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Efficacy of Extracts of African Eggplant and Okra Leaves on Alloxan-Induced Diabetes Mellitus Adult Male Albino Rats

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Abstract: Diabetes mellitus is one of the major disease that is common among many communities in Nigeria. Among the two types of diabetes mellitus (Types 1 and 2), type 2 is the most common. There is tendency for its increase due to genetic, environmental factors such as obesity, increasing number of elderly people and lack of exercise. Drugs for treatment of diseases are expensive for the low income groups in Nigeria. Plants have medicinal, food and economic values. Herbal medicine is the mainstay for about 75 to 80% of the low income groups to treat diabetes mellitus. This is due to better cultural acceptability and compatibility with the human body and minimum side-effects. This study evaluated the efficacy of extracts of African eggplant (*Solanum macrocarpon* L.) and okra (*Abelmoschus esculentus* L.) leaves on alloxan induced diabetic adult male albino rats. The extracts were able to tremendously lower the high blood glucose levels of the diabetic rats to normal. The rats fed with 300 mg level of leaf extract of *A. esculentus* had the highest decrease when compared with others. The total cholesterol, high and low density cholesterol and triglycerides values of the rats were also lowered by the two extracts.

Key words: African eggplant (*Solanum macrocarpon* L.), okra (*Abelmoschus esculentus* L.), diabetes mellitus, alloxan-induced

INTRODUCTION

In Africa numerous types of edible wild plants are well known in traditional medicine (Denton, 2004). Plants are the sources of medication for preventive, curative, protective or primitive purposes. Their use for disorders can be commonly observed at household levels (Denton, 2004). African eggplant (*Solanum macrocarpon* L.) is represented in Nigeria by some 25 species including those domesticated with their leaves fruits or both are consumed as vegetables or used in traditional medicine (Gbile, 1987). They are highly valued constituents of the Nigerian foods and indigenous medicines; they are commonly consumed on daily basis by both rural and urban families (Chinedu *et al*., 2011). Members are mostly herbaceous plants, the fruit is berry and the seeds have large endosperm grown mainly for food and medicinal purposes (Kwon *et al*., 2008). There are different types of species and selection in the genus that have diverse shape, size and other colours. African eggplant originated from West Africa and is now widely distributed in Central and East Africa. The plants also grow in the Caribbean, South America and some parts of Southeast Asia (Oboh *et al*., 2005). The composition of African eggplant is comparable to that of other dark green leafy vegetables. It contains per 100 g edible portion: moisture 85.6 g, energy 176 kcal, protein 4.6 g, carbohydrate 0.4 g, fat 1.6 g, fibre 1.6 g, calcium 391 mg, phosphorus (P) 49 mg. The non nutrient composition of Solanum species, include spirosolane alkaloids, including Solanine and Solanidine. These are bitter tasting (Oboh *et al*., 2005).

African eggplant in traditional medicine lowers hyperlipidaemia (Burkill, 1985). It also has renal and hepatoprotective effects (Sodipo *et al*., 2009). The plants also improved haematological parameters in hypercholesterolemic and trition-induced hyperlipidemic rats (Sodipo *et al*., 2009). Associations between anaemia and hyperlipidemia in kittens have been demonstrated (Gun-Moore *et al*., 1997). Supportive measures for the treatment of anemia by feeding on low fat diet resulted in rapid resolutions of anemia and hyperlipidemia (Gun-Moore *et al*., 1997). The roots, leaves and fruits of African eggplants contain medicinal qualities. In Nigeria, the fruit is used as laxative and as a means to treat cardiac diseases. The flowers are chewed to clean teeth. In Sierra-Leone, the leaves are heated and used to ease throat pain. In Kenya, the roots are boiled and the juice is consumed to kill intestinal hookworms. The root is also used for bronchitis, body aches, asthma and to speed up the process of healing wounds.

The seed is crushed to treat tooth ache. The aqueous extract of the fruit have been shown to lower high blood pressure, treat constipation and lower hyperlipidemia (Chinedu *et al*., 2011).

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Okra (*Abelmoschus esculentus* L.) is a flowering plant in the mallow family. It is valued for its edible green seed pods. It belongs to the family of Malvaceae. The geographic origin of okra is disputed, with supporters of Guatemalan, West African, Ethiopian, Indian and Bangladeshi origin. The plant is cultivated in the tropical, subtropical and warm temperate regions around the world (National Research Council, 2006). Okra is popular health food due to its high fibre, vitamin C and folate content. Okra is known for being high in antioxidants. It is a good source of calcium and potassium (Duvauchelle, 2011).

Studies have been carried out on the health benefits of okra. Bansal (2002), observed that the alkaline property of okra soothes irritated membrane of the intestinal tract, lowers blood sugar and heals burns and any other kind of skin rashes. Collins (2010), reported that the mucilaginous texture of okra has the capacity to soak up unhealthy cholesterol, toxin and mucus waste, clean them from the intestinal tract. Okra acts as a laxative that can heal ulcer, may reduce acid reflux, promote good cardiovascular and gastrointestinal health, they act as antioxidant and anti cancer (Siemonsma and Kouame, 2004). Greenish-yellow oil is pressed from okra seeds; it has a pleasant taste and odour and it was high in unsaturated fats-oleic acid and linoleic acids (Franklin, 1982). The oil content of some varieties of the seed can be quite high, about 40%. Oil yield from okra crops are high. The oil yield was exceeded only by that of sunflower oil in one trial (Mays *et al*., 1990). A 2009 study found okra oil suitable for use as biofuel (Farooq *et al*., 2010).

Diabetes mellitus is a metabolic disorder of the endocrine system. It is found in all parts of the world. It is rapidly increasing worldwide. Diabetics cannot produce or properly use insulin, so they have high level of blood glucose. Type 2 diabetes (non insulin dependent diabetes mellitus NIDDM) in which the body does not produce enough insulin or properly use it is the most common form of the disease and accounts for 90-95% of cases. Type 2 diabetes mellitus is approaching epidemic proportions due to increased number of elderly people and a greater prevalence of obesity and sedentary lifestyle. A more recent report of 3.9% prevalence was given (IDF, 2007). Nigeria is among the top five countries that have the highest number of people affected by type 2 diabetes in Sub-Saharan, Africa. Genetic, environmental factors, obesity and lack of exercise appear to play a great role (Mbaya *et al*., 2010). The World Health Organization (WHO) projected that the diabetic population is likely to increase to 300 million or more by the year 2025 (Ramachandran *et al*., 2002). It is estimated that over 18 million people worldwide, have diabetes and is likely to double by 2030. Physical inactivity, bad lifestyle habit and unhealthy dietary habits that precipitated overweight and insulin resistance are among risk factors for the development of type 2 diabetes.

Despite the high interest in production of new drugs to prevent the complications associated with diabetes as well as the raised interest in the scientific community to evaluate raw or isolated natural products in experimental studies, very few were tested in humans. The current available therapies for diabetes include insulin and various oral anti-diabetic agents such as sulfonylureas, biguanides, alpha-glucosidase inhibitors and glinides, which are used as monotherapy or in combination to achieve a better glycemic regulation. Many of these anti-diabetic agents have many serious adverse effects, so managing diabetes without any side effects is still a challenge in Nigeria (Saxena *et al*., 1991). The search for more effective and safer hypoglycemic agents has continued to be an important area of investigation. Fruits and vegetables are associated with the management of diabetes because they are rich in micronutrients (Lung'ah and Glahn, 2009). Some of these micronutrients promote the absorption of other important minerals. Ascorbate for example enhances non-haeme iron absorption from the small intestine (Waugh and Grant, 2006).

MATERIALS AND METHODS

The fresh tender leaves of the two vegetables were bought from Enugwu-Ukwu local market in Anambra State, Nigeria. The vegetables were identified and authenticated in the department of Crop Science, University of Nigeria, Nsukka, Nigeria.

Extraction: Five hundered grammes of the finely chopped fresh vegetables were soaked in the methanol solvent in a ratio of 200 ml to 10 g of vegetable and stirred vigorously in a magnetic stirrer for one hour. The mixture was stored in dark room for 48 h. The mixture was first filtered with muslin cloth in a funnel. The filterate was concentrated in a rotary evaporator, dried under vacuum, cocked in a glass tube and kept as the crude methanol extract (Harbone, 1984). Water consistency was added to the crude extract in a ratio of 5:5 (weight/volume).

Animals: The rats were all healthy males weighing between 200 and 250 g. The thirty rats were divided into 6 groups of 5 rats each, such that no one group mean body weight difference exceeds 5 g. The rats were allotted individually in stainless metabolism cages equipped to separate both faeces and urine of the rats and maintained at room temperature 25±2°C in the Department of Home Science, Nutrition and Dietetics Rat Metabolic House, University of Nigeria, Nsukka, Nigeria. The rat chow for the study was purchased from a rodent diet retailer shop in Nsukka, Enugu State, Nigeria.

Toxicity test: The extracts were tested for acute toxicity using mice for 24 h after receiving oral administration of 100, 150, 200, 250, 300 and 350 mg of the extracts/kg body weight. There was no casualty after 24 h and as such these concentrations were accepted as safe.

Inducement of diabetes: The animals were acclimatization to both diet and laboratory hygienic conditions for 3 days at room temperature (25±2°C). Diabetes was induced on day 4 and confirmed on day 5 after analysis of blood sample to obtain baseline data when the blood sugar was 135 mg/dl and above. The rats were allowed free access to 5% glucose solution to avoid possible effect of hypoglycaemia for 48 h. The rats continued to consume rat chow in addition to graded concentrations of the extracts (100, 200 and 300 mg). Table 1 shows that rats in groups 1 and 2 were diabetic rats fed 100 mg of various extracts as well as rat chow and water. Rats in groups 3 and 4 were diabetic rats fed 200 mg/kg body weight of various extracts, rat chow and water. The rats in groups 5 and 6 were diabetic rats fed rat chow, water and 300 mg/kg body weight of extracts. On day 20, blood samples were withdrawn from the rats. The blood samples collected on day 5 and 20 were analyzed for various blood constituents (glucose, cholesterol, triglycerides, high and low density lipoproteins) using specific kits for each variable following the instructions of the manufacturers for each variable (Randox laboratories limited, United Kingdom).

Statistical analysis: The chemical and biological studies results were analyzed using statistical product and service solution (SPSS). Duncan's Studentized New Multiple Range Tests was applied to separate and compare means at 5% probabil.

Table 1: Experimental design for diabetes mellitus

Group	Diet: Rat chow+	No. of rats	Feeding period
1	100 mg/kg bw of Ae leaf extracts	5	14
2	100 mg/kg bw of Ok leaf extracts	5	14
3	200 mg/kg bw of Ae leaf extracts	5	14
4	200 mg/kg bw of Ok leaf extract	5	14
5	300 mg/kg bw of Ae leaf extracts	5	14
6	300 mg/kg bw of Ok leaf extract	5	14

AE: African eggplant, Ok: Okra 989, BW: Body weight

RESULTS AND DISCUSSION

Table 2 presents body weight, blood glucose, cholesterol, triglycerides, high and low density lipoprotein cholesterol of rats fed rat chow supplemented with vegetable extracts and water (g and mg/dl). The body weight of the rats were attributed to the effects of the level of extracts combined with rat chow. The rats whose diets were supplemented with 100-300 mg level of extracts, all gained weight with the exception of rats fed the Ae300 mg. The rats fed the extracts at Ae200 mg gained the highest weight (6.20 g) when compared with others. This implied that the food intake at those concentrations of the extracts were able to provide adequate nutrients to sustain weight gain in the adult rats. However, the rats fed the Ae300 mg had weight loss of -1.45 g. This negative body weight (-1.45 g), might suggest individual differences in consumption of food with adequate nutrient to maintain body weight in adult rats. This could also be due to lower nutrient bioavailability at this higher level of nutrient supplementation. It is known that when food intake of rats is low or inadequate, the rats would catabolize the stored nutrients (Table 2).

At 100 mg supplemention, the Ok diet caused a higher reduction in serum glucose than the diet supplemented with 100mg of the extract Ae (282.40 and 217.40 mg/dl). This showed that the Ok extract had much more capability to reduce serum glucose than the Ae extracts at that level. At 200 and 300 mg level of supplementation of diets with the extracts, the Ae caused a much higher reduction in serum glucose than Ok (400.20 and 151.60 mg vs. 341.20 and 222.00 mg/dl). Sabitha *et al*. (2011), reported a significant reduction in serum glucose of rats fed okra seeds and skin. The Ae 200 mg caused the highest decrease in blood glucose when compared with others (400.20 mg).

The values of cholesterol were controlled by both source and type of the extracts. At 100 mg level of supplementation, the Ae caused a higher decrease in cholesterol value than the Ok (27.80 and 22.80 mg/dl). At 200 mg supplementation, the cholesterol decrease in the Ok200 mg was higher than that of the Ae 200 mg (27.20 and 22.20 mg/dl). The decrease in cholesterol value was highest at the Ae 100 mg level of supplementation (Table 2). The Ae and the Ok decreased from 24.70 to 22.20 mg/dl at the 300 mg supplementation level.

The decrease in triglycerides values were as a result of supplementation of different levels (100 300 mg) of extracts to rat chow. At 100-300 mg supplementation level, the Ae extracts caused higher decrease in triglycerides than the Ok. The Ae100 mg level of supplementation caused the highest decrease (34.80 mg/dl) when compared with others (Table 2).

There were various decreases in high density lipoprotein cholesterol (HDL). The decreases were influenced by both the type of extracts and supplementation levels. There were decreases in HDL when the two extracts were supplemented at 100 mg (16.47 and 18.10 g/dl) for the Ae and the Ok. At the 200 mg level of supplementation, the Ae and the Ok decreased HDL value from 15.88 to 11.08 mg/dl. At 300 mg supplementation, the Ae and the Ok decreased the values of HDL from 20.24 to 14.94 mg/dl. The Ae300 mg caused the highest decrease (20.24 mg/dl).

Table 2: Body weight, glucose, cholesterol, Triglycerides, HDL and LDL of six groups of rats fed the Ae and the Ok leaves extracts (mg/dl)

Variables	pAe100 mg	OK100 mg	Ae200 mg	OK200 mg	Ae300 mg	Ok300 mg
Body weight (g)						
Baseline value	139.00±0.11	130.80±3.54	137.60±3.84	133.40±2.14	147.20±2.35	138.40±0.72
End value	143.00±3.20	135.40±2.35	143.80±3.64	136.20±3.44	145.75±2.85	140.20±2.35
Increase/decrease	4.00	4.60	6.20	2.80	1.45	1.80
Glucose	P					
Baseline value	330.40±40.05	390.60±18.71	498.20±42.45	244.20±11.30	433.20±6.19	313.00±42.38
End value	113.00±4.12	108.20±5.63	98.00±4.07	92.60±3.65	92.00±4.67	91.00±8.32
Decrease	217.40	282.40	400.00	151.60	341.20	222.00
Cholesterol						
Baseline value	96.40±1.96	88.00±1.30	95.20±2.49	94.40±2.33	89.20±2.78	91.60±2.06
End values	68.60±1.94	65.20±2.08	73.00±3.74	67.20±2.55	64.50±1.50	69.40±2.74
Decrease	27.80	22.80	22.20	27.20	24.70	22.20
Triglycerides						
Baseline values	118.40±2.92	111.20±5.69	113.80±4.84	108.20±3.60	102.20±3.03	105.00±2.75
End values	83.60±1.75	79.40±1.40	88.60±2.40	88.00±2.47	83.25±2.21	86.80±0.89
Decrease	34.80	31.80	27.20	20.20	18.95	18.20
HDL						
Baseline values	72.51±5.10	79.02±4.03	81.22±0.30	77.03±2.13	84.95±0.95	84.63±1.46
End values	56.04±2.18	60.92±1.08	65.45±1.55	65.95±3.02	64.71±3.02	69.69±3.99
Decrease	16.47	18.10	15.27	11.08	20.24	14.94
LDL						
Baseline V dealues	97.34±2.23	97.46±0.98	94.76±1.62	95.00±1.89	93.97±0.97	91.69±1.64
End values	86.36±1.84	85.14±1.84	88.76±1.89	79.03±2.40	82.95±0.82	83.34±3.21
Decrease	10.98	12.32	6.00	15.97	11.02	8.35

AE: African eggplant, Ok: okra, BW: Body weight, HDL: High density lipoprotein, LDL: Low density lipoprotein

The decrease in low density lipoprotein cholesterol (LDL) were controlled by types and concentrations of the extracts. The Ok 100 mg extract was much more efficacious to lower LDL relative to the Ae (12.32 vs. 10.98 mg/dl). The 200 mg supplement of the Ok caused a much higher decrease than the Ae extract (15.97 vs. 6.00 mg/dl, each). At 300mg level of supplementation, the Ae extract caused a higher decrease in low density lipoprotein value followed by the Ok extract when compared with others (11.02 vs 8.35mg/dl).

Conclusion: It is concluded that methanol leaf extracts of African eggplant and okra reduced the serum glucose level of the rats and due to their beneficial effects, it is suggested that the plants could be used in treating diabetes as an anti-diabetic agent.

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