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EFFECT OF *BALANITES AEGYPTIACA* (HEGLIG DATES) AND *PERSEA AMERICANA* (AVOCADO FRUIT) ON SOME HEMATOLOGICAL AND BIOCHEMICAL PARAMETERS IN STREPTOZOTOCIN INDUCED DIABETIC MALE RATS.

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ABSTRACT

Diabetes is a syndrome of impaired carbohydrate, fat and protein metabolism caused by either lack of insulin secretion or decreased sensitivity of the tissues to insulin. Diabetes mellitus is the most common endocrine disease worldwide. Diabetes mellitus was induced by injection streptozotocin intraperitonealy at dose 47 mg/kg body mass. The present study was designed to investigate the possible therapeutic effects of *Balanites aegyptiaca (Heglig dates) and Persea americana (Avocado fruit)* water extracts on some hematological and biochemical parameters in streptozotocin diabetic rats at doses 100 mg/kg and 500 mg/kg body mass respectively for 30 days. Treatment extracts were given orally through a gavage tube. The current results revealed a significant decrease in RBCs, WBCs counts, Hb concentration, MCHC, serum total protein, albumin, insulin and C-peptide level in diabetic rats. On the other hand a significant increase was recorded in MCV value, serum glucose and Hb A1c level in diabetic group in comparison with the control group. Treatment with Balanites aegyptiaca, Persea americana revealed an improvements in these parameters.

Keywords: Balanites aegyptiaca(heglig dates); Persea americana (avocado); Diabetes mellitus; Streptozotocin; Kidney function, Hematology.

1. INTRODUCTION

Diabetes is most known metabolic disorder characterized by high level of blood glucose resulting from defects concerning insulin secretion, insulin action, or both. Diabetes is divided into three types, Type I diabetes, which occurs when the body failed to produce enough insulin, the primary hormone in the body responsible for regulating the level of sugar within our blood stream. This condition can usually be treated effectively with insulin injections. Type I diabetes is a relatively rare immunological disorder. Till now there is no definite preventive measure against type 1 diabetes. All people even the healthy are susceptible to the disease. They always show normal sensitivity and response to insulin especially in the early stages. Type 1 diabetes traditionally termed "juvenile diabetes" because a majority of these diabetes cases were in children. On other side 95% of diabetes cases are Type II diabetes which results mostly due to a combination of insulin resistance and an inadequate compensatory insulin secretory response **(Kamal Eldin and Ogail 2013).**

Streptozotocin is well known for its selective pancreatic islet β-cell cytotoxicity and has been extensively used to induce diabetes mellitus in animals. It interferes with cellular metabolic oxidative mechanisms **(Papaccio, *et al.*, 2000)**.

The phytochemical constituents of the medicinal plants, revealed the presence of secondary metabolites that were shown to have hypoglycemic and hypolipidemic effects such as Saponins, alkaloids, flavonoids, tannin, phenol derivatives and Terpenoids **(Tanko *et al.*, 2007)**.

Medicinal plants are known to exhibit many biological activities from the ancient period. They were applied in the alternative medicine for the treatment of various diseases. They were proved to possess many of the phytochemical constituents that were responsible for the actual mechanism of the activities. One such plant possessing the novel biological activities is *Balanites aegyptiaca.* They possess many biological activities such as antimicrobial, antioxidant, anti diabetic, antiasthmatic, etc. They were found to be toxic to pests, molluscs and larvae. They possess pharmacologically active substances such as flavonoids, saponins in their callus culture. Their anti-inflammatory activity has been

known from the ancient period. The plant possesses promising applications for the drug development and research purposes. This review summarizes the biological activities of the plant obtained from the literature **(Gajalakshmi *et al.*, 2013).**

Pranay and Varma, (2013) concluded that, erythrocyte count, haemoglobin, packed cell volume, mean corpuscular volume, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration were decreased in diabetic rats.

Eman, *et al.* (2013) reported that, diabetic group recorded hyperglycemia, hypoinsulinemia, significant increase in some parameters of liver and kidney functions, changes in proteins level and decreased liver glycogen content. While, treatment with *Balanites aegyptiaca* (seeds) was ameliorated most of the toxic effects of alloxan (chemical component induce diabetes) and showed partially improvement in histological changes produced by alloxan. The aqueous extract of *Balanites aegyptiaca* (seeds) has hypoglycemic, hypolipidemic effects, increasing insulin level, and decreasing insulin resistance.

Supplementation of *Balanites aegyptiaca* kernel cake 10% and 20% to diabetic rats for Three weeks significantly reduced blood glucose, urea, and creatinine but increased the levels of albumin. The same study showed that, *Balanites aegyptiaca* kernel cake has an anti hyperglycaemic and anti hyperlipidemic effect and consequently may decrease liver and renal damage associated with alloxan induced diabetes mellitus in rats **(Nadro and Samson, 2014)**.

Persea americana seeds (96% ethanolic extract) at doses of 300; 600 and 1200 mg / kg. body mass can reduce blood glucose levels in diabetic rats induced by alloxan **(Sutrisna *et al.*, 2015).** The ethanolic extract of avocado leaves (*Persea americana*) (Lauraceae) has a hypoglycemic effect in diabetic rats induced by Streptozotozin **(Gondwe *et al.*, 2008)**.

Edem, *et al.* (2009) found that, the aqueous extract of avocado seeds (*Persea americana*) at doses of 300 mg and 600 mg / kg bw was able to reduce blood glucose levels in normal mice and rats induced diabetes by alloxan. The decline of blood glucose levels in rats induced by alloxan are 73.26-78.24%.

Mahadeva, *et al.* (2011) reported a significant decrease in the plasma insulin level in diabetic rats, which have been elevated to near normal after treatment with avocado fruit extract, suggesting the insulin stimulative effect of *Persea americana* fruit.

A significant recovery was noted in the level of serum insulin, glycosylated hemoglobin, activities of carbohydrate metabolic enzymes and serum transaminases after treatment with methanolic extract of Persea americana in streptozptozotocin induced diabetic group in respect with other treated groups. Glycosylated hemoglobin was increased significantly in diabetic group in comparison with the positive control group. After administration of *Avocado* extract in STZ-induced diabetic rat, the level of this parameter was recovered towards the control level **(Thenmozhi, *et al.* 2012).**

Anthonet *et al.* (2013) recorded the significant hypoglycaemic effect and reversed histopathological damage that occurred in alloxan-induced diabetic rats after treatment with avocado fruit aqueous extract. The same author observed that, three weeks of daily, oral *Persea americana* aqueous extract treatment (20, 30, or 40 mg/L) significantly reduced the blood glucose levels of diabetic rats. The reductions that were observed when treating with plant extracts compared to those of the positive control ranged from 45.8% to 58.9%. Administration of *Persea americana* increased the body weight of alloxan-induced diabetic rats in comparison to control group.

MATERIALS AND METHODS

Chemicals:

Streptozotocin solution was prepared by dissolving 1 g of streptozotocin powder in 100 ml saline solution 0.9 N NaCl. Streptozotocin solution was injected intraperitonealy at dose 47 mg/kg rat's body mass **(Hosseini, *et al.* 2012)**

Experimental animals:

Rats obtained from the animal house of Zoology department, Science Faculty, Al-Azhar University in Cairo, all animals are placed in regular designed cages and maintained in conditions of good ventilation, normal temperatures, and humidity range for seven days after Transfer, with free access to food and water.

Experimental design:

40 adult male rats (*Rattus norrvegicus*) average weight (180-200 g) were conducted in accordance with the criteria of the investigations and Ethics Committee of the Community Laws governing the use of experimental animals. Animals were divided equally into 5 groups, each group contains 8 rats:

Group 1: Control group.

Group 2: Diabetic group.

Group 3: Rats treated orally with *Balanites aegyptiaca* (Heglig dates) 100 mg/kg. b.w. for 30 days.

Group 4: Rats treated orally with *Persea americana* (Avocado) 500 mg/kg. b. w. for 30 days

Group 5: Rats treated orally with Heglig dates + Avocado mixture treated group for 30 days.

Induction of diabetes:

Diabetes mellitus was induced by interperetonial injection of streptozotocin in a single dose at (47 ml/kg) diluted in saline solution for all animals except 8 rats which will be the negative control group.

Blood Samples collection:

At the end of the experiment all animals were sacrificed and blood samples were collected on 3 parts, 1st part collected on EDTA (Ethylene diamine tetra acetic acid) for hematological measurements, 2nd part collected on sodium fluoride for glucose profile and 3rd part collected without anti coagulant and centrifugated for 10 minutes at 3000 r.p.m. for biochemical parameters.

Hematological parameters:

Red blood cells count and hematocrit value, WBCs count and blood indices calculation were determined according to the method of **(Zaakouk, 2005).**

Biochemical parameters:

Urea enzymatic was determined according to the method of **Patton and Crouch, (1977)**, colorimetric determination of serum uric acid was determined by the method of **Fassati, (1982),** colorimetric determination of serum creatinine was measured by **Young, (1975),** serum total protein was determined according to the method described by **Henry, (1991),** serum albumin was determined according to the method of **Doumas, *et al.*, (1971)**, serum blood glucose was determined according to the method of **Trinder, (1969),** using kit from Elitech diagnostic Co., glycosylated hemoglobin was measured by the method of **Nathan, (1984),** serum insulin and C-Peptide levels were estimated according to the enzyme linked immune Sorpetant assay (ELISA) Microplate method described by **Eastham (1985),** using the kits of Diagnostic automation.

Statistical analysis

The statistical package for social sciences SPSS/PC computer program (version 19) was used for statistical analysis of the results. Data were analyzed using one-way analysis of variance (ANOVA). The data were expressed as mean ±S.D. Differences were considered statistically significant at ($P < 0.05$) **(Turner and Thayer, 2001)**.

RESULTS:

Data in table (1) showed a significant decrease ($p < 0.05$) in RBCs count, WBCs count and hemoglobin concentration in diabetic group when compared the control group. The treatment with plant extracts (heglig dates and avocado fruit in combination together) revealed an improvement in RBCs count, WBCs count and Hb concentration.

Rats injected with streptozotocin recorded a significant increase ($p < 0.05$) in mean corpuscular volume (MCV) value while insignificant increase was observed in mean corpuscular hemoglobin (MCH) value. In contrast, a significant decrease ($p < 0.05$) was noticed in mean corpuscular hemoglobin

concentration (MCHC) value in comparison with the control group. On the other hand, rats treated with heglig dates and avocado fruit alone or together showed an improvement in MCV, MCH and MCHC values (table 2).

Resulted data in tables (3 & 4) revealed a significant decrease ($p < 0.05$) in serum total protein, albumin, glucose and Hb A1c level in diabetic group when compared with the control group. The treatment with heglig dates and avocado fruit extracts alone and in combination together recorded an improvement in these parameters.

It is clear from table (5) that, rats injected with streptozotocin recorded a significant decrease ($p < 0.05$) in serum insulin level and C-peptide in comparison with the control rats. Groups treated with plant extracts (Heglig dates, avocado fruit and in combination together) revealed an improvement in serum insulin level and C-peptide.

Table (1): Hematological parameters (RBCs, WBCs, Platelets, Hb and Hct) in streptozotocin induced diabetic rats (*Rattus norvegicus*) treated with some medicinal plants (*Balanites aegyptiaca and Persea americana*) for 30 days.

Parameters / Groups	RBCs × 10^6, cell /mm^3	WBCs × 10^3, cell /mm^3	Hb, g/dl	Hct, %
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Control group	8.14 [a] 0.23	16.74 [a] 0.69	14.08 [a,e] 0.96	45.20 [a,c] 1.48
Diabetic group	6.22 [b] 0.31	11.18 [b,c,d,e] 2.86	11.02 [b,c] 0.65	42.80 [a] 4.15
Balanites aegyptiaca	6.98 [a,b] 1.30	10.22 [c,d,e] 0.87	13.36 [a,e] 1.86	44.00 [a,c] 4.00
Persea americana	6.66 [b,e] 1.69	11.26 [d,e] 3.38	12.70 [a,b] 1.93	41.60 [a] 6.27
Balanites + Persea	7.56 [a,e] 1.81	10.78 [f,b,c,d,e] 2.56	14.34 [a,d] 2.12	46.60 [a,c] 5.64

Each value represented means of 8 animals ± S.D.

a, b, c, d, e means comparison between all groups, groups having the same superscript letters mean there is no significance difference between them and groups which have different letter mean there is a significance change.

Table (2): Mean values ± S.D. of MCV, MCH and MCHC values in streptozotocin induced diabetic rats (*Rattus norvegicus*) treated with some medicinal plants (*Balanites aegyptiaca and Persea americana*) for 30 days.

Parameters / Groups	MCV, μ^3	MCH, Pg	MCHC, %
	Mean ± SD	Mean ± SD	Mean ± SD
Control group	55.60 [a] 3.26	17.29 [a] 0.91	31.20 [a,d,c] 2.74
Diabetic group	68.99 [b] 7.89	17.75 [a,d] 1.36	26.07 [b] 4.28
Balanites aegyptiaca	64.26 [c,d,b] 8.66	19.31 [a,b,c] 1.29	30.29 [d] 2.39
Persea americana	64.02 [a,b,c] 8.52	19.56 [b,d] 2.80	30.59 [a,d] 2.13
Balanites + Persea	63.23 [a,b,c] 8.41	19.40 [a,b] 2.67	30.79 [e] 2.69

Each value represented means of 8 animals ± S.D.

a, b, c, d, e means comparison between all groups, groups having the same superscript letters mean there is no significance difference between them and groups which have different letter mean there is a significance change.

Table (3): Serum total protein and albumin levels in streptozotocin induced diabetic rats (*Rattus norvegicus*) treated with some medicinal plants (*Balanites aegyptiaca and Persea americana*) for 30 days.

Parameters / Groups	Total protein, g/dl	Albumin, g/dl
	Mean ± SD	Mean ± SD
Control group	7.56 [a] 0.48	3.56 [a] 0.27
Diabetic group	6.44 [b,c,d,e,f] 0.43	2.80 [b,c,d,e] 0.24
Balanites aegyptiaca	6.46 [c,d,e,b,f] 0.30	2.88 [c,d,e] 0.20
Persea americana	6.34 [d,e,b,f] 1.10	2.78 [d,e,b] 0.49
Balanites + Persea	6.96 [a,b,g] 0.42	3.04 [f,b,c] 0.28

Each value represented means of 8 animals ± S.D.
a, b, c, d, e, f, g means comparison between all groups, groups having the same superscript letters mean there is no significance difference between them and groups which have different letter mean there is a significance change.

Table (4): Serum glucose and glycosylated hemoglobin Hb A1-C levels in streptozotocin induced diabetic rats (*Rattus norvegicus*) treated with some medicinal plants (*Balanites aegyptiaca and Persea americana*) for 30 days.

Parameters / Groups	Glucose, mg/dl	Hb A1-C, %
	Mean ± SD	Mean ± SD
Control group	108.60 [a] 7.13	4.66 [a] 0.36
Diabetic group	410.20 [b] 45.63	8.10 [b] 1.43
Balanites aegyptiaca	209.40 [c] 48.29	6.72 [c,d,e] 1.56
Persea americana	278.60 [d,g] 28.42	7.02 [d,b] 0.44
Balanites + Persea	323.00 [g,f] 34.84	6.48 [g,c,d] 0.90

Each value represented animals of 8 animals ± S.D.
a, b, c, d, e, f, g means comparison between all groups, groups having the same superscript letters mean there is no significance difference between them and groups which have different letter mean there is a significance change.

Table (5): Serum insulin and C-peptide levels in diabetic rats (*Rattus norvegicus*) treated with some medicinal plants (*Balanites aegyptiaca and Persea americana*) for 30 days.

Parameters / Groups	Insulin, µIU/ml	C-peptide, ng/ml
	Mean ± SD	Mean ± SD
Control group	1.62 [a,d] 0.19	0.29 [a,d] 0.01
Diabetic group	1.26 [b] 0.31	0.22 [b] 0.02
Balanites aegyptiaca	1.92 [a,c] 0.33	0.27 [a,b] 0.04
Persea americana	1.70 [a,d,c] 0.16	0.35 [c,d,e] 0.09
Balanites + Persea	1.58 [a,b] 0.26	0.29 [a,c] 0.03

Each value represented means of 8 animals ± S.D.
a, b, c, d, e means comparison between all groups, groups having the same superscript letters mean there is no significance difference between them and groups which have different letter mean there is a significance change.

DISCUSSION:

In the current study, red blood cells count and Hb concentration showed a significant decrease in diabetic group in comparison to the control group. The decrease in total hemoglobin from normal to diabetic control albino rats may be due to the formation of glycosylated hemoglobin **(Anitha and Chandra, 2007).**

The occurrence of anaemia in diabetes mellitus has been reported due to the increased non-enzymatic glycosylation of RBC membrane proteins, which correlates with hyperglycemia. Oxidation of these proteins and hyperglycaemia in diabetes mellitus causes an increase in the production of lipid peroxides that lead to haemolysis of RBC **(Oyedemi *et al.*, 2011).**

A decrease in MCHC value was observed in diabetic mice when compared to control group. The MCHC expresses the concentration of haemoglobin in the cytoplasm of the erythrocytes. Increased level of blood glucose and decreased level of insulin decline capacity

to manufacture haemoglobin at the required rate in bone marrow, so the haemoglobin content of each cell has reduced MCHC value **(Suricuchi, *et al.*, 2002).**

The current results agreed with **Stookey, *et al.* (2007)** who stated a decrease, but not significantly, in MCH and MCHC values, observed after administration of STZ, is an indication of abnormal hemoglobin synthesis, failure of blood osmoregulation, and plasma osmolarity. Flavonoids can stimulate the formation or secretion of erythropoietin, which stimulates stem cells in the bone marrow to produce red blood cells. The stimulation of this hormone enhances rapid synthesis of RBC which is supported by the improved level of MCH and MCHC.

Ahamefule *et al.* (2008) stated that, decrease in number of WBC below the normal range is an indication of allergic conditions, anaphylactic shock and certain parasitism, while elevated values (leucocytosis) indicate the existence of a recent infection, usually with bacteria. The value for MCV and MCHC were higher in diabetic group and not affected after treatment with flavinoids (one of heglig dates components). This may be due to the negative interaction between protein and energy levels in the diets.

High WBC might indicate presence of infections. Platelet, percentage of lymphocyte and neutrophil were higher on the second day of diabetes induction and progressively reduced with increased treatment in balanites extract treated rats. Moreover the decrease in these parameters increased over time with administration of fruit mesocarp **(Salihu, *et al.*, 2013)**.

The current results showed a significant decrease in total protein and albumin levels in diabetic control group when compared to the control group. It is also revealed insignificant changes in all treated groups in comparison to the diabetic control group. These results agreed with **Matter and Helal, (2001)** who stated that, treatment with aqueous seeds extract of *B. aegyptiaca* showed insignificant change in total protein and albumin parameters when compared with the diabetic control group.

In addition, the decrement of total protein and albumin in diabetic rats may be attributed to enhance rate of gluconeogenesis, which is a secondary effect of insulin deficiency. These results are in agreement with **Eman *et al.* (2013); Helal (2000)** and **Abdel-Moneim *et al.* (2002)** who found marked decrease in serum total proteins and albumin in diabetic animals and this decrease in total serum protein content of diabetic rats may be due to the decreased of amino acids uptake. In addition, increased conversion rate of glycogenic amino acids to CO_2 and H_2O.

These results are in agreement with **Octavio *et al.* (2014)** who concluded that, total proteins and albumin levels revealed insignificant change in Avocado treated group in comparison to the normal diabetic group.

In the present study serum glucose level revealed a significant increase in diabetic control group in comparison with the negative control group as a result to sever hypoinsulinemia and increasing insulin resistance which lead to high serum glucose level. On the other hand, all treated groups showed a significant decrease when compared to the diabetic. The hypoglycemic effect may be because of elevation of hepatic glycogen as a result of insulin glycogenesis or enhancement of peripheral metabolism of glucose and an increase in insulin release or may be due to an intestinal reduction of the absorption of glucose or increase in islet numbers and to its effect on the time course of glucose absorption from the intestine or recovered endocrine pancreatic tissue at both structural and functional levels or due to the presence of betatrophin hormone which lead to increase the number of β-cells.

Also glycosylated hemoglobin showed a significant increase in diabetic rats when compared to negative control group because the excess glucose present in the blood reacts with hemoglobin to form glycosylated hemoglobin.

Only balanites, Balanites + Avocado treated groups recorded a significant decrease in comparison to diabetic group because the blood glucose level recovered near to the normal level as a result of that, glycosylated hemoglobin will not be formed. While, Avocado treated group showed a decrease, but not significantly, in comparison to diabetic group.

The possible mechanism of hypoglycemic action by *Balanites aegyptiaca* may be through increase of pancreatic secretion of insulin from beta cells or due to enhanced transport of blood glucose to the peripheral tissue. **(Doda, 1996).**

Hypoglycemic effect of either aqueous or ethanolic extract of *Balanites aegyptiaca* fruits may be attributed to increase in islet numbers and to its effect on the time course of glucose absorption from the intestine **(Abdel-Moneim, 1998)**

It was suggested that the hypoglycemic activity may be generally mediated through enhancement of peripheral metabolism of glucose and an increase in insulin release, or may be due to an intestinal reduction of the absorption of glucose **(Aderibigbe *et al*., 1999).**

This hypoglycemic effect of balanites attributed to high content of bioactive compounds as suggested by **Georg *et al*., (2006).** The pure saponin extracted from the balanites fruit mesocarp, was reported as a hypoglycemic agent when tested on albino rats in different doses. The aqueous extract of the mesocarp of fruits of balanites aegyptiaca was reported to have antidiabetic effect in streptozotocin-induced diabetic mice **(Mansour and Newairy, 2000).**

The present results are in the way with **Samir, *et al.* (2002)** who stated a significant decrease in serum glucose level in diabetic rats treated with Balanites aegyptiaca water and ethanolic extracts and reported that, induced a stimulation of islet insulin release and also, it potentiated the glucose stimulation to insulin secretion. The observed hypoglycemic action accompanied by increased serum insulin in animals treated with *Balanites aegyptiaca* fruit extract may be resulted from the elevation of hepatic glycogen observed in treated animals, indicates increased glucose storage as a result of increased insulin glycogenesis.

The reason for increased glycosylated hemoglobin in diabetic rats is the excess glucose present in the blood reacts with hemoglobin to form glycosylated hemoglobin. Oral administration of balanites to STZ-induced diabetic rats reduced the formation of glycosylated hemoglobin because the blood glucose level recovered near to the normal level. The decreased level of glycosylated hemoglobin in treated diabetic rats showed the antihyperglycemic activity of balanites aegyptiaca **(Haller, *et al.*, 2004).**

Neuwinger *et al*. (2004) stated that, some tested plants have a blood sugar lowering effect shown in animal tests, where this plant may have a moderate inhibitory effect on a-amylase activity so it can lower the blood sugar concentration. The possible mechanism of *Balanites aegyptiaca* hypoglycaemic action may be through potentiation of pancreatic secretion of insulin from Beta cells of islets or due to enhanced transport of blood glucose to the peripheral tissue.

Otherwise, the improvement of general diabetic conditions in rats treated by the extract of *B. aegyptiaca* (seeds) is possibly due to recovered endocrine pancreatic tissue at both structural and functional levels. This can lead to elevated insulin level and improved insulin sensitivity that lowers the concentration of glucose in blood. Where, insulin inhibits hepatic glucose production, stimulates both of glucose uptake and metabolism by muscle and adipose tissues and increases liver glycogen content. In addition, *B. aegyptiaca* (seeds) containing diosgenin, which may be useful for ameliorating the glucose metabolic disorder, associated with diabetes and obesity **(Chapagain and Wiesman, 2005).**

In the same line with **Mohamed, *et al.* (2006)** oral administration of Balanites extract

for 21 days to STZ-diabetic rats resulted in a significant reduction in blood glucose level by 24%.

Six different flavinoids were detected in *Balanites aegyptiaca*. Leaves, steam bark and root extracts contain more than 100 mg/kg of saponins, steroids or alkaloids. The saponin extracted from B.aegyptiaca fruits was reported to have a hypoglycemic effect in diabetic rats **(George, *et al.*, 2006)**.

The present results are in agreement with **Kanchana *et al.*, (2011)** who reported that, rats induced with STZ, showed a significant increase in the level of plasma glucose and decrease in the levels of plasma insulin and C-peptide as compared to normal rats.

These are In agreement with **Abdulrahman, *et al.*, (2015)** who reported that, rats injected with STZ experienced a significant elevation in blood glucose level compared with the control group, while treatment with balanites aqueous extract showed a significant reduction in blood glucose compared with the untreated diabetic animals. HbA1c was also significantly increased in the diabetic rats compared with control group. However, treatment of animals with balanites extract reduced HbA1c.

The present study agreed with **Bartholomew, (2007)** who reported that, oral treatment with *avocado* extract depleted the level of blood glucose and enhanced the insulin level in STZ- induced hyperglycemic rats. The antihyperglycemic potential of medicinal plant extract is normally reliant on the degree of β-cell demolition. The antihyperglycemic effect of *avocado* fruits may be due to increased insulin stimulation effect.

The current results for serum insulin level revealed a significant decrease in diabetic group when compared to negative control group. Balanites, Avocado treated groups showed a significant increase in comparison to diabetic group. Balanites + avocado treated group showed a normal increase, but not significantly, when compared to the diabetic group.

C-Peptide level revealed a significant decrease in diabetic group in comparison to negative control group. Avocado and balanites + avocado treated groups showed a significant increase in C-Peptide level when compared to diabetic rats. While balanites treated group recorded insignificant increase in C-peptide secretion when compared to the diabetic group.

Defect in insulin level or function leads to alteration in carbohydrates metabolism causing hyperglycemia. While, this sever serum hypoinsulinemic level recorded in diabetic rats may be attributed to reduction in β-cells mass or β-cells' cytoplasmic vacuolation. Which in agreement with **Defronzo and Goodman, (1995),** who attributed hyperglycemia to increase hepatic glucose production, a decrease in peripheral glucose uptake, and significant decrease in the conversion of glucose to glycogen in the liver.

In addition, the decrease in insulin secretion in diabetic group may be due to its sudden activation of quiescent cell for a high level of protein synthesis and produced rapid and massive β-cell death which, leading to a decrement in β-cells number which in turn will decrease the insulin secretion **(Majno and Joris, 1996)**.

C-peptide and insulin levels were significantly decreased in STZ-induced diabetic rats due to the destruction of β-cells of pancreas which will inhibit insulin release. Oral administration of Heglig dates significantly increased the levels of plasma insulin and C-Peptide in STZ-induced diabetic rats when compared with diabetic control rats. This is because, flavonoids found in balanites stimulate the secretion of insulin from β-cells of pancreas. **(Doda, 1996).**

These results disagreed with **Mohamed, *et al.* (2006)** who recorded that, the reduced serum insulin level of STZ-diabetic rats is not significantly affected by *Balanites aegyptiaca* water extract and their hypoglycemic effect

may be via different mechanisms other than stimulation of insulin secretion.

In agreement with **Walter *et al*., (2013)** who concluded that, according to the increase in the number of β-cells, insulin level increased in *B. aegyptiaca* treated rats and suggested that, Avocado fruit might be inducing betatrophin secretion from the liver and adipose tissues where this hormone is secreted into the blood stream to signal β-cells in the pancreas to reproduce.

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تأثير كلا من بلح الهجليج وفاكهة الأفوكادو على بعض المعايير الدموية والبيوكيميائية في الجرذان المصابه بالسكري المحدث بواسطة ستريبتوزوتوسين.

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مرض السكري هو متلازمة الاختلال في عمليات أيض الكربوهيدرات والدهون والبروتين الناتج عن نقص إفراز الأنسولين أو انخفاض حساسية الأنسجة للإنسولين. داء السكري هو مرض الغدد الصماء الأكثر شيوعا في جميع أنحاء العالم. تم إحداث داء السكري عن طريق حقن الستربتوزوتوسين داخل التجويف البطني بجرعة ٤٧ مج / كجم من وزن الجسم. صُممت الدراسة الحالية لمعرفة التأثيرات العلاجية الممكنة لمستخلص بلح الهجليج وفاكهة الأفوكادو بجرعات ١٠٠ مج/كجم و ٥٠٠ مج/كجم على التوالي لمدة ٣٠ يوم على بعض المعايير الدموية والكيميائية الحيوية في الجرذان المصابة بداء السكري عن طريق الحقن بمادة الاستريبتوزوتوسين. وأعطيت مستخلصات المعالجة عن طريق الفم بواسطة أنبوبة التجريع. وأظهرت النتائج انخفاض معنوي في عدد كرات الدم الحمراء والبيضاء وتركيز الهيموجلوبين والبروتين الكلي في الدم والألبيومين والإنسيولين ومستوى سي ببيتيد في الجرذان المصابة بداء السكري بالمقارنة مع المجموعة الضابطة. من ناحية أخرى تم تسجيل زيادة معنوية في قيمة متوسط حجم الكرية والهيموجلوبين السكري في مجموعة السكري مقارنة بالمجموعة الضابطة. وأوضحت النتائج تأثير ملحوظ في علاج مرض السكري بواسطة مستخلص البلح وفاكهة الأفوكادو.