT and AST enzymes and decreases hepatic injury.

The non-significant (P>0.05) differences in ALP, ALT and AST enzymes were observed between reduced fat cupcake diets at 2.5% and 5% replacement level. Reduced fat cupcake at 80% replacement level of baked sweet potato was more effective (P≤0.05) in reducing AST enzyme than other replacement levels of baked sweet potato. The reduction in the AST enzyme of the rats fed reduced fat cupcake at 80% replacement level of baked sweet potato diets was 6.14% as compared with positive control rats. A non-significant (P>0.05) difference in AST enzyme was observed between negative control rats and rats fed reduced fat cupcake at 80% replacement level of baked sweet potato. Data indicate that feeding obese rats with a reduced fat cupcake at 80% replacement level of baked sweet potato for 30 days led to restoring the normal AST enzyme level of negative control rats. The reduction in ALP and ALT enzymes of the rats fed reduced fat cupcake at different replacement levels of baked sweet potato diets were ranged from 1.89 to 2.98% and 12.98 to 17.79%, respectively as compared with positive control rats. Although reduced fat cupcake at different replacement levels decreased ALP and ALT enzymes in the obese rats, their values still higher than negative control rats. This may be due to the short of the trial period.

## CONCLUSION

From the above results, it could be concluded that feeding obese rats with reduced fat cupcake prepared with baked sweet potato proved to be effective in improving the body weight gain, organ weight, TG, TC, LDL, blood glucose level, liver function, and serum creatinine.

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# التأثير الوقائي للكيك المصنع باستبدال الدهن بمستويات مختلفه من البطاطا الحلوة المشوية علي الفئران المصابه بالسمنه

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## الملخص العربي

إزداد الإهتمام فى الآونة الأخيرة لإكتشاف منتجات طبيعية كبديل للدهون فى المنتجات الغذائية لإنتاج أغذية صحية تفى برغبات المستهلكين. لذلك يهدف هذا البحث الي استخدام البطاطا كمنتج غذائي طبيعي فى انتاج كيك منخفض الدهن وعالي القيمه الغذائيه وذو فوائد صحيه نظرا لكونها ذات قيمه غذائيه عاليه وكذلك خصائص معززه للصحه, تم تقييم الاثار المحتمله للكيك منخفض الدهن الذي يحتوي علي البطاطا المشوية علي الفئران المصابه بالسمنه, أظهرت النتائج البيولوجية التالى: أدت تغذية الفئران البدينة على الوجبات المحتوية على الكيك منخفض الدهن والمحتوى على البطاطا المشوية إلى إنخفاض فى وزن الجسم بحوالى ٤٣-٦٣% مقارنة بالفئران البدينة القياسية. كذلك تغذية الفئران البدينة على وجبات تحتوى على ٤٠-٨٠% من البطاطا المشوية لمدة ٣٠ يوم أعادت وزن الأعضاء لمعدلها الطبيعى كما فى الفئران الطبيعية. أدت تغذية الفئران البدينة على الكيك منخفض الدهن والمحتوى على البطاطا المشوية الى خفض كل من وزن الجسم المكتسب، وزن الأعضاء، الجلسريدات الثلاثية, الكوليستيرول الكلى, الليبوبروتينات منخفضة الكثافة, ومستوى جلوكوز الدم، إنزيمات الكبد، الكرياتينين مقارنة بالفئران البدينة القياسية. كما لوحظ فروق غير معنويه في كل من ازان الاعضاء، الليبوبروتينات عاليه الكثافه، جلوكوز الدم، وظائف الكلي، وظائف الكبد بين وجبات الكيك منخفض الدهن عند مستوي استبدال 2.5%، ٥%. بينما ادي تغذية الفئران علي الكيك منخفض الدهن عند مستوي ٥% الي خفض في كل من الجلسريدات الثلاثيه، الكوليسترول الكلي، الليبوبروتينات منخفضه الكثافه، كما ادي الي زياده في وزن الجسم المكتسب وذلك مقارنه بالكيك المنخفض الدهن عند مستوي استبدال 2.5%. بينت نتائج الدراسة إمكانية إضافة البطاطا المشوية كمنتج طبيعى الى صناعة الكيك للحصول على منتج صحى عالى القيمة الغذائية وكذلك تحسين السمنه.

الكلمات الدالة: البطاطا المشوية، الكيك، الفئران البدينة، وظائف الكبد والكلى، الليبوبروتينات