# Effect of using sweet potato powder on diabetic rats[1]

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**ABSTRACT**

The main aim of this research was to study the influence of sweet potato powder on diabetic rats. A total of 24 adult male albino rats of "Sprague Dawley" strain (150 ±5g) were used and randomly divided into 4 equal groups including negative control group, positive control group, while the other two groups were treated with 10% raw potato and 30% cooked potato depending on sensory evaluation of biscuits supplemented with raw and cooked sweet potato powder. The experiment lasted for 28 days. Measurements included determining glucose, liver functions, kidney functions and lipid profile in serum and pancreas histopathology. The results indicated that induced alloxan resulted in significant increases in glucose in urine and serum, in addition to a significant increase in liver and kidney functions, lipid profile expect HDL-C were decreased compared with a negative control group and abnormal histopathological changes were noticed in pancreas dysfunction resulted from abnormal histopathology was observed. Like raw and cooked sweet potato induced anti-diabetic effects and decreased glucose in blood serum. Moreover, they alleviated alloxan-induced abnormalities in body weight, liver and kidney functions. Accordingly, this study recommends diabetic patients to regularly consume sweet potato and its leaves with a suitable dose since they can induce an improvement in increase blood sugar.

**Keywords:** Diabetes mellitus, alloxan, sweet potato, insulin, lipid profile.

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## INTRODUCTION

Blood sugar is the problem of chronic high diabetics in blood and it has been subdivided into type 1 diabetes (the autoimmune destruction of β cells) and also, type 2 diabetes (with insulin resistance and features of the relating to syndrome) (**Tuomi *et al.,* 2014)**.

Diabetes mellitus (DM) is a significant public health problem, considered one of the highest challenges in our century owing to the number of people suffering from DM has massively increased in the last 20 years **(Sandu *et al*., 2016).** DM is a metabolic disorder that is characterized by chronic high blood glucose level that leads to complications in the eyes, kidneys, heart, vessels and nerves **(Park and Jang, 2016).**

Blood sugar is a happen either when the pancreas does not produce sufficient insulin or when the body cannot use the insulin it produces. Elevate diabetes is a result of uncontrolled blood sugar and leads to dangerous injure to many of the body's systems (**WHO, 2018**).

Patients with blood sugar type 2 constitute about 90%-95% in worldwide. People with hyperglycemia are at the greatest danger of macrovascular and microvascular complications **(Hegazi *et al*., 2015).**

This chronic complex disease requiring permanent medical care involving risk-reduction strategies is beyond blood sugar control (**ADA, 2017).** More therapy drugs are commercially available for utilizing in the administration of blood sugar, their side influences and expensive confirm the necessity to natural products as a replacement therapy (**Hossen *et al*., 2017).** For example, metformin is a biguanide which can cause vitamin B12 and folic acid deficiency **(Fogelman *et al*., 2017).**

**Strugała *et al* (2019)** estimated that influence of purple potato (PP) on diabetes and its antioxidant activities after two-week management to streptozotocin (STZ)-induced diabetic rats. The findings observed that the PP showed antioxidative impact, inhibition malondialdehyde levels, and restored antioxidant enzyme activities in diabetic rats. In addition, the inhibition of oxidative modified proteins, progress glycation end-product, and advanced oxidation protein product formation in the rats' blood plasma utilizing a purple potato.

Sweet potato is abundant in dietary fiber, minerals, vitamins and compound of substance with biological effect such as B carotene, phenolic acid and anthocyanin that give sweet potato its unique flesh colors (cream, yellow, orange and purple) **(Teow, 2007).**The anthocyanin that found in sweet potato could regulate the blood glucose level by inhibit the alpha-glucosidase **(Ghosh and Konishi, 2007)** and could also increase the phosphorylation of insulin receptor (**Nizamutdinova *et al*., 2009).**The antioxidant agents of this potatoes

increased antioxidant enzymes, which is superoxide dismutase (SOD) **(Jawi and Budiasa, 2011)**.

Sweet potato had contained carbohydrates, proteins, vitamins and natural antioxidants in various ratios depending on the variety. It has been found high amounts from phenolic as caffeic acid and flavonoids compounds like quercetin **(Wang *et al*., 2016)**. Vitamins and natural antioxidants are some of the bioactive compounds which are particularly abundant in the purple-potato varieties (**He *et al*., 2015 and Alam *et al*., 2016)**.The pharmacological mechanism of this hypoglycemic effect is still studied. One of the proposed mechanisms is a protection of pancreatic β - cells by the antioxidant agents of this sweet potato (**Jawi *et al*., 2016**).

This research was achieved to investigate influence treatment of raw and cooked sweet potato powder on diabetic rats.The influences of sweet potato powder on feed intake, body weight gain, and liver and kidney functions were also studied.

## MATERIALS AND METHODS

**Materials:**

The yellow sweet potato (*Ipomoea batatas* L) was obtained from the local market, Tanta City, Gharbia Governorate, Egypt.

Casein was obtained from El –Sharqiya Co., while vitamin and salt mixture were obtained from Adwiya Co., Kafr El- Zayat, Egypt. Fats, cellulose powder, sugar, corn oil and corn starch was purchased from local market, Tanta City, Gharbia Governorate, Egypt.

Wheat flour 72% extraction, sugar, salt, vegetable oil, egg, vanillin and ammonium bicarbonate were purchased from the local market Tanta City, Gharbia Governorate, Egypt

Alloxan monohydrate was purchased from El-Gomhorya Company for Chemicals and Drugs, Tanta City, Gharbia Governorate, Egypt.

A total of twenty four (24) adult male albino rats of *"Sprague Dawley*" strain (150 ± 10 g) were obtained from the Animal Colony, Helwan Farm, Vaccine and Immunity Organization, Ministry of Health, Cairo Governorate, Egypt.

**Methods:**

**Preparation of plant materials:**

The yellow sweet potato was being washed thoroughly with clean water, sliced cut into small pieces. The sliced portions were being soaked in warm water to prevent subsequent browning, another portion of sweet potato was being cooked in boiling water were sundried for about 10 days. The dried samples of slices were being blended into powder separately then it was being transferred into a plastic package with cover and labeled accordingly.

**Chemical constituents of raw and cooked sweet potato:**

Moisture, protein, total fat, ash and crude fiber were determined in raw materials (raw sweet and cooked sweet potato) and also, some minerals as calcium, potassium and magnesium were determined according to AOAC **(2012).**

**Preparation of biscuits sample:**

Samples were prepared with biscuits supplemented with raw sweet and cooked potato powder was prepared at 3 levels (10, 20 and 30%). The best results were chosen based on the sensory evaluation by trained panelists. Biscuits sample supplemented with 10% raw sweet potato and 30% cooked sweet potato were used in a biological experimental.

**Preparation of biscuits:**

Marie type biscuits were prepared according to a commercial formula and baking in Bisco Misr Company. The base recipe is given in table (1) wheat flour was replaced with raw sweet potato powder and cooked sweet potato powder) at levels 10, 20 and 30 %. After baking at 220$^{o}$C for 12 minutes and cooling for 30 minutes, the biscuits were packed into polythene bags for chemical and sensory evaluation.

**Organoleptic Evaluation**

The organoleptic evaluation of biscuits was carried out using a panel test according to **Sudha *et al.*(2007).** The trained panelists of Nutrition and Food Sciences Dept., Faculty of Home Economics, Al-Azhar University were asked to evaluate the biscuits for color, texture, acceptability, odor, hardness and taste The results were subjected to the statistical analysis according to the least significant differences test at $p<0.05$ level was used to verify the differences among treatments.

**Table (1): Biscuits supplemented with raw and cooked sweet potato powder at levels 10 and 30%.**

| Ingredients | Control | Raw sweet potato10% | Cooked sweet potato30% |
|---|---|---|---|
| Wheat flour 72% extraction | 100g | 90g | 70 g |
| Egg | 20g | 20g | 20g |
| Sucrose | 30g | 30g | 30g |
| Vegetable oil | 35g | 35g | 35g |
| Vanillin | 0. 4g | 0. 4g | 0. 4g |
| Salt | 0.15g | 0.15g | 0.15g |
| Ammonium bicarbonate | 1.2g | 1.2g | 1.2g |
| Water | 10-15ml | 25ml | 10ml |

**Biological experimental**

**A) Animals**

Male Albino rats (n = 24) of Sprague Dewey Strain weighting (150 ± 10 g) were kept in single wire cages with wire bottoms under hygienic conditions. The diet was fed in Table (2) according to **Pell *et al*. (1992).** Also, water was provided to the rats by glass tube projection through the wire cages. Food and water were provided *ad-libitum* and checked daily.

**Table (2): Percentage composition of the experimental diet (g/100 g).**

| Diet | Control (-) | Control (+) | RSPFP (Row) | CSPFP (cooked) |
|---|---|---|---|---|
| Casein | 10 | 10 | 10 | 10 |
| Vitamin mixture | 1 | 1 | 1 | 1 |
| Salt mixture | 4 | 4 | 4 | 4 |
| Cellulose | 5 | 5 | 5 | 5 |
| Corn oil | 10 | 10 | 10 | 10 |
| Starch | 70 | 70 | 60 | 40 |
| Powdered | | | 10 | 30 |

The rats were randomly divided into two main groups, the first main group-containing (6) rats as a negative control group fed on basal diet. The second group (18) rats were injected by120 mg/kg body weight of alloxan monohydrate in normal saline water in a volume of about 3 mL. After 72 hours of alloxan injection, we were done urine examination each to rat, the diabetic rats (glucose level >250 mg/dL) according to **Yaday *et al.* (2008).** The second diabetics' rats group was re-divided to the positive group fed on basal diet. In addition, two diabetics' rats' groups were fed on diet containing 10 and 30% raw and cooked sweet potato.

The body weight rats were recorded every week and at the end of the experimental period, rats were fasted overnight and anaesthetized using diethyl ether and blood samples were taken and centrifuged at 5000 r p.m for 15 minutes to separate serum, and then kept in plastic vials at – 20 $^{o}$C until analysis.

Blood glucose was determined according to the method described by **Trinder, (1969).** Liver function enzymes as AST and ALT were determined in the serum according to the method described by **Murray (1984), whereas,** alkaline phosphates (ALP) was determined according to **Wenger and Kaplan, (1984).** Kidney functions serum urea and creatinine were determined according to **Kaplan, (1984) and Murray (1984),**

Total Cholesterol was determined in the serum according to the method described by **Allain *et al.*(1974**) Serum HDL –C, LDL-C and VLDL –Cwere determined according to **Friedwald *et al.* (1972).**Triglycerides were determined in the serum according to the method described by **(Trinder and Ann, 1969).**

**Histological analysis:**

Specimen of the pancreas was taken immediately after sacrificing rats and immersed in 10 % neutral buffered formalin, the fixed specimens were then trimmed and dehydrated in ascending grades of alcohol, cleared in xylene, embedded in paraffin, sectioned (4-6 micro thickness), stained with hematoxylen –eosin and examined microscopically **(Carleton, 1979).**

**Statistical analysis:**

Statistical analysis was carried out using the programme of Statistical Package for the Social Sciences (SPSS), PC statistical software (Version 11; Untitled – SPSS-Data Editor). The results were expressed as mean ± standard error (mean ± S.E.). Data were analyzed using one way classification, analysis of variance (ANOVA). The difference between means were tested for significance using least significant difference (**Duncan, 1955) test** at $P<0.05$**.** Independent T test was also used to determine the statistical difference between two means.

## RESULTS AND DISCUSSION

**Chemical analysis of raw and cooked sweet potato:**

Results in Table (3) showed that chemical analysis of the raw sweet potato and cooked sweet potato. Cooked sweet potato has the highest value in moisture (8.37±0.42) and total carbohydrates (72.65±0.38) followed by raw sweet potato (7.06±0.04 and 69.41±0.62), respectively. While the highest value of protein and fiber were recorded for raw sweet potato (5.19±0.17and 13.22±0.85) then cooked sweet potato (4.27±0.32 and10.15±0.86). Sweet potato cooked and raw were recorded the highest value in ash and potassium (4.43±0.50, 1.58±0.26) and (2.97±0.19, 0.83±0.07), respectively. In addition the highest value in calcium and Mg were recorded for cooked sweet potato (0.14±0.01, 0.15±0.03) followed by raw sweet potato (0.09±0.01 and 0.13±0.03).

The result of proximate analysis of orange sweet potato flour indicated that it contained 68.92% carbohydrate, 5.32% crude protein, ether extract 2.10% ash and 0.80% crude fiber **(Samiha, 2015).**

Sweet potato (SP) flour showed that the range of values for the composition of flour had contained high amounts the chemical constituents like moisture content (8.06–12.86%), protein (0.55–5.87%), fat (0.04–1.45%), fiber (0.08–5.54%), ash (0.15–2.09%) and carbohydrate (74.55–90.92%),

respectively. (**Ganiyat *et al.* 2016)**. Also, **Rodrigues *et al.*, (2016)** showed the chemical composition of orange sweet potato flour that contains moisture, ash, protein, fats, starch, fiber, total carbohydrates. The mean values were 10.97± 0.95, 2.11± 0.12, 4.80± 0.24, 0.39± 0.03, 33.66± 3.76, 2.57± 0.14 and 90.13±8.35, respectively.

**Table (3): Chemical analysis of raw and cooked sweet potato g/100g**

| Components% | Raw Sweet Potato | Cooked Sweet Potato |
|---|---|---|
| Moisture% | 7.06±0.04 $^{b}$ | 8.37±0.42$^{a}$ |
| Total Carbohydrates% | 69.41±0.62$^{b}$ | 72.65±0.38 $^{a}$ |
| Protein% | 5.19±0.17$^{b}$ | 4.27±0.32$^{c}$ |
| Fat% | 1.58±0.35$^{a}$ | 0.00±0.00$^{c}$ |
| Fiber% | 13.22±0.85$^{b}$ | 10.15±0.86 $^{c}$ |
| Ash% | 2.97±0.19$^{c}$ | 4.43±0.50 $^{b}$ |
| Calcium mg/100g | 0.09±0.01$^{b}$ | 0.14±0.01$^{b}$ |
| Potassium mg/100g | 0.83±0.07$^{c}$ | 1.58±0.26$^{b}$ |
| Magnesium | 0.13±0.03$^{b}$ | 0.15±0.03 $^{b}$ |

Means in the same column with various letters are significantly varied at ($p<0.05$).

**Sensory evaluation of biscuits:**

Sensory evaluation of biscuits supplemented with raw and cooked sweet potato at levels 10, 20, 30%, respectively, compared with control biscuit made from wheat flour 72% extraction and the finding are tabulated in Table (5). From the results it cleared that the best results of the sensory evaluation were indicated the use of both 10% raw and 30% cooked sweet potato powder and support for rat fed with these proportions.

Sensory evaluations revealed that biscuits produced from ratio wheat flour 72% extraction as control were not significantly influenced ($p\leq0.05$) in taste than biscuits were prepared from sweet potato at level 10 and 30%. In this respect **(Onabanjo and Ighere, 2014)** reported that the color and overall acceptability between biscuits produced at levels 10, 30, 40 and 50% potato flour had no significant variation than control biscuit during the evaluation. Moreover, most of the panelist reported that biscuits made from ratio 10and 30% were more acceptable

**Table (4): Sensory evaluation of biscuits supplemented with raw and cooked sweet potato powder compared to control**

| Groups | Color | Taste | Oder | Texture | Acceptability | Hardness |
|---|---|---|---|---|---|---|
| Control | 8.78±1.42 [a] | 8.33±1.47 [a] | 4.26±0.82 [a] | 4.05±0.65 [a] | 8.47±1.15[a] | 8.71±1.29 [a] |
| Raw potato 10% | 8.10±1.27 [ab] | 8.05±1.30[ab] | 3.87±0.80 [ab] | 4.08±0.62 [a] | 8.28±1.28[ab] | 8.51±1.70 [a] |
| Raw potato 20% | 7.82±1.68 [b] | 7.38±2.12 [b] | 3.79±1.10 [b] | 4.03±0.87 [a] | 7.72±2.49[ab] | 8.97±0.99 [a] |
| Raw potato 30% | 7.59±1.77 [b] | 7.44±1.92 [b] | 3.64±0.99 [b] | 3.85±0.84 [a] | 7.49±1.90 [b] | 9.1±1.1.19 [a] |
| Cooked potato 10% | 7.69±1.96 [b] | 7.56±1.57 [a] | 3.72±0.89 [b] | 3.72±1.00 [a] | 7.38±1.62[b] | 7.56±1.93 [b] |
| Cooked potato 20% | 8.05±1.50[ab] | 7.56±1.57 [a] | 3.90±0.85[ab] | 3.74±1.02 [a] | 7.49±1.70[b] | 7.56±1.87 [b] |
| Cooked potato 30% | 7.85±1.55[a] | 8.44±1.25 [a] | 4.10 ±0.94[ab] | 3.82±1.00 [a] | 7.69±1.70 [b] | 7.90±1.77 [b] |

Means in the same column with various letters are significantly varied at ($p<0.05$).

**Biological experimental**

**Influence of sweet potato powder on food intake (FI), body weight gain (BWG) and feed efficiency ratio (FER) on diabetic rats**

From the result in Table (4) showed that negative control recorded a significant increase in food intake and gain body weight (14.60±1.00 and 53.14±9.56 g) as compared to a positive control (11.35±1.68 and 34.95±7.49 g). No significant difference in food intake among the groups which were treated with 10% raw potato (13.48±2.17g) and 30% cooked potato (15.12±1.57g). Meanwhile, a significant difference in BWG between the groups which treated with 10% raw potato (45.28±8.45g), 30% cooked potatoes (42.33±9.91g) as compared to positive group (34.95±7.49g). In addition, the results from feed efficiency ratio was parallel the results from food intake and gain bodyweight.

The decreases in body weight may be caused by the elevate amount of feed consumed for the presence of protease inhibitor which had been found to lowering proteolytic enzyme activity, thereby reducing nutrient absorption **(Eusebio *et al*., 2004).**

**Akram *et al*. (2018)** demonstrated the body weight of diabetic rats after two week treatment with water extract of white skin sweet potato (WSSP) peel and found decrease in body weight was caused that the sweet potatoes are rich in dietary fibers and low glycemic index with decreasing digestion and delays gastric emptying time**.**

**Table (5): The effect of sweet potato powder on feed intake, body weight gain and feed efficiency ratio in diabetic rats**

| Groups | FI (g)/d | BWG (g) | FER |
|---|---|---|---|
| Negative control | 14.60±1.00[a] | 53.14±9.56[a] | 0.13±0.01[a] |
| Positive control | 11.35±1.68[b] | 34.95±7.49[c] | 0.11±0.03[ab] |
| 10% raw potato | 13.48±2.17[a] | 45.28±8.45[ab] | 0.12±0.02[ab] |
| 30% cooked potato | 15.12±1.57[a] | 42.33±9.91[b] | 0.10±0.02[b] |

Means in the same column with various letters are significantly varied at ($p<0.05$).

**Influence of sweet potato powder on lipid profile and glucose on diabetic rats**

Lipid profile as triglycerides, total cholesterol, cholesterol fractions and glucose in serum were determined in diabetics' rats groups and the results are reported in Table (6).

Results demonstrated that, positive control markedly recorded high significant increase in serum glucose (146.33±13.47mg/dl) as compared to negative control group 87.00±3.58). Percentage of increase in serum glucose was 68.2%.The nearest results for normal group were noticed in group treated with 10%raw potato (97.83±11.3647mg/dl) followed by treated with 30% cooked potato (126.00±15.7647mg/dl). These results are confirmed with **Srijita (2015)** suggested that sweet potatoes are a good food choice for diabetics; it could be high in fiber and lowering blood sugar. Therefore can assistance diabetics control their blood sugar.

**Shaohualiu and Yunong (2016)** observed that the sweet potato residue cellulose can be lowering the intestinal absorption of glucose and prevent postprandial hyperglycemia and inhibition the propagation of glucose and lipids; by lowering intestinal absorption of glucose and lipid, which is the synergistic influence of decreasing blood glucose.

Results from the same table observed that the positive control group recorded significant increase in total cholesterol (124.12±25.8047mg/dl) as compared to negative control group (83.49±4.9447mg/dl). The best results were recorded for groups which treated with 10% raw potato (101.17±4.4547mg/dl) followed by 30% cooked potato (116.50±5.8647mg/dl). These results are agreement with **Omodariniro and Omodamiro (2018)** who found that the sweet potato is a good anti-lipidemic plant and in addition serve as the best means of diabetes administration. Furthermore, total cholesterol in diabetic rats elevated than control and metformin-treated rats. This could be caused an increase in mobilization of free fatty acids from peripheral fat deposited. Management of aqueous sweet potato extract decreased the serum total cholesterol, TG and LDL concentrations while it significantly elevated the concentration of HDL (**Rafiu and Luka, 2018).**

It was cleared that positive control group recorded significant decrease in HDL (37.40±1.62mg/dl) as compared to negative control group (49.17±5.7847mg/dl). It was showed that positive control group recorded significant increase in LDL (63.25±9.3747mg/dl) as compared to negative control (17.47±8.74). The best results were recorded for groups which treated with 10% raw potato (39.67±5.41).**Trindad *et al*., (2013)** proved that sweet potato and cassava are good sources of dietary fiber and resistant starch. Sweet potato and cassava increased HDL-C and lowering LDL-C in humans with moderately raised serum glucose and cholesterol levels. Possible intake of sweet potato and cassava could be favorable in the protection for the danger of cardiovascular diseases in addition to obesity and type 2 diabetes mellitus.

It was found that positive control group recorded significant increase in T.G and VLDL (117.40±12.8 and 23.47±2.4447mg/dl) as compared to negative group (84.85±5.28, 16.85±1.22 47mg/dl, respectively). While there were no significant difference in T.G and VLDL among all treated and negative control group. Group that treated with 10% raw sweet potato recorded significant decrease in T.G (87.50±5.4747mg/dl) and VLDL (17.50±1.0947mg/dl).

**Table (6): Effect of sweet potato powder on lipid profile and glucose in serum of diabetic rats**

| Groups | T.C (mg/dL) | T.G (mg/dL) | HDL (mg/dL) | LDL (mg/dL) | VLDL (mg/dL) | Glucose (mg/dL) |
|---|---|---|---|---|---|---|
| Negative control | 83.49 ±4.94$^{c}$ | 84.85 ±5.28$^{b}$ | 49.17 ±5.78$^{a}$ | 17.47 ±8.74$^{e}$ | 16.85 ±1.22$^{b}$ | 87.00 ±3.58$^{d}$ |
| Positive control | 124.12 ±25.80$^{a}$ | 117.40 ±12.8$^{a}$ | 37.40 ±1.62$^{c}$ | 63.25 ±9.37$^{a}$ | 23.47 ±2.44$^{a}$ | 146.33 ±13.47$^{a}$ |
| 10% raw potato | 101.17 ±4.45$^{bc}$ | 87.50 ±5.47$^{b}$ | 44.00 ±2.53$^{b}$ | 39.67 ±5.41$^{c}$ | 17.50 ±1.09$^{b}$ | 97.83 ±11.36$^{cd}$ |
| 30% cooked potato | 116.50 ±5.86$^{b}$ | 92.67 ±8.04$^{b}$ | 42.33 ±2.42$^{b}$ | 54.88 ±4.96$^{b}$ | 18.28 ±3.23$^{b}$ | 126.00 ±15.76$^{b}$ |

Means in the same column with various letters are significantly varied at ($p<0.05$).

**Influence of sweet potato powder on liver functions in diabetic rats**

Result in Table (7) illustrated that the positive control group recorded a significant increase in AST and ALT (75.55±17.87 and 42.93±7.44 U/L) as compared to the negative control group (42.60±4.50 and 25.40±4.50 U/L) While there were no significant differences in AST and ALT between groups treated with 10 and 30% raw and cooked potatoes were gradually decreased.

AST and ALT activities act as an indicator of liver function, thus the reconquest of these enzymes after the management of *Ipomoea batatas*, point

out that the normal functioning of the liver and the bile duct was restored (**Udayakumar *et al.*, 2009).**

In the same table, it was noticed that the positive control group recorded a significant increase in ALP (3.58±0.53 U/L) as compared to negative control group (2.58±0.26 U/L). The rats' groups were treated with 10 and 30% raw and cooked potatoes and the results were decreased to 3.20±0.33 and 3.25±0.60U/L, respectively, compared to control positive. The decreasing in ALP activity following *Ipomoea batatas* treatment found its stability of biliary function versus the risk due to by alloxan **(Latha*et al*., 2013).**

**Table (7): Effect of sweet potato powder on some liver functions in serum of diabetic rats**

| Groups | AST (U/L) | ALT(U/L) | ALP (U/L) |
|---|---|---|---|
| **Negative control** | **42.60±4.50$^{c}$** | **25.40±4.50$^{b}$** | **2.58±0.26$^{b}$** |
| **Positive control** | **75.55±17.87$^{a}$** | **42.93±7.44 $^{a}$** | **3.58±0.53 $^{a}$** |
| **10% raw potato** | **70.00±10.73$^{a}$** | **32.60±6.83 $^{b}$** | **3.20±0.33$^{a}$** |
| **30% cooked potato** | **65.83±5.78$^{ab}$** | **26.75±3.87$^{b}$** | **3.25±0.60$^{a}$** |

Means in the same column with various letters are significantly varied at ($p<0.05$).

**Effect of sweet potato powder on kidney functions in serum of diabetic rats**

In Table (8) observed that there were no significant difference in urea among negative control group, positive control group, group treated with 10%raw potato. The values were (42.40±2.42, 46.83±5.34 and 41.60±5.71 mg/dL respectively) and slightly significant decreased was recorded in group treated with 30% cooked potato was 38.83±5.56 mg/dL. In the same table the positive control group recorded significant increase in creatinine (0.92±0.10 mg/dL) as compared to negative control (0.63±0.10 mg/dL. The best results were recorded for groups which group treated with 30% cooked potato (0.67±0.05 mg/dL) followed by 10% raw potato (0.83±0.14 mg/dL). These results are confirmed with **Abd-Elmeged and Alzahrani (2018)** improved that diabetic rats fed on taro, carrot, sugar beet and sweet potato showed significant decrease of urea and creatinine compared to diabetic groups.

Purple sweet potato tuber extract lowers mallondialdehyde and improves plasma glucose through several mechanisms, and that the extract was safe for the liver and kidney functions (**Mahadita*et al*, 2016).**

**Table (8): Effect of sweet potato powder on kidney functions in serum of diabetic rats**

| Groups | Urea(mg/dL) | Creatinine(mg/dL) |
|---|---|---|
| **Negative control** | 42.40±2.42$^{ab}$ | 0.63±0.10$^{b}$ |
| **Positive control** | 46.83±5.34 $^{a}$ | 0.92±0.10 $^{a}$ |
| **10% raw potato** | 41.60±5.71$^{ab}$ | 0.83±0.14$^{a}$ |
| **30% cooked potato** | 38.83±5.56$^{b}$ | 0.67±0.05$^{b}$ |

Means in the same column with various letters are significantly varied at ($p<0.05$).

**Histopathological experimental to pancreas in diabetic rats**

Pancreas of rat from control negative group revealed that no histopathological changes (Photo.1). Meanwhile, pancreas of rat in group-2 (control positive rats) showed a vaculation of cells of islets of Langerhans's and congestion of pancreatic blood vessels (Photo.2). Pancreas of rat in Group 3 resaved with (10% raw potato) showed no histopathological changes (Photo.3) but, pancreas of rat in-group 4 treated with (30% cooked potato) showed a congestion of pancreatic blood vessels (Photo.4). These results are agreement with**Al-Qudah *et al.* (2016**) who found that in diabetic control rats, abnormalities in the pancreas were found. The congestion of RBCs in blood vessels, in addition, thickening of the septa, was clearly shown. Furthermore, the islets of Langerhans have been prominently varied and a slight differences in its cells was noticed as appear **(Al-Qudah *et al.*, 2016**).

Microscopic histopathological of pancreatic tissues observed a marked lower in the islets of Langerhans size accompanied by a significantly reduced in the number of β-cells, insulin-secreting cells, in the diabetic group. These abnormalities were healed after therapy of diabetic rats with BV, which could have the ability to regenerate beta cells of islets of Langerhans. (**Elkotby *et al.*, 2018).**

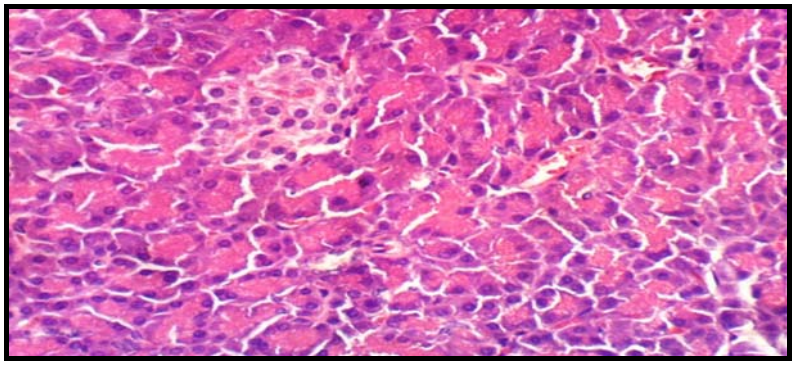

**Photo (1): Pancreas of rat from group 1 (control negative) showing no histopathological changes (H & E X 400)**

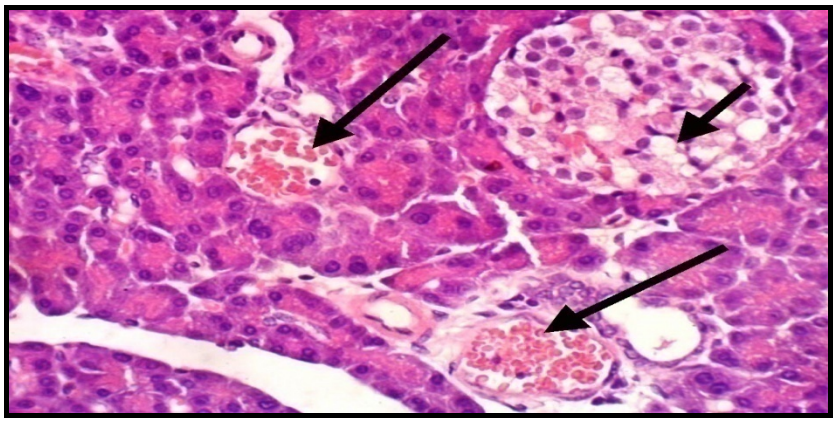

**Photo (2): Pancreas of rat from group 2 (control positive) showing vaculation of cells of islets of Langerhans's and congestion of pancreatic blood vessels (H & E X 400).**

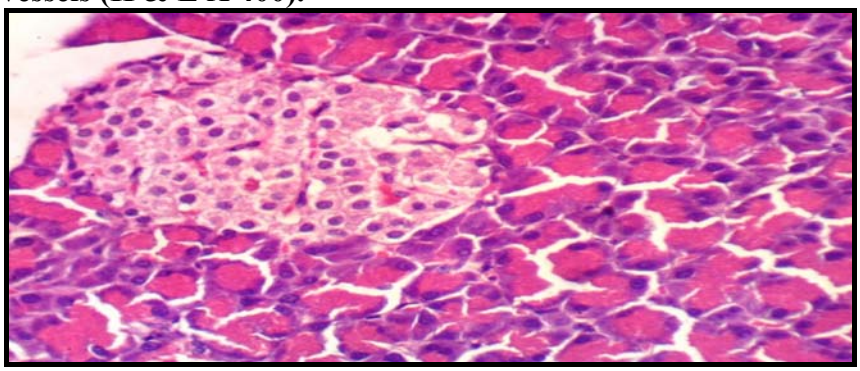

**Photo (3): Pancreas of rat from group 3 (10% row potato) showing no histopathological changes (H & E X 400).**

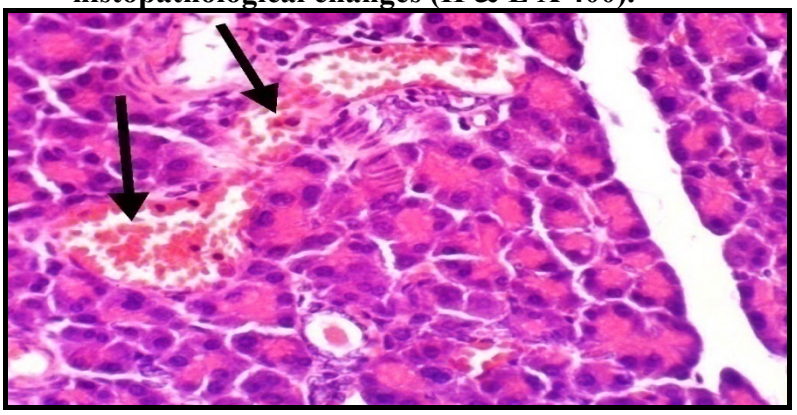

**Photo (4): Pancreas of rat from group 4 (30% cooked potato) showing congestion of pancreatic blood vessels (H & E X 400).**

## CONCLUSION

From the obvious results, it could be concluded that the potato raw and cooked had contained high amounts of carbohydrates, protein, fiber and some minerals. The biological experimental was fed on 10% raw potato and 30% cooked potato and the results observed that the glucose level, lipid profile, liver and kidney functions were improved in diabetics' rats' group. Therefore, it could be recommended that the biscuits prepared from 10and 30% from raw and cooked sweet potatoes had contained a good source of nutrition value and improved lipid profile and glucose in the blood.

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## الملخص العربى

## تأثير استخدام مسحوق البطاطا على الفئران المصابة بأرتفاع السكر فى الدم

يهدف البحث لمعرفة تأثير العلاج بمسحوق البطاطا الحلوة النيئة والمطبوخة على الفئران المصابة بأرتفاع فى سكر الدم. تم استخدام ما مجموعه ٢٤ من الفئران البيضاء الذكور البالغين من سلالة"Sprague Dawley" (150±5جم) وتم تقسيمها عشوائيًا إلى أربع مجموعات متساوية،المجموعة القياسية السالبة ، المجموعة القياسية الإيجابية ، في حين تم علاج المجموعتين الأخريين بنسبة ١٠ ٪ من البطاطس الخام و ٣٠٪ البطاطس المطبوخة حسب التقييم الحسي للبسكويت. استمرت التجربة لمدة ٢٨ يومًا. وشملت القياسات تقدير الجلوكوز ، وظائف الكبد ، وظائف الكلى والكوليسترول الكلى والجليسريدات الثلاثية والليبوبروتين منخفض ومرتفع الكثافة وتحليل الأنسجة البنكرياسية.

أشارت النتائج إلى المجموعة القياسية الإيجابية زاد زيادات كبيرة في الجلوكوز في المصل ، بالإضافة إلى زيادة كبيرة في وظائف الكبد والكلى ، والكوليسترول الكلى والجليسريدات الثلاثية وانخفاضالليبوبروتين مرتفع الكثافة مقارنا مع المجموعة القياسية السالبية، كما لوحظت تغييرات نسيجية غير طبيعية فى البنكرياس بسبب أرتفاع سكر الدم. البطاطا الحلوة الخام والمطبوخة كان لها تأثيرات مضادة للسكري وانخفاض الجلوكوز في مصل الدم. علاوة على ذلك ، خففت من التشوهات التي يسببها الألوكسانفي وزن الجسم ، وظائف الكبد والكلى. وبناءً على ذلك ، توصي هذه الدراسة مرضى السكري بتناول البطاطا الحلوة بانتظام على ١٠% والبطاطا الامطهية بنسب ٣٠% حيث يمكنهم إحداث تحسن في زيادة نسبة السكر في الدم.

مفتاح الكلمات: سكر الدم– الألوكسان– البطاطا الحلوة– شكل اللبيدات