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Some biomedical applications of *Balanites aegyptiaca* grown naturally in radioactive area, Southeastern Desert, Egypt

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ABSTRACT

Balanites aegyptiaca is a naturally grown desert plant at some radioactive places in Wadi El-Gemal area, Southeastern Desert. The aim of the present study was to highlight on the *B. aegyptiaca* species grown naturally at radioactive places in Wadi El-Gemal area (fruit part) on the ability of using the fruit in some biomedical application (glucose, cholesterol, triglycerides, HDL-cholesterol, LDL-cholesterol and diabetes). The investigated plant was collected from different location at Wadi El-Gemal area. The uranium content was determined previously and different concentrations from the fruit with highest uranium content were used to examine the effect of *B. aegyptiaca* (fruit part) on the glucose, triglycerides, total cholesterol (HDL and LDL-cholesterol) levels using experimental rats. Different analysis techniques were used in order to determine different parameters. The obtained data suggest the beneficial role of *B. aegyptiaca* fruit as an anti-diabetic and hypo-lipidimic agent.

1. Introduction

Day after day medicinal plants gain more importance due to the presence natural antioxidants believed to exert their effect by reducing the formation of the final active metabolite of the drug-induced systems or by scavenging the reactive molecular species to prevent their reaching a target site [1,2] It has been documented that several medicinal plants show their hypoglycaemic effects associated with a significant alteration in the activity of liver hexokinase [3] and glucokinase [4]. *Balanites aegyptiaca* plant is one of these types of plants used locally in the treatment of diabetes. 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. In 2002 around 173 million people suffered from diabetes mellitus. Around two thirds of these people lived in developing countries. Diabetes epidemic spreads in the developing world; the number of people with diabetes will increase by 150% in the next 20 years, with an increasing proportion of affected people in younger age groups. This multiple disorder is characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from absolute or relative lack of insulin secretion and insufficient cellular effect of insulin respectively. The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs [5]. In developed countries more than half of all people with diabetes are older than 65 and only 8% of adults with diabetes are younger than 44 [6]. That a reliable, cost saving therapy with traditionally used plants could be a possibility to lower the problems of untreated diabetes because of a lack of synthetic drugs. On the other side medicinal plants contain an enormous potential for the development of new drugs and the efficient treatment of diabetes. But it is necessary that their effectiveness is proofed. This study deals with the effect of *B. aegyptiaca* species (that have the ability of uranium absorption) which grow naturally at some radioactive places in Wadi El-Gemal area on its efficiency in the treatment of diabetes. In other word we try to find if there was a correlation between the absorbed uranium on the plant efficiency in treatment of diabetes. Wadi El-Gemal is one of the main wadies in the Southeastern Desert of Egypt.

B. aegyptiaca follow the zygophliace family popularly called the 'desert date' (Heiglige in Arabia), it is a highly drought-tolerant evergreen desert plant species. *B. aegyptiaca* is a widely distributed African plant of medicinal interest containing a number of cytotoxic and cytostatic compounds. A mixture of steroidal saponins: balanitin-6 (28%) and balanitin-7 (72%) isolated from *B. aegyptiaca*

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kernels have anti-cancer activity [7]. The morphological structure of the kernel using a scanning electron microscope revealed that the protein matrix was embedded in a lake of oil droplets.

B. aegyptiaca protected the livers of treated mice against paracetamol *B. aegyptiaca* hepatotoxicity as evidenced by a significant improvement of liver function tests. *B. Aegyptiaca* had a relatively modest hepato-protective activity [8]. Extracts of Balanites aegyptiaca had a moderate biological activity on major promastigotes [9]. Chapagain et al. [10] revealed that saponins from in vitro cultures of the *B. aegyptiaca* roots can be used as a larvicidal agent against *B. aegyptiaca* larvae. The analysis of total saponin content of these tested extracts and fractions revealed a strong correlation between saponin content and larval mortality [11]. *B. aegyptiaca* has been used as various folk medicines in Africa and Asia where the fruit is used as fumigator in liver disease in Chad [12] the bark is used in treatment of Syphilis round worm infection and as fish poison [13], the fruit and branches were lethal to snails, miracidia cercae of schistosoma [14]. Also the importance of *B. aegyptiaca* is back to presence of a steroidal sapogenin compound named diosgenin which is useful in pharmaceutical industries as a natural source of steroidal hormones. Studies have also revealed that diosgenin produces changes in the lipoxygenase activity of human erythroleukemia cells and is responsible for morphological and biochemical changes in megakaryocyte cells [15,16].

Morsy [17] found that *B. aegyptiaca* species has the ability to uptake uranium (natural source of radiation) where the concentration of uranium ranges between 0.08 and 2.35 ppm. He also found that the elevated concentration of uranium has a clear passive effect on the saponin content and precisely on the diosgenin amount (Main active constituent). Also uranium has a negative effect on the oil content, while no effect was found on the total soluble sugar amount [17].

2. Materials and methods

The investigated plant species *Balanites aegyptiaca* is collected from uncultivated area located at Wadi El-Gemal area southeastern Desert (characterized by the presence of uranium as a natural source of radiation) with their associated soil samples (Fig. 1) the investigated plant were identified by the authors following [18]. The uranium content was determined in the plant to insure its safety to oral intake by experimental rats for biomedical treatment of some diseases. The investigated plant samples Fig. 2 were identified by the first author. The plant samples were air dried and ground into uniform powder using milling machine. The concentration of the uranium in the investigated plant species were previously analyzed and the data was published in Morsy PhD [17], where the uranium concentration ranged between 0.08 and 2.35 ppm variable concentrations from the fruit with highest uranium content (2.35 ppm) were used to examine the effect of *B. aegyptiaca* (fruit part) on the glucose, triglycerides, total cholesterol (HDL and LDL-cholesterol) levels using experimental rats.

2.1. Experimental animals

In the present study 50 rats were divided into five groups, each group consisted of 10 rats. Group one was the control group that received normal diet without *B. aegyptiaca*, while group 2–5 received normal diet mixed with *B. aegyptiaca* at variable doses of 3.6 g/week/rat, 5.4 g/week/rat, 7.2 g/week/rat and 9.0 g/week/rat

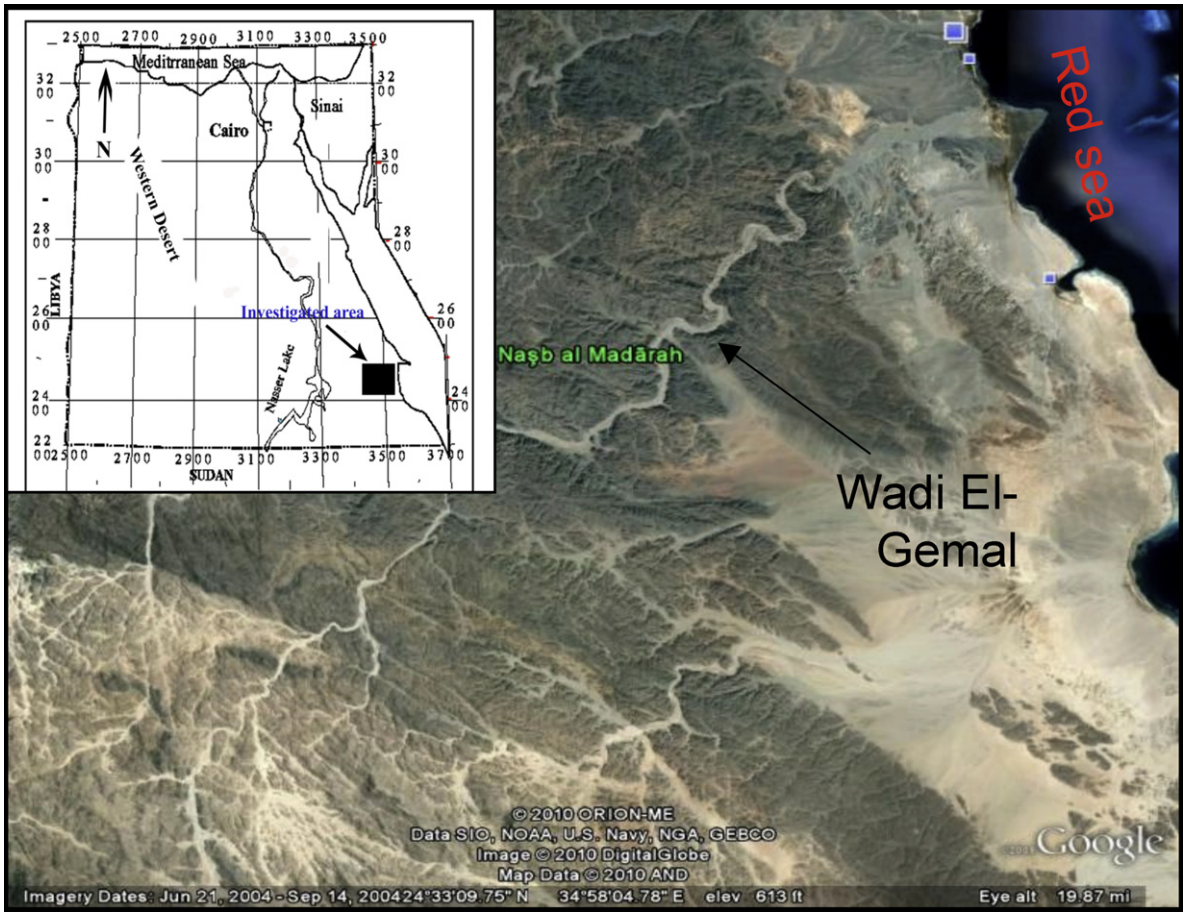

Fig. 1. Location map of the investigated plant samples Wadi El-Gemal area, Southeastern Desert, Egypt.

Fig. 2. The investigated *Balanites aegyptiaca* species, Wadi El-Gemal area, South-eastern Desert, Egypt.

respectively (random doses). After 10 days the rats were sacrificed and the blood were collected from the hearts, then the serum were separated immediately where some biochemical parameters were measured. All animals received 100 μl of 500 mg/dl glucose intravenously 2 h before collecting the blood.

2.2. Measurement of some biochemical parameters in the serum

The biochemical parameters (glucose, total cholesterol, Triglycerides, HDL-Cholesterol) were measured in the serum of all groups using different methods [19–23]. While LDL-cholesterol was measured in the serum according to the following formula:

$$\text{LDL-cholesterol} = \text{Cholesterol} - \text{Triglycerides} - \text{HDL-cholesterol}$$

All the grouped data was statistically evaluated via the Statistical Package for Social Sciences version 7.5 (SPSS Inc, Chicago, IL, USA). Hypothesis testing methods included one way analysis of variance

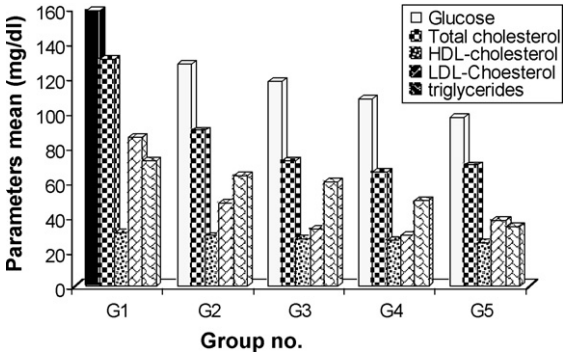

Fig. 3. Effect of *B. aegyptiaca* on different biochemical parameters of diabetic rats.

(ANOVA) followed by least significant differences test *p*-values of less than 0.05 were considered to indicate statistical significance. All the results were expressed as mean ± S.D. for ten animals in each group

3. Results and discussion

The obtained result in Table 1 and Fig. 3, indicated that the orally use of *B. aegyptiaca* decrease the blood glucose level, where by increasing the dose of the plant, the sugar concentration decrease and the recommended dose was that dose of G_3 where at this dose the blood glucose decreased and at doses higher than the dose of G_3 there is a slightly decrease in glucose concentration. This result agree with [24] who 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 *B. aegyptiaca* hypoglycaemic action may be through potentiation of pancreatic secretion of insulin from β-cell of islets or due to enhanced transport of blood glucose to the peripheral tissue.

The results obtained in Table 2 illustrated that the *B. aegyptiaca* had an effect on decreasing cholesterol level in the blood compared to that of the control group and the recommended dose was that dose of G_3 (5.4 g/week/rat) and this dose was chosen because of the low difference between the results obtained (mean of G_3 and G_5), so the low dose was recommended to decrease the side effect of the drug. These results agree with Kameswara [25] who stated that *B. aegyptiaca* fruit part lowered blood glucose with a simultaneous decrease in triglyceride and total cholesterol blood.

Table 1
Effect of *B. aegyptiaca* fruits on plasma glucose level on diabetic male rats.

Parameters	Groups				
	G_1	G_2 (3.6 g)[a]	G_3 (5.4 g)[a]	G_4 (7.2 g)[a]	G_5 (9 g)[a]
Glucose	158.9 ± 24.9	128.3 ± 13.6***	118.1 ± 10.2***	108.3 ± 13.3***	97.2 ± 8.1***

Each value is ±S.D. for 10 rats. Values not sharing superscript differ significantly at $p < 0.001$ for glucose.
[a] g/week/rat.

Table 2
Effect of *B. aegyptiaca* fruits on total cholesterol, HDL-cholesterol, LDL-cholesterol and triglycerides on diabetic rats.

Parameters	Groups				
	G_1	G_2	G_3	G_4	G_5
Total cholesterol	131.4 ± 68.4	90 ± 26.5**	72.8 ± 22.3**	66.1 ± 20.3**	70 ± 17.7**
HDL-cholesterol	30.8 ± 9.6	29.2 ± 11.7NS	27.4 ± 8.5 NS	26.5 ± 3.2 NS	25.1 ± 2.6 NS
LDL-cholesterol	86.2 ± 66.2	48 ± 31.1	33.3 ± 23*	29.6 ± 24.6*	38 ± 14.9
Triglycerides	72.3 ± 16.1	63.9 ± 23.5	60.2 ± 25.4	49.8 ± 20.8*	34.6 ± 30.9***

Each value is ±S.D. for 10 rats. Values not sharing superscript differ significantly at 0.05 for triglycerides, LDL, and HDL-cholesterol while at 0.01 for total cholesterols comparing to G_1.
NS = not significant.

By comparing the level of HDL-cholesterol compared to that of control group it is found that there is slightly difference between them and there is no clear effect of different dose on the level of HDL-cholesterol (Table 2). On the other hand it is found that at doses of 5.4 and 7.2 g/week/rat, there was a significant effect for *B. aegyptiaca* on the concentration of LDL-cholesterol (Fig. 3) These results agree with [26] who stated that *B. aegyptiaca* extract induced significant reduction in serum glucose, glucagons, total lipids, total cholesterol, triglycerides level and transaminases (AST, ALT and γGT) activities.

As for the concentration of triglycerides it is found that the effect of *B. aegyptiaca* on the of triglycerides concentration in the diabetic blood rats was found to be positive and precisely in group 5 where at the dose of 7.2 g/week/rat used the triglycerides concentration clearly decreased when compared with that of the control group.

4. Conclusion

These data show that a reliable, cost saving therapy with traditionally used plants could be a possibility to lower the problems of untreated diabetes because of a lack of synthetic drugs. On the other side medicinal plants contain an enormous potential for the development of new drugs and the efficient treatment of diabetes. But it is necessary that their effectiveness is proofed. In our study we found that although *Balanites aegyptiaca* grow on naturally radiated environment and the active constituent content was affected by the absorbed uranium (Morsy [17]) but it was found that *B. aegyptiaca* species are able to lower the blood sugar content and can be considered as high potential anti-diabetic plants which may be attributed at least in part to increased glucose metabolism and produces an increase in serum insulin (Samir et al. [26]) this mechanism belongs to first line therapies in diabetes treatment. The demonstrated results might be a base for further studies with plants. Also the plant fruit can be used for decrease the level of total cholesterol (HDL and LDL-cholesterol) and triglycerides, where the suitable dose for oral intake was 5.4 g/week/rat.

References

[1] E.R.B. Shanmugasundaram, G. Rajeswari, K. Baskaran, Use of *Gymnema sylvestre* leaf extract in the control of blood glucose in insulin-dependent diabetes mellitus, J. Ethnopharmacol. 30 (1990) 281–294.
[2] M. Kaleem, D. Kirmani, M. Asif, Q.U. Ahmad, B. Bano, Biochemical effects of *Nigella sativa* L seeds on diabetic rats, Indian J. Exp. Biol. 44 (2006) 745–748.
[3] T.P. Almdal, H. Vilstrup, Effect of streptozotocin-induced diabetes and diet on nitrogen loss from organs and the capacity of urea synthesis in rats, Diabetologia 30 (1987) 952–956.
[4] A. Jorda, M. Gomez, J. Cabo, S. Grisolia, Effect of streptozotocindiabetes on some urea cycle enzymes, Biochem. Biophys. Res. Commun. 106 (1982) 37–43.
[5] World Health Organization, Screening for Type 2 Diabetes: Report of a World Health Organization and International Diabetes Federation meeting, World Health Organization, Geneva, 2003.
[6] World Health Organization and International Diabetes Federation, Diabetes Action Now, 2004.
[7] C. Gnoula, V. Mégalizzi, N. De Nève, S. Sauvage, F. Ribaucour, P. Guissou, P. Duez, J. Dubois, L. Ingrassia, F. Lefranc, R. Kiss, T. Mijatovic, Balanitin-6 and -7: diosgenyl saponins isolated from *Balanites aegyptiaca* Del. display significant anti-tumor activity in vitro and in vivo, Int. J. Oncol. 32 (1) (2008) 5–15.
[8] B.H. Ali, A.K. Bashir, R.A. Rasheed, Effect of the traditional medicinal plants *Rhazya stricta*, *Balanitis aegyptiaca* and *Haplophylum tuberculatum* on paracetamol-induced hepatotoxicity in mice, Phytother. Res. 15 (7) (2001) 598–603.
[9] F. Fatima, A. Khalid, N. Nazar, M. Abdalla, H. Mohomed, A.M. Toum, M. Magzoub, M.S. Alı, In vitro assessment of anti-cutaneous leishmaniasis activity of some Sudanese plants, Turkiye Parazitol. Derg. 29 (1) (2005) 3–6.
[10] B.P. Chapagain, V. Saharan, Z. Wiesman, Larvicidal activity of saponins from *Balanites aegyptiaca* callus against *Aedes aegypti* mosquito, Bioresour. Technol. 99 (5) (2008) 1165–1168.
[11] Z. Wiesman, B.P. Chapagain, Larvicidal activity of saponin containing extracts and fractions of fruit mesocarp of *Balanites aegyptiaca*, Fitoterapia 77 (6) (2006) 420–424.
[12] P. Croach, Phytochemical survey of some medicinal plants used in Sudanese folk-medicine, J. Afr. Med. Plants 6 (1962) 79–105.
[13] P.R.D. Bailey, in: J.M. Watt, N.G. Breyer-Brandwijk (Eds.), Medicinal and Poisonous Plants of Southern and Eastern Africa, Livingstone, Ltd., London, 1962.
[14] J.M. Watt, M.G. Breyer-Brandwijk, The Medicinal and Poisonous Plants of Southern and Eastern Africa, Livingstone, Ltd., London, 1962.
[15] J.L. Beneytout, C. Nappez, M.J. Leboutet, G. Malivvand, A plant steroid, diosgenin a new megakaryocytic differentiation induce of HEL cell, Biochem. Biophys. Res. Commun. 207 (1995) 398–404.
[16] C. Nappez, B. Liagre, J.L. Beneytout, Changes in lipoxygenase activities in human erythroleukemia (HEL) cells during diosgenin induced differentiation, Cancer Lett. 96 (1995) 133–140.
[17] A.M.A. Morsy, Environmental and biochemical assessment of some wild plants growing south of the eastern desert, Ph.D. thesis, Dept of Biochem., Fac. of Agric., Ain Shams Univ., 2008, pp. 1–161.
[18] Lotfy Boules, Medicinal plants of North Africa, Reference publication, Inc., Agonac Michigen 48001 Box, 1983, p. 344.
[19] P. Trinder, Enzymatic measurement of glucose, Ann. Clin. Biochem. 6 (1969) 24.
[20] W. Richmond, Enzymatic colorimetric method of cholesterol, Clin. Chem. 19 (1973) 1350.
[21] M.F. Lopez-Virella, Enzymatic colorimetric method of HDL-cholesterol, Clin. Chem. 23 (1977) 882.
[22] C.A. Burtis, E.R. Ashwood, D.E. Brums (Eds.), Tietz Fundamentals Textbook of Clinical Chemistry, vol. 22, 6th ed., Saunders, Philadelphia WB, 2008, p. 382.
[23] W. Marshall, S. Bangert, Clinical Chemistry, 6th ed. Philadelphia, USA, 2008, 14, 271.
[24] Neuwinger HD, Pflanzen zur behandlung von Diabetes mellitus in der afrikanischen traditionellen medizin, Z. Phytother. 25 (2004) 224–233.
[25] R. Kameswara, B. Giri, M.M. Kesavulu, C. Apparao, Herbal medicine in the management of diabetes mellitus, Manphar Vaidhya 1 (1997) 33–35.
[26] A.M. Samir, Z.A. Zaahkouk Somaia, A.F. Rashidand Mattar, Anti-diabetic properties of water and ethanolic extracts of *Balanites aegyptiaca* fruits flesh in senile diabetic rats, Egypt. J. Hosp. Med. (2000) 1.