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The Effects of Plant Extracts on Plasma Glucose Levels in Rats

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Summary. **The purpose of this study was to investigate the effects of various plant extracts of the genus used elsewhere on plasma glucose and serum insulin concentrations in normal and diabetic rats. Extracts of *Solanum incarnum* ripe fruit, *Solanum incarnum* roots, *Opuntia megacantha* leaves, *Aloe chabaudii* leaves, *Morus alba* leaves, *Ficus thoningii* bark, *Allium sativum* bulb and *Tapinathus nyasicus* leaves were given orally over a 5 week period at a dose of 20 mg/100 g body weight to normal rats and rats made diabetic by streptozotocin (STZ). All the plants except *S. incarnum* roots and *T. nyasicus* leaves lowered plasma glucose concentrations. *M. alba* leaves, *A. sativum* bulb and *F. thoningii* bark had the greatest effect in both normal and diabetic rats, lowering glucose by between 17-31% in normal rats and 17-21% in diabetic rats in comparison with their respective controls. The plant extracts did not have any significant effects on plasma insulin levels in either normal or diabetic rats. The mechanisms for the hypoglycaemic effects observed are not clear but appear to involve mechanisms the are not insulinometric.**

Key words—diabetes mellitus, hypoglycaemic plants, rats, insulin.

INTRODUCTION

The use of plant extracts in managing various disorders in developing countries has increased in the last few years, as this method is cheap and easily accessible. In Asia, South and Central America, plants such as *Aloe barbadensis, Opuntia streptacantha* and *Solanum verbascifolum* are used in the treatment of diabetes.[1,2,3] We therefore collected herbs of the same genus or closely related to those used in these parts of the world and investigated their effects on plasma glucose concentrations and serum insulin levels in normal and in streptozotocin (STZ)-induced diabetic rats. We have previously employed the STZ-diabetic rat model to study disorders associated with chronic diabetes mellitus.[4] Streptozotocin selectively destroys β cells of the pancreas[5] to induce insulin dependent diabetes. The systemic changes that occur after its injection are considered related to the induced diabetic state.[6]

MATERIALS AND METHODS

Preparation of plant extract

Plants were collected from areas around Harare in Zimbabwe and authenticated at the National Herbarium, Ministry of Lands, Agriculture and Water Development, where voucher specimens are deposited. Roots, leaves, bulbs and barks were homogenised using a blender, and dried for 48 hr at 40℃. 100 g of plant material was mixed with 150 ml of 80% ethanol and stirred for four hours and filtered. The filtrate was dried in an evaporator and redissolved in saline.

Animals

Experiments were performed on male Sprague-Dawley rats (300-400 g) bred and housed at the Animal house at the University of Zimbabwe. The rats were kept in separate cages that were cleaned daily and were given water and food (mouse comproids, National Foods, Harare) *ad-libitum*.

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Experiment A

Non-diabetic rats were divided into the following groups of eight each, and were given 20 mg/100 g body weight of the particular plant extract daily for 5 weeks by means of a bulbed steel tube passed orally into the stomach: Control, *S. incarnum* roots, *S. incarnum* ripe fruit, *O. megacantha* leaves, *A. chabaudii* leaves, *M. alba* leaves, *F. thoningii* bark, *A. sativum* bulb and *T. nyasicus* leaves. Controls rats were given saline.

Experiment B

The rats were made diabetic by an intra-peritoneal (i. p) injection of streptozotocin (STZ 60 mg/kg body weight) in citrate buffer pH 6.3. control animals were injected with citrate buffer. Animals that exhibited glycosuria after 24 h, as tested by Medi-Test Combi 9 (Boehringer) were considered diabetic. The rats were then divided and treated as in Experiment A.

Measurement of glucose and insulin

All blood was collected by decapitation. Blood for glucose was collected into fluoride tubes and glucose was measured by the glucose oxidase method immediately after collection. Blood for insulin was collected into plain tubes and spun and frozen immediately at −70℃ until assayed. The measurements was done by a radioimmunoassay (Amersham, Rat Insulin [^{125}I] assay system with Amerlex ™-M magnetic separation) and counts read on the LKB 1261 multigamma counter Wallac (Finland).

Data analysis

Results are expressed as mean ± standard error. Data was processed using unpaired student's t-tests. A p value of less than 0.05 was considered significant.

RESULTS

Tables 1 and 2 compare plasma glucose and serum insulin concentrations in normal and STZ-diabetic rats. Plasma glucose concentrations were significantly ($p<0.01$) increased in diabetic rats by comparison with controls (37.68±1.09 mmol/l versus 7.49±0.09 mmol/l, n=8 in both groups). Serum insulin levels were also significantly ($p<0.01$) reduced in STZ-diabetic rats by comparison with controls (1.24±0.14 ng/ml versus 13.62±0.61 ng/ml, n=8 in both groups).

In comparison with normal controls, plasma glucose levels were lowered in rats administered with *M. alba* leaves (31%), *A. sativum* bulb (31%), *F. thoningii* leaves (27%), *O. megacantha* leaves (16%), *S. incarnum* ripe fruit (13%), *A. chabaudii* leaves (12%), in normal rats. However, *S. incarnum* roots and *T. nyasicus* leaves did not change plasma glucose

Table 1. Effect of herbs on terminal plasma glucose and serum insulin in non-diabetic rats after 5 weeks. Control rats were given saline and experimental rats 20 mg/100 g body weight of the extract daily (n=8 in all groups)

	Glucose mol/l	*p value	Insulin ng/ml	*p value
Control	7.49±0.09		13.62±0.61	–
S. incarnum (roots)	7.48±0.06	–	11.88±0.38	–
S. lncaarnum (ripe fruit)	6.49±0.12	<0.05	11.95±0.45	–
O. megacantha (leaves)	6.31±0.13	<0.01	12.56±0.57	–
A. chabaudii (leaves)	6.61±0.10	<0.01	13.00±0.57	–
M. alba (leaves)	5.16±0.06	<0.01	12.73±0.67	–
F. thoningi (bark)	5.48±0.13	<0.01	13.23±0.33	–
A. sativum (bulb)	5.15±0.07	<0.01	12.28±0.64	–
T. nyasicus (leaves)	7.28±0.08	–	12.23±0.40	–

*p value is compared with the control group.

Table 2. Effect of herbs on terminal plasma glucose and serum insulin in STZ-diabetic rats after 5 weeks. Control rats were given saline and experimental rats 20 mg/100 g body weight of the extract daily (n=8 in all groups)

	Glucose mol/l	*p value	Insulin ng/ml	*p value
Control	37.68±1.09		1.24±0.14	–
S. incarnum (roots)	38.84±1.11	–	2.09±0.71	–
S. lncarnum (ripe fruit)	33.51±0.55#	<0.05	0.99±0.41	–
O. megacantha (leaves)	30.71±0.73*	<0.01	1.49±0.19	–
A. chabaudii (leaves)	32.78±0.61#	<0.05	2.17±0.84	–
M. alba (leaves)	31.16±0.62*	<0.01	0.89±0.35	–
F. thoningii (bark)	29.90±0.91*	<0.01	1.86±0.55	–
A. sativum (bulb)	30.12±0.91*	<0.01	2.21±1.00	–
T. nyasicus (leaves)	34.40±0.79	–	1.34±0.22	–

*p value is compared with the control group.

levels (Table 1).

In diabetic rats, *F. thoningii* bark lowered plasma glucose by 21%, *A. sativum* bulb by 20%, *O. megacantha* leaves, 19%, *M. alba* leaves, 17%, *A chabaudii* leaves, 13%, *S. incarnum* ripe fruit, 11% and *T. nyasicus* leaves, 9% by comparison with the diabetic controls. No effect was observed in rats on *S. incarnum* roots. There were also no significant changes in serum insulin levels observed between control rats and rats administered with extract in either normal or diabetic rats.

DISCUSSION

S. incarnum ripe fruit, *O. megacantha* leaves, *A. chabaudii* leaves, *M. alba* leaves, *F. thoningii* bark lowed plasma glucose in rats and *A. sativum* bulb lowered plasma glucose in rats after 5 weeks of study. However, *S. incarnum* roots and the leaves of *T. nyasicus* did not have any effect on plasma glucose concentrations. Although the ripe fruit of *S. incarnum* lowered plasma glucose concentration, the roots of the same plant did not have any significant effect. Al-khazraji et al. using *Artemisia herba alba*, showed that different parts of plants could have different hypoglycaemic effects.[7]

A pelargonidin derivative isolated from the bark of *F. bengalensis* has been reported to decrease fasting blood glucose in isolated perfused pancreae from moderately diabetic rats.[8] In this study glucose tolerance and insulin secretion were also improved. The present study has demonstrated a decrease in plasma glucose concentrations in both normal and diabetic rats, with no effect in serum insulin levels. Using boiled stems of *O. streptacantha*, Frati et al. reported a significant decrease in serum glucose levels in normal humans and type II diabetic subjects.[9] In both cases C-peptide, an index of insulin production,[10] remained unchanged. This is in agreement with the present study since the plants studied did not change serum insulin levels.

Since streptozotocin selectively destroys the β cells of the pancreas, we would expect the herbs to exert no effect in STZ diabetic rats if the mode of action is mediated through insulin production. However, our results show that the herbs decrease plasma glucose levels in diabetic rats, suggesting that other factors may also be involved. We suggest that the plants exert their effect by either promoting the entry of glucose into cells, stimulation of glycolytic enzymes and glycogenic enzymes and hormones, depression of gluconeogenic enzymes and hormones, or a decrease in food absorption.

CONCLUSION

Although the plants investigated have shown a hypoglycaemic effect, it seems that, in severe hyperglycaemia as induced by streptozotocin in this study, their effect is minimal at the dosage we used. Increasing the dosage did not appear to have any effect (Unpublished observations). The herbs could be of effect in mild diabetes or in cases of glucose tolerance impairment. It would be of interest if these herbs would slow or reverse the progression of diabetic complications.

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REFERENCES

1) Lin CC: Crude drugs used for the treatment of diabetes mellitus in Taiwan. *Amer J Chi Med* **20:** 269-279, 1972.
2) Roman-Ramos R, Flores-Saenz JL, Partida-Hernandez G, Lara-Hemus A: Experimental study of the hypoglycemic effects of some antidiabetic plants. *Arch Invest Med* **22:** 87-93, 1991.
3) Ajabnoor MA: Effect of aloes on blood glucose levels in normal and alloxan diabetic mice. *J Ethnopharmacol* **28:** 215-220, 1990.
4) Bwititi P, Msamati BC, Musabayane CT: Ultrachanges in the kidney of streptozotocin diabetic rats. *Centr Afr J Med* **38(Suppl):** 5, 1992.
5) Grussner R, Nakhleh R, Grussner A, Tomadze G, Diem P, Sutherland D: Streptozotocin-induced diabetes in pigs. *Horm Met Res* **25:** 199-203, 1993.
6) Seyer-Hansen K: Renal hypertrophy in experimental diabetes mellitus. *Kidney Int* **23:** 643-646, 1983.
7) Al-Khazraji M Shahba, Al-Shamaony A Loai, Husni A. Twaij: Hypoglycemic effect of Artemisia herba alba. *J Ethnopharmacol* **40:** 163-166, 1993.
8) Cherian S, Kumar RV, Augusti KJ, Kidwai JR: Antidiabetic effect of a glycoside of pelargonidin isolated from the bark of *Ficus bengalensis*. *Ind J Biochem Biophys* **29:** 380-382, 1992.
9) Frati AC, Xilotl Diaz N, Altamiramo P, Ariza R, Lopez-Ledesma R: The effect of two sequential doses of *O. streptacantha* upon glycaemia. *Arch Invest Med* **22:** 333-336, 1991.
10) Junod A, Lambert AE, Stauffacher W, Renold AE: Diabetogenic action of streptozotocin: relationship of dose to metabolic response. *J Clin Invest* **48:** 2129-2139, 1969.