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Effect of some medicinal plants on some biochemical parameters in diabetic rats

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Abstract
The present study was designed to investigate the possible therapeutic effects of *Balanites aegyptiaca (Heglig dates), Persea Americana (Avocado fruit)* and *Aphanizomenon flos-aquae* (AFA) water extracts on some biochemical parameters such as ALAT, ASAT, alkaline phosphatase, acid phosphatase, triglycerides, cholesterol, LDL-cholesterol, HDL-cholesterol, total lipids and risk ratio 1&2 in streptozotocin diabetic rats. The results of the current study recorded a significant increase in serum ALAT, ASAT and ALP enzymes activities in diabetic group in comparison with the negative control group. Also a significant increase was observed in serum triglycerides, cholesterol, LDL-cholesterol, total lipids level and risk ratio 1 &2. On contrast, a significant decrease was recorded in serum ACP enzyme activity, HDL-cholesterol level in diabetic group. Rats treated with Balanites aegyptiaca, Persea Americana and AFA alone or mixed together showed an improvement in these parameters.

Keywords: *Balanites aegyptiaca* (heglig dates), *Persea Americana* (avocado), *Aphanizomenon flos-aquae* (AFA); diabetes mellitus, hypoglycemic effect, streptozotocin, liver function, lipid profile

Introduction

Diabetes mellitus is often described as a group of complex metabolic disorders with a partial or absolute insufficiency of insulin secretion or its action. These disorders are generally characterized by chronic hyperglycemia and glucose intolerance. Diabetes mellitus is considered to be a bi-hormonal disease involving insulin deficiency or defect in its utilization together with glucagon excess. Diabetes is one of the most common non–communicable diseases in the world, affecting 5 to 10% of the adult population in the western world and hence, representing a major cause of morbidity and mortality [1].

Medicinal plants are widely used in management of diseases all over the world historically; the use of medicinal plants is as old as mankind and medicine. *Balanites aegyptiaca* is a perennial tropical plant used in food preparations and herbal medicine, especially in Africa and some developing countries. It is also called desert date (English), adua (Hausa, Nigeria), tanni (Fulfulde, Nigeria) and heglig (Arabic). *B. aegyptiaca* belongs to the family *Balanitecea* [2, 3].

Balanites aegyptiaca induced improvement in the blood cholesterol, triglycerides and creatinine levels of the diabetic rats[4]**.** The same author also concluded that, from this extract, at least four different types of saponins were isolated and identified. The hypoglycemic effect of Balanites fruits has been attributed to the presence of these saponins as well as a polysaccharide fraction.

The water and the ethanolic extracts obtained from Balanites aegyptiaca has been investigated for their hypoglycemic and hypolipidimic effect in the normal senile diabetic rats in addition to the hormones that are associated to diabetes mellitus. The changes in the serum total protein, albumin and globulin level during the experimental period was found to be insignificant. The experiments conducted have suggested the beneficial role of *Balanites aegyptiaca* fruit as a hypoglycemic, hypolipidimic agent and also as a protective agent of liver from damage or injury. The fruit flesh was found to attribute at least in part to the increased glucose metabolism and produces an increase in serum insulin concentration [5].

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 [6].

Persea americana, also known as the avocados, is a commercially valuable crop whose trees and fruits are cultivated in tropical climates throughout the word. The fruits and leaves of *Persea Americana* to be very useful in the treatment and management of various diseases. The aqueous leaf extracts of *Persea Americana* are known for their anti-inflammatory [7], cutting cancer risk [8], hypoglycemic and hypocholesterolemic [9], wound healing [10].

Treatment with various doses of the methanolic extract of the seeds of *Persea Americana* caused a significant reduction in the levels of total cholesterol, triglyceride, low density lipoprotein cholesterol and very low density lipoprotein cholesterol. While the levels of high density lipoprotein cholesterol increased significantly. These effects observed at the highest concentration (300mg/kg) of the methanolic extract of *Persea Americana* seeds. It was concluded that *Persea Americana* seeds showed an hypolipedimic effect and may serve as possible alternative treatment for hyperlipemia and hypertension [11].

Clinical chemistry measurements including AST, ALT, ALP,

blood urea, and serum creatinine revealed no differences between control and avocado extract-administrated groups of rats [12].

The levels of total cholesterol, triglyceride and low density lipoprotein cholesterol was significantly decreased for the groups fed on avocado (fruit and seed) in comparison with the hypercholesterolemia group. Also, the activities of AST and ALT enzymes decreased significantly for the groups fed on avocado (fruit, seed) in comparison with the hypercholesterolemia group. The levels of total cholesterol and triglyceride decreased significantly for the avocado (fruit, seed) fed rats compared to the hypercholesterolemic group [13]. Avocado may improve hypercholesterolemia and may be useful in the treatment of hypertension and type 2 diabetes mellitus (T2DM). This way, avocado plays an important role in the cardiovascular health [14].

Spirulina, a blue-green alga, is now becoming a health food worldwide. It is a multicellular, filamentous cyanobacterium belonging to algae of the class *Cyanophyta*. The United Nations world food conference declared spirulina as "the best for tomorrow", and it is gaining popularity in recent years as a food supplement [15].

There are more than 30,000 different species of microalgae. Microalgae is a term often used to represent a group of organisms ranging from the true Eukaryotic algae to the cyanobacteria (e.g. *spirulina* spp. and *Aphanizomenon flos-aquae* (AFA) spp.). Although all of the species of microalgae are photosynthetic and contain a large variety of pigments that absorbs many spectra of light, the relationship between true algae and cyanobacteria is not very close. Cyanobacteria are relatives of bacteria, not eukaryotes and it is only the chloroplast organelle in eukaryotic algae to which the cyanobacteria are related [16].

Spirulina schmidlei also reduced the blood glucose level and would probably function like insulin or stimulate the β cells of islets of Langerhans to increase the output of insulin which could result in lowering of blood sugar level [17].

Herbal medicines are used in North Sudan to treat diabetes due to their traditional acceptability and availability. The plants are used in crude form or as extract, individually or as a mixture. Many investigations have made to study the effect of aqueous extract treatment of Balanites aegyptiaca on blood glucose level [18].

Materials and Methods

Experimental Design

72 male rats (Rattus norrvegicus) average weight (180-250 g) were conducted following the ethics by INSA, Animal Welfare Division of the Ministry of Environment & Forest, Council of International Organisation of Medical Sciences (WHO/UNESCO), NIH and PHS.

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. All animals were injected with Streptozotocin (47 mg/kg body weight dissolved in Saline solution) to be diabetic animals (if serum glucose level exceeded 250 mg/dl) except 8 animals which will be the negative control group. The first 24 hours after injection rats were drinking glucose solution 10%.

Animals were divided equally into 9 groups:

Group 1: Negative control group.

Group 2: Positive 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 Aphanizomenonflos-aquae AFA (Blue green algae) 30 mg/kg. b. w. for 30 days.

Group 6: Rats treated orally with Balanites + AFA mixture treated group for 30 days.

Group 7: Rats treated orally with Balanites + Avocado mixture treated group for 30 days.

Group 8: Rats treated orally with Avocado + AFA mixture treated group for 30 days.

Group 9: Rats treated orally with Balanites + Avocado + AFA mixture treated group for 30 days.

Blood Samples collection

Blood samples were collected without anti coagulant and centrifugated for 10 minutes at 3000 r.p.m. for biochemical parameters.

Biochemical Parameters

Colorimetric determination of ALAT has been estimated[19], Serum ASAT was determined colorimetrically [20], Serum alkaline phosphatase [21], Serum acid phosphatase [22], Serum triglycerides [23], Serum cholesterol level [24], Serum HDL-cholesterol level [25], the LDL-C calculations were conducted according to the formula [26], Serum total lipids [27].

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 highly significant at ($P < 0.01$) and statistically significant at ($0.05 \geq p \geq 0.01$).

Results

Statistical data in table (1) showed a significant decrease ($p < 0.05$) in serum ALAT, ASAT and ALP enzymes activities in diabetic groups in comparison with the control rats. On contrast, a significant decrease ($p < 0.05$) was observed in serum ACP enzyme activity in diabetic rats when compared with the control group. Rats treated with Balanites aegyptiaca extract recorded a significant increase in the activity of serum ALAT enzyme. While a significant decrease was observed in serum ALAT enzyme in rats treated with extract of Persea Americana + AFA and Balanites aegyptiaca + Persea Americana + AFA extracts. While a slight improvement was recorded in ALAT enzyme activity in rats treated with Persea Americana and AFA extracts alone or together when compared with the diabetic group. Also a slight improvement in the activity of serum ASAT enzyme in all groups in comparison with the diabetic group. It was observed that, the activity of serum ACP and ALP enzymes was significantly improved in all groups treated with Balanites aegyptiaca, Persea Americana and AFA extracts alone or in combination

together in comparison with the diabetic group.

Table (2) revealed a significant increase ($p < 0.05$) in serum triglycerides, cholesterol and LDL – cholesterol level in diabetic group when compared with the control group. On the other hand rats injected with streptozotocin recorded a significant decrease ($p < 0.05$) in serum HDL – cholesterol level. Treatment with plant extracts (Balanites aegyptiaca, Persea Americana and AFA) showed a significant improvement in triglycerides, cholesterol, LDL – cholesterol and HDL – cholesterol level in diabetic rats alone or in combination together except for the groups treated with Balanites + AFA and Balanites + Persea showed a slight improvement in serum triglycerides level in comparison with the diabetic rats.

Presented data in table (3) showed a significant increase ($p < 0.05$) in serum total lipids level, risk ratio 1 and risk ratio 2 values in diabetic group in comparison with the control. The treatment with plants extracts (Balanites, Persea and AFA) alone or together recorded an improvement in these parameters in comparison with the control group.

Table 1: Serum ALAT, ASAT, ALP and ACP enzymes activities in diabetic rats (*Rattus norvegicus*) treated with some medicinal plants (Balanites aegyptiaca, Persea Americana and Aphanizomenon Flos aquae) for 30 days.

Parameters / Groups	ALAT, u/l	ASAT, u/l	Alkaline phosphatase, /L	Acid phosphatase, U/L
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Negative control	145.00 [a] 44.33	378.80 [a] 28.70	165.00 [a] 29.76	8.70 [a,c,d,f,g] 0.52
Diabetic control	258.00 [b,d,e,f,g] 44.25	442.20 [b] 46.47	389.80 [b] 38.80	6.52 [b] 1.25
Balanites aegyptiaca	330.80 [c] 36.84	422.80 [a,b] 41.82	793.40 [c,h] 58.86	7.58 [a,b,c,f] 1.23
Persea americana	219.20 [d,e,f,h] 10.28	303.20 [c,f] 45.38	533.20 [d,f,g,I] 68.94	9.58 [f,d] 1.34
AFA	258.60 [e,f,g] 12.50	375.60 [a] 28.55	878.60 [e,h] 60	7.82 [c,e] 0.70
Balanites + AFA	225.20 [f,h] 51.12	309.60 [d,c] 49.58	602.40 [f,g,I] 105.23	7.66 [a,b,c,e] 0.76
Balanites + Persea	283.20 [g] 23.21	407.80 [a,b] 61.24	541.60 [g,I] 31.95	8.00 [a,c,e] 0.97
Persea + AFA	196.40 [h] 46	210.00 [e] 55.41	807.20 [h] 104.52	9.40 [d,g] 0.96
Balanites + Persea + AFA	187.40 [a,h] 11.68	304.20 [f,c] 14.10	582.20 [I] 43.45	8.30 [e,g] 0.72

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

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

Table 2: Serum triglycerides, cholesterol, LDL and HDL cholesterol levels in diabetic rats (*Rattus norvegicus*) treated with some medicinal plants (Balanites aegyptiaca, Persea Americana and Aphanizomenon Flos aquae) for 30 days.

Parameters / Groups	Triglycerides, mg/dl	Cholesterol, mg/dl	LDL, mg/dl	HDL, mg/dl
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Negative control	77.00 [a] 14.85	97.20 [a] 14.48	58.98 [a] 11.21	17.60 [a] 3.36
Diabetic control	152.00 [b,f] 8.89	140.20 [b] 15.26	100.72 [b] 8.37	10.96 [b] 1.96
Balanites aegyptiaca	70.80 [a] 17.57	79.00 [c,d] 6.78	46.24 [c,f] 5.16	18.60 [a,e] 4.28
Persea americana	64.40 [a] 8.85	77.40 [d] 12.99	46.92 [d,c] 8.76	17.60 [a] 5.60
AFA	86.60 [e,a] 17.90	91.00 [a,c] 6.04	49.40 [e,c] 7.03	18.20 [a,e] 2.59
Balanites + AFA	128.60 [c,f] 37.12	87.00 [a,c,d] 6.52	38.72 [f,d] 3.68	23.60 [c] 2.97
Balanites + Persea	130.00 [d,f] 66.09	83.60 [e,c,d] 9.53	43.40 [c,f] 4.81	22.00 [a,c] 3.39
Persea + AFA	70.20 [a] 7.98	85.80 [a,c,d] 8.47	49.58 [a,c] 5.63	26.40 [d,c] 4.16
Balanites + Persea + AFA	96.20 [a,c,d] 10.18	87.60 [a,c,d] 8.79	51.60 [a,c] 8.17	22.60 [e,c] 2.88

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

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

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Table 3: Serum total lipids, risk ratio 1&2 in diabetic rats (*Rattus norvegicus*) treated with some medicinal plants (*Balanites aegyptiaca, Persea Americana* and Aphanizomenon Flos aquae) for 30 days.

Parameter / Groups	Total lipids	Risk Ratio 1	Risk Ratio 2
	Mean ± SD	Mean ± SD	Mean ± SD
Negative control	273.40 [a] 42.58	5.62 [a] 0.88	2.99 [a] 1.13
Diabetic control	387.80 [b] 22.21	7.37 [b] 2.02	5.30 [b] 1.44
Balanites aegyptiaca	237.00 [a,c,d] 23.96	4.44 [a,c,d,e,f] 1.06	2.63 [a,c] 0.79
Persea americana	215.20 [c,d] 22.97	4.58 [a,c,d,e,f] 0.76	2.80 [a] 0.64
AFA	244.00 [a,c,d] 45.71	5.09 [a,c,d,f] 0.89	2.77 [a] 0.70
Balanites + AFA	279.20 [a] 23.27	3.75 [c,d,e,f] 0.65	1.66 [c] 0.22
Balanites + Persea	268.00 [a,d] 47.04	3.85 [d,e,f] 0.53	2.03 [a,c] 0.49
Persea + AFA	273.00 [a] 53.52	3.29 [e,f] 0.42	1.92 [a,c] 0.34
Balanites + Persea + AFA	224.40 [d] 27.32	3.89 [f] 0.31	2.28 [a,c] 0.18

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

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

Discussion

A significant increase in serum ALAT and ASAT activities in diabetic rats. The elevation of serum ASAT and ALAT activities in diabetic untreated rats may be attributed to the

excessive release of such enzymes from the damaged liver cells into the blood circulation. Where, there is an inverse relationship between the liver activity and the level of enzymes in serum. This may be consistent with their greater need for gluconeogenesis substrates or may reflect damage of the hepatic cells due to hepatotoxic effect of streptozotocin [28, 29].

ALAT activity increased significantly in balanites treated group in comparison to diabetic control group and this increase may be because the highly damage of liver cells or the body dehydration which agreed with another study concluded a significant recovery in serum ALAT activity after treatment with Balanites aegyptiaca extract at higher concentration doses [28, 30].

A significant decrease was recorded in serum ALAT and ASAT activities in avocado + AFA and Balanites + avocado + AFA mixture treated groups in comparison to the diabetic control group. This recovery may be due to hepatoprotective effects of the present treatment. The improvement in liver functions may be resulted from return gluconeogenesis process towards their normal levels. In agreement with an experiment which indicated that, enzymes activities were completely normalized following insulin administration [31].

The increase in serum ALAT and ASAT in diabetic control group also agreed with [32] and may be due to leaking of enzymes from the tissues and migrating into the circulation by the adverse effect of alloxan. In addition it may result from metabolic changes in the liver, such as administration of toxin, cirrhosis of the liver, hepatitis and liver cancer including diabetes [33].

The current results for ALAT and ASAT activities disagreed with a previous study reported a significant reduction in ALAT and ASAT activities after treatment with spirulina crude extract, aqueous extract, ethanolic extract, and insulin-like protein of Spirulina and attributed this reduction to the increased insulin level [34].

Serum transaminases and alkaline phosphatase activities agreed with a study which recorded a significant increase in these parameters in diabetic rats when compared to the negative control group. This elevation may be due to STZ toxicity or extensive tissue destruction. It is known that elevation of transaminases could be a common sign of impairment in liver function. Acute cellular necrosis librates alkaline phosphatase in the circulation and the serum enzyme levels elevated [35].

The current results agreed with [36] who stated a significant increase in alkaline phosphatase activity in streptozotocin induced diabetic rats when compared with the negative control group. In agreement also with [37] who reported a significant increase in diabetic rats when compared with the negative control group and a significant increase also in balanites treated group in comparison with the diabetic control group. This is because alkaline phosphatase and alanine transaminase are not present in the cellular flow and are only released after tissue damage as a result of that, it is not affected with the balanites treatment.

The same results were reported also in an experiment to study the hepatotoxic effect of Persea Americana treatment effect on albino rats which stated a significant increase in avocado treated group when compared with the diabetic control group. This might be as a result of administration of aqueous extract of avocado seed which might have certain constituent, that affect cellular permeability of the hepatocyte [38]. The increase in liver enzymes could be due to hepatocellular damage caused by cytotoxic agent present in some plants [39].

Serum acid phosphatase activity showed a significant decrease in diabetic group in comparison with the negative control group. It is also showed a significant increase in all treated groups except balanites treated group and balanites + AFA treated group. Acid phosphatase activity may continued to increase after treatment with balanites and avocado because the changes in their activities are indicative of tissue damage by toxicants. Elevated level of these enzymes in diabetes may be due to extensive damage of liver in the experimental animals. Balanites aegyptiaca, Persea Americana and AFA aqueous extracts have no treatment effect on acid phosphatase and alkaline phosphatase activities [40].

The present study disagreed with [41] who stated a significant increase of acid phosphatase activity in diabetic group when compared to negative control group and a significant decrease in balanites treated group in comparison with the diabetic group.

Cholesterol-lowering effects of Balanites aegyptiaca fruit extract either with water or ethanol, may be due to increased utilization of cholesterol for bile synthesis in the liver [42].

In addition, there is a marked decrease of HDL-cholesterol in serum of diabetic patients and alloxan diabetic rats. These abnormalities certainly play a role in the increased risk of cardiovascular disease. While, increased serum LDL-cholesterol level may be due to overproduction of VLDL by the liver or decreased removal of VLDL and LDL from the circulation [43].

In agreement with [5] who stated a decrease of serum total lipids, total cholesterol and triglyceride levels of senile diabetic rats after treatment with either water or ethanolic extract of *Balanites aegyptiaca* fruit flesh for 30 days compared to normal senile diabetic rats. The reduction of total lipids, cholesterol and triglycerides in senile diabetic rats of the present study may be attributed to increased clearance and decreased production of the major transporters of endogenously synthesised total cholesterol and triglycerides. All these observations indicated the hypolipidemic effect of Balanites aegyptiaca fruits. The decrease in LDLC and increase in HDLC concentration after treatment is a result from the reduction in triglycerides because there is an inverse relation between triglycerides reduction and HDLC elevation which will react on LDLC reduction.

The significant decrease in lipid profile may be due to the role of Balanites aegyptiaca in increasing over mobilization of lipids from blood vessels to liver or decrease lipogenesis mechanism in liver and decrease the mobilization of lipids from liver to the blood vessels. The same author also concluded that, the reason for triglyceride-lowering effect of water or ethanol extract of Balanites aegyptiaca fruits could be contributed to a reduced availability of free fatty acid for hepatic uptake and triglyceride synthesis release with subsequent hypotriglyceridemia [5].

The abnormal high concentration of serum lipids of diabetic rats is mainly due to increase in the mobilization of free fatty acids from the peripheral fat deposits, because insulin inhibits

the hormone sensitive lipase production [44].

The same lowering effect was reported by Persea Americana (avocado) extract in a study made on avocado fruit, treatment with *Persea Americana* significantly reduced the elevated levels of triglycerides and also reduced the plasma LDLC concentration in diabetic rats[11]. There is an inverse association between plasma triglycerides concentration and HDLC levels and therefore, since there is reduction in the triglycerides concentration by the methanolic extract of the seeds of persea Americana, one should expect an increase in the plasma concentration of HDLC. The decreased levels of triglycerides suggests that the bile acid synthesis was reversed. Similar findings have been reported [45].

The current results also agreed with an experiment recorded a significant increase in total cholesterol, triglycerides and LDLC concentration, as well as a significant decrease in HDLC concentration was noticed in hypercholesterolemic rats when compared to healthy control group. Supplemented diet of hypercholesterolemic rats with different concentrations of avocado (fruit and seed) lead to significantly decrease in total cholesterol, triglycerides and LDLC concentration as well as a significant increase in HDLC concentration. These results may be due to the micronutrient such as vitamin C and present phenolic compounds, act as antioxidant to scavenge free radical and can delay or inhibit the oxidation of both lipid and other molecules [13]. Another explanation which attributed the lowering effect in lipid profile by avocado because avocado fruit rich in monounsaturated fatty acid, fiber, flavonoids, phenolic compound and sterols [46].

Spirulina platensis was found to be effective in normalizing the triglyceride levels, the reduction in triglyceride level could be through lipoprotein lipase, a key enzyme in the metabolism of triglyceride [47].

Hypocholesterolemic effect of blue green algae may be attributed to the presence of c- phycocyanin. Phycocyanin is a water soluble protein and enriched in spirulina and it was suggested that phycocyanin might be the active ingredient in spirulina responsible for the hypolipidemic activity [48].

In addition, our results are in accordance with [49] who found a significant lowering effect of blue green algae on plasma triglyceride concentration of type 2 diabetes mellitus patients.

The increase in blood triglycerides concentration in STZ-treated rats is in the same line with [50] who reported that, diabetes-induced hyperlipidemia and this hyperlipidemia is attributable to excess mobilization of fat from the adipose tissue due to the underutilization of glucose. The observed regression of the diabetic state due to the administration of spirulina treatment may have increased the utilization of glucose, thereby depressing the mobilization of fat as a result of that, triglycerides decreased significantly.

Spirulina maxima was effective in normalizing the triglyceride levels and the authors attributed this effect to decreased VLDL triglyceride production or increased VLDL clearance in the peripheral tissues[51].

Also, the present data are in harmony with[52] who found that cholesterol, LDL and VLDL showed a significant reduction with an increase in HDL- cholesterol following administration of algae for 30 days. This study showed a marked increase in blood triglycerides concentration in STZ-treated rats. This data is in agreement with[53] who reported that diabetes-induced hyperlipidemia is attributable to excess mobilization of fat from the adipose due to the underutilization of glucose.

A significant increase in serum lipid cholesterol level in STZ-treated rats compared to control animals. Administration of *S. platensis* suspension to rats after hyperglycemia produced a marked decrease in blood cholesterol level. In addition, cholesterol, LDL and VLDL showed a significant reduction with an increase in HDL- cholesterol following administration of algae for 30 days. This effect might be due to the presence of γ-linoleic acid in spirulina, which prevents accumulation of fats and cholesterol in human body[52].

The current results for triglycerides, total cholesterol, LDL and HDL disagreed with[54] who recorded no significant changes in triglycerides, total cholesterol, LDL and HDL before and after treatment with *Aphanizomenon flos-aquae* (AFA).

Conclusion

The results of this experiment suggest that, both heglig dates and avocado extracts should be used alone or mixed together with the same concentrations used in the trial as a treatment to reduce cholesterol, triglyceride, total lipids and high density HDL but without mixing with the blue-green algae extract.

References

1. Naim S, Raanan S, Moshe B. Amos E, Insulin in human milk and the prevention of type 1 diabetes. Pediatric Diabetes. 2001; 2:175.
2. Rahman MW, Mostafa SA, Sardar MR, Sultana MM Choudhury ME. Investigation of comparative hypoglycemic effect of neem (*Azadirachta indica*), karala (*Momordica charantea*) and nayantara (*Cathranthus roseus*) with glibenclamide on rat. *Int J Pharmac*. 2005; 1:257.
3. Aliyu R, Adebayo A, Gatsing D, Garba I. The effects of ethanolic leaf extract of *Balanites aegyptiaca* (Balanaeceae) on rat liver and kidney functions. J Phar Toxi. 2007; 2:373.
4. Saeed A, Ibrahim N, Bashandy S, El-Gengaihi S. Saponin of Balanites aegyptiaca fruits and biological evaluation. Bull Fac Pharm Cairo Univ, 33(special issue), 1995, 105.
5. Samir AM, Somaia ZA, Mattar AF. Anti diabetic properties of water and ethanolic extracts of *Balanites aegyptiaca* fruits flesh in senile diabetic rats. *Egy J Hosp Med.* 2002; 10:90.
6. Nadro MS, Samson FP. The effects of *Balanites aegyptiaca* kernel cake as supplement on alloxan induced diabetes mellitus in rats. J App Pharmaceu Scie. 2014; 4:58.
7. Adeyemi OO, Okpo SO, Ogunti OO. Analgesic and anti-inflammatory effects of the aqueous extract of leaves of Persea Americana mill (lauraceae). *Fitoterapia*. 2002; 73:375.
8. Lu QY, Arteaga JR, Zhang Q, Huerta S, Go VL, Heber D. Inhibition of prostate cancer cell growth by an avocado extract: Role of lipid-soluble bioactive substances. J Nutr Biochem. 2005; 16:23.
9. Brai BI, Odetola AA, Agomo PU. Hypoglycemic and hypocholesterolemic potential of *Persea Americana* leaf extracts. J Med Food. 2007; 10:356.

10. Nayak BS, Raju SS, Chalapathi RA. Wound healing activity of *Persea Americana* (avocado) fruit, a preclinical study on rats. J Wound Care. 2008; 17:123.
11. Asaolu F, Asaolu S, Oyeyemi O, Aluko T. Hypolipemic effects of methanolic extract of *persea Americana* seeds in hypercholestrolemic rats. J Medic Sci. 2010; 4:126.
12. Mahadeva R, Mainul H, Atif A. Insulin stimulative and anti-oxidative effects of Persea Americana mill fruit extract on streptozotocin induced hyperglycemic rats. J Med Biol Sci. 2011; 4:1.
13. Manal MS, Shehata M, Sahar SA. Effects of bioactive component of Kiwi fruit and avocado (fruit and seed) on hypercholesterolemic rats. J Dai Food Sci. 2013; 8:82.
14. Camila W, Júlia LD, Priscilla AL, Viviane PC, Aline M. Avocado and cardiovascular health. J Endo Meta Dis. 2015; 5:77.
15. Kapoor R, Mehta U. Effect of supplementation of blue green algae on outcome of pregnancy of rats. Pla Food Hum Nutr. 1993; 43:131.
16. Brian S. Introduction to the Cyanobacteria architects of earth's atmosphere. University of California, Berkeley, 1995.
17. Sundararaman M, Subramanian G, Averzl HI, Akbarsha MA. Evaluation of the bioactivity of Marine cyanobacteria on some biochemical parameters of Rat serum. Phytotherapy Res. 1996; 10:9.
18. Kamal Eldin G, Ogail D. Hypoglycemic and hypolipidaemic effects of some common plants extract in Type 2 diabetic patients at Eldabba area (North Sudan), J Phar Bio Sci. 2013; 8:38.
19. Sherman K. Alanine amino-transferase in clinical practice. Arch Int Med. 1991; 151:260.
20. Johnston D. Special considerations in interpreting liver function tests. Am Fam Phys. 1999; 59:2223.
21. Tietz NW. Specimen collection and processing; sources of biological variation, in Clinical Chemistry (2nd Edition, W.B. Saunders, Philadelphia), 1994.
22. Bowers G, Comb R. A continuous spectrophotometric method for measuring the activity of serum alkaline phosphatase. J Clin Chem. 1966; 12:70.
23. Fassati P, Prencipe L. Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. J Clin Chem. 1982; 28:2077.
24. Allain C, Poon L, Chan C, Richmond W. Enzymatic determination of total serum cholesterol. J Clin Chem. 1974; 20:470.
25. Lopez Virella M, Stone P, Ellis S, Colwell J. Cholesterol determination in high-density lipoproteins separated by three different methods. J Clin Chem. 1997; 23:882.
26. Wieland H, Seidel D. Improved assessment of plasma lipoprotein patterns. J Clin Chem. 1982; 28:1335.
27. Zollner N, Kirsch K. Assessment of total lipids. Z ges exp Med. 1962; 135:545.
28. Kadry Z, Hassan Z, Manal M, Hoda B. The effect of herbal tea from Balanites aegyptiaca fruits on streptozotocin-induced diabetes mellitus in rats. Int J Phar Tech. 2016; 9:8.
29. Youssef M, Osman A. Hypoglycemic effect of *Ambrosia maritima* and Origanummajorana on alloxan induced diabetic rats. J Drug Res Egy. 2002; 24:151.
30. Eman H, Samia A, Hesham E, Anwaar M. Antidiabetic and antihyperlipidemic affect of *Balanites aegyptiaca* seeds (Aqueous Extract) on diabetic rats" Egy J Hosp Med. 2013; 52:725.
31. Hough S, Avioli L, Teitebrum S, Fallon M. Alkaline phosphatase activity in chronic streptozotocin-induced insulin deficiency in the rat. J Ins Replac Meta, 1981, 1190.
32. Stanely P, Mainzen P, Venugopal M. Hypoglycemic and other related actions of Tinospora cordifolia roots in alloxan induced diabetic rats. J Ethnopharmacol. 1999; 70:9.
33. Chalasani N, Aljadhey H, Kesterson J, Murray M, Hall S. Patients with elevated liver enzymes are not act high risk for statin hepatotoxicity. Gastroentero J. 2004; 126:1287.
34. Razique A, Anzar A, Saima K, Mohamad K, Hifzul K, Tasneem F. Spirulina: possible pharmacological evaluation for insulin-like protein. J Appl Phycol. 2012; 24:112.
35. Nadia SM, Amany SM, Ebtehal KF, Hanaa HA, Abdel Razek HF, Doaa SF, *et al*. Efficiency of the Algae *(Spirulina platensis)* as antidiabetic agent. W J Pharmac Res. 2015; 4:18.
36. Mouhammad Z, Syed N, Masood A, Zahid A. Altered liver morphology and enzymes in streptozotocin induced diabetic rats. Int J Morphol. 2009; 27:719.
37. Salihu M, Nwozo S, Oloyede B. Aqueous extract of *Balanites aegyptiaca* fruit mesocarp protects against CCl4 – Induced liver damage in rats. Brit J Pharmac Res. 2013; 3:917.
38. Umar A, Sabiu M, Abdullahi S. Comparative hepatotoxic effects of aqueous and phenolic extracts of avocado (*Persea americana*) seed in wistar albino rats. Int J Biochem Res. 2016; 10:1.
39. Abdel- Monein A, El-Feki M & Salah E, Effect of Nigella sativa, fish oil and glicalzde on alloxan diabetic rats biochemical and histopathological studies. *J Egy Ger Soci Zool*. 2011; 23:237.
40. Som Nath S, Praveen V, Shoba S, Radhey S, Kumaria M, Ranganathan S, Sridharan K. Effect of an antidiabetic extract of Catharanthus roseus on enzymic activities in streptozotocin induced diabetic rats. J Ethnopharmacol. 2001; 76:269.
41. Ravikumar R, Krishnamoorthy P, Kalidoss A. Antidiabetic and antioxidant efficacy of *Andrographis paniculata* in alloxanized albino rats. Int J Phar Tec. 2010; 2:1016.
42. Chautan M, Chanussot F, Portugal H, Pauli A, Lafont H. Effect of salamon oil and corn oil on plasma level and hepatobiliary cholesterol metabolism in rat. Biochem Biophys Acta. 1990; 104:40.
43. Tsutsumi K, Inoue Y, Shime A, Murase T. Correction of hypertriglyceridemia with low and high densities lipoprotein cholesterol, a lipoprotein lipase-promoting agent, in STZ- induced diabetic rats. Diab Int J. 1995; 44:414.
44. Udayakumar R, Kasthurirengan S, Mariashibu T, Rajesh M, Anbazhagan V, Kim S, *et al*. Hypoglycaemic and hypolipidaemic effects of Withania somnifera root and

leaf extracts on alloxan-induced diabetic rats. Int J Mol Sci. 2009; 10:2367.
45. Shirdel Z, Madani H, Mirbadalzadeh R. Investigation into hypoglycemic effect of hydroalcoholic extract of Ziziphus Jujuba leaves on blood glucose and lipids in Alloxan-Induced diabetes in rats. Iran J Diab Lip Dis. 2009; 8:2.
46. Mohammed S. Hypolipdemic and antioxidant activities of avocado fruit pulp on high cholesterol fed diet in rats. Afr J Phar Pharmac. 2011; 5:1475.
47. Nassir F, Mazur A, Felgines C, Rayssiguier Y. Age related response to dietary fructose in the rat discrepancies in triglyceride and apolipoprotein B synthesis as a possible mechanism for fatty liver induction in adult rat. Proc Soc Exp Biol Med. 1993; 204:180.
48. Nagaoka S, Shimizu K, Kaneko H, Shibayama F, Morikawa K, Kanamaru Y. A novel protein C–phycocyanin plays a crucial role in the hypocholesterolemic action of Spirulina platensis concentrate in rats. J Nutr. 2005; 135:2425.
49. Lee E, Park J, Choi Y, Huh K, Kim W. A randomized study to establish the effects of Spirulina in type 2 diabetes mellitus patients. Nutr Res Pract. 2008; 2:295.
50. Akpan H, Ekaidem I, Usoh I, Ebong P, Isong N. Effect of aqueous extract of Azadirachta indica (Neem) leaves on some Indices of pancreatic function in alloxan induced diabetic Wistar rats Pharmacol. 2012; 3(9):420-425.
51. Jarouliya U, Anish Z, Kumar P, Bisen P, Prasad G. Alleviation of metabolic abnormalities induced by excessive fructose administration in Wistar rats by Spirulina maxima" Indian J. Med. Res. 2012; 135(3):422-428.
52. Moura L, Gurjao A, Filho J, Mizuno J, Suemi C, DeMello M. Spirulina exercise and serum glucose control in diabetic rats Arq. Bras. Endocrinol. Metab. 2012; 56(1):25-32.
53. Krishnakumar K, Augustti KT, Vijayammal PL. Hypolipidaemic effect of Salacia oblonga wall root bark in streptozotocin diabetic rats Med. Sci. 2000; 28:65-67.
54. Maryam S, Mehdi E, Zahra B, Gita S, Fatemeh K, Zeinab A, Ramin H. Consequences of *Aphanizomenon Flos-aquae* (AFA) extract (Stemtech TM) on metabolic profile of patients with type 2 diabetes" J. Diab. Met. Disord. 2015; 5:14-50.