ORIGINAL ARTICLE

Effect of Unripe Plantain (*Musa paradisiaca*) and Ginger (*Zingiber officinale*) on Renal Dysfunction in Streptozotocin-Induced Diabetic Rats

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ABSTRACT

Context Although unripe plantain *(Musa paradisiaca)* and ginger *(Zingiber officinale)* are used as single plants to manage diabetes mellitus in Nigeria, the possibility of combining them in a typical diabetic diet and the glycemic response elicited as a result of such combination has not been investigated. **Objective** To determine the effect of unripe plantain and ginger on serum total proteins, albumin, creatinine and urea levels of streptozotocin induced diabetic rats. **Methods** Twenty four male albino rats were used and were divided into 4 groups of 6 rats each. Group 1 (non-diabetic) received standard rat feeds; Group 2 (diabetic) received standard rat feeds; Group 3 received unripe plantain pellets and Group 4 received unripe plantain+ginger pellets. **Results** There were significant increases (P=0.045) of both serum urea and creatinine, but significant decreases (P=0.045) of both serum total protein and albumin levels, in Group 2 rats compared with Group 1. There were significant decreases (P=0.033) of both serum urea and creatinine levels of Group 3 and 4 rats compared with Group 2. In addition, there were significant increases of both serum total protein and albumin levels (P=0.033) in Group 3 rats compared with Group 2, but the comparison of serum total protein and albumin levels between Group 4 and Group 2 did not reach the significant level (P=0.056 and P=0.065 for serum total protein and albumin levels, respectively. Conclusion Combination of unripe plantain and ginger at the ratio used in the management of renal dysfunction in diabetics was not very effective compared with unripe plantain alone.

INTRODUCTION

Diabetes mellitus is a metabolic disease characterized by hyperglycemia, resulting from partial or total destruction of the pancreatic β-cells [1].

Although insulin and other synthetic drugs such as biguanides, sulphonylureas, α -glucosidase inhibitors are used for the management of diabetes mellitus, there are side effects like hypoglycaemia, frequent diarrhoea, hypertension, hypercoagulability, lactic acidosis, hepatotoxicity and dyslipidemia [1].

Despite much research work, the diabetic kidney epidemic keeps increasing, and over 40% of diabetic patients worldwide have been reported to develop severe diabetic nephropathy [2]. Patients with diabetic kidney failure undergo either painful dialysis or kidney transplant which is costly and harmful. This has therefore led to the increased interest in research into plants with anti-diabetic potentials.

Plantain (*Musa paradisiaca*) is a staple crop in the humid and sub-humid parts of Africa, Asia, Central and South America that is usually eaten as an energy yielding food. In folklore medicine, unripe plantain is used in the management of management of diabetes, renal and liver dysfunction [3]. The hypoglycaemic action of unripe plantain in experimental animals has been reported [4]. In folklore medicine, unripe plantain is useful for inducing weight loss/management of obesity, treatment of anemia, management of diabetes, renal and liver disorders [3]. Ginger (*Zingiber officinale*) is cultivated in the tropics for its edible rhizome. Studies have also shown its hypoglycemic properties [5, 6].

Although unripe plantain and ginger are used as single plants to manage diabetes mellitus in Nigeria, the possibility of combining them in a typical diabetic diet and the glycemic response elicited as a result of such combination has not been investigated.

This study was therefore set up to study the effect of a dietary combination of unripe plantain and ginger on renal function parameters in streptozotocin induced diabetic rats.

MATERIALS AND METHODS

Plant Materials

The unripe plantain variety (*Musa paradisiaca*) locally known in the south eastern parts of Nigeria as "*Seed Plantain*" was obtained from Umuahia, Nigeria main market. It was identified by Mr. Ibe of the Forestry Department, Michael Okpara University of Agriculture, Umudike (MOUAU). The ginger variety (*Zingiber officinale*) (UGII- black ginger) was obtained at harvest from National Root Crops Research Institute, Umudike, Nigeria that has a

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National mandate on Ginger. It was also identified by Mr. Ibe and by Dr. C.O. Amadi, the Co-ordinator, Ginger Program, National Root Crops Research Institute, Umudike, Nigeria. The plants were deposited in the herbarium of MOUAU for authentication.

Processing of the Plant Materials

The samples were properly peeled, soaked in water for about 10 min, washed and oven dried at 70°C to constant weight and processed to flour. The processed flours were pelletized, oven dried at 80°C to constant weight before they were fed to the rats.

The composition of the unripe plantain incorporated feed was: 81% unripe plantain flour, 9% soybean flour, 4% vitamin mixture, 2% salt and 4% groundnut oil while the composition of the unripe plantain + ginger incorporated feed was: 71% unripe plantain flour, 10% ginger flour, 9% soybean flour, 4% vitamin mixture, 2% salt and 4% groundnut oil [7].

Chemicals

Streptozotocin (Sigma No.S0130) used was a product of Sigma-Aldrich Chemical Company, UK. Every other chemical that was used for the experiment was bought from HosLab, Umuahia, Abia State, Nigeria and was of analytical grade.

ANIMAL EXPERIMENTS

Selection of Animals

Forty eight male albino rats of the wistar strain (130.68-232.91 g) obtained from the animal house of University of Nigeria, Nsukka, Enugu State, Nigeria, were used for the study. The animals were kept in standard rat cages in the animal house of the Department of Biochemistry, Michael Okpara University of Agriculture, Umudike, Nigeria. The animals were acclimatized for two weeks to their diets prior to the commencement of the experiment and were maintained under a room temperature of 27-30°C.

Induction of Diabetes

Freshly prepared solution of streptozotocin (0.1 g dissolved in 5 mL of freshly prepared sodium citrate buffer 0.1 M, pH 4.5) was injected intraperitoneally to 42 of the rats at a dosage of 65 mg/kg body weight at fasting state while 6 of the remaining rats served as non-diabetic control group. Blood was collected from the tail vein and the blood glucose concentration was analyzed in the STZ treated rats prior to the commencement of the dietary feeding using a blood glucose meter (Double G glucometer, USA) and subsequently, twice in a week, throughout the duration of the experiment. The STZ-treated rats with fasting blood glucose levels >200 mg/dL after twelve days of induction of STZ were considered to be diabetic and were used for the study.

Experimental Procedure

The STZ treated rats with stable diabetic condition were then divided into 3 subgroups (Groups 2 to 4) comprising of six animals per group while the non-diabetic group formed the first group as follows:

Group 1. Normal rats fed standard rat pellets (Non-diabetic control).

Group 2. Diabetic control rats which also received standard pellets

Group 3. Diabetic rats fed with unripe plantain incorporated feeds (81%)

Group 4. Diabetic rats fed with unripe plantain + ginger incorporated feeds (71% + 10%)

Their diets and water were both given *ad libitum* for 28 days, after which the rats were stunned by blow, sacrificed and blood was drawn from their heart using 10 mL syringes and poured into plain tubes for assay of serum total protein, creatinine, urea and albumin.

Assay of Biochemical Parameters in the Sera

The serum creatinine of the rats was determined using Biosystems kit and the principle based on the reaction of the creatinine in the samples with picrate in alkaline medium to form a colored complex that is measured spectrophotometrically at 500 nm. The serum total proteins, albumin and urea levels of the rats were also determined using Biosystems diagnostic kits using the methods described by previous researchers [9, 10].

ETHICS

All animal protocols were approved by the ethical committee of Michael Okpara University of Agriculture, Umudike, Nigeria which was in line with the National Institutes of Health's Principles of Laboratory Animal Care [8]. All animals received humane care according to the criteria outlined in the "Guide for the Care and Use of Laboratory Animals (1996)" prepared by the National Academy of Sciences.

STATISTICAL ANALYSIS

Data was subjected to analysis using the statistical package for social sciences (SPSS), version 17.0. Results were presented as means±standard deviations. One way analysis of variance (ANOVA) was used for comparison of the means. Differences between means were considered to be significant when two-tailed P was less than 0.05.

RESULTS

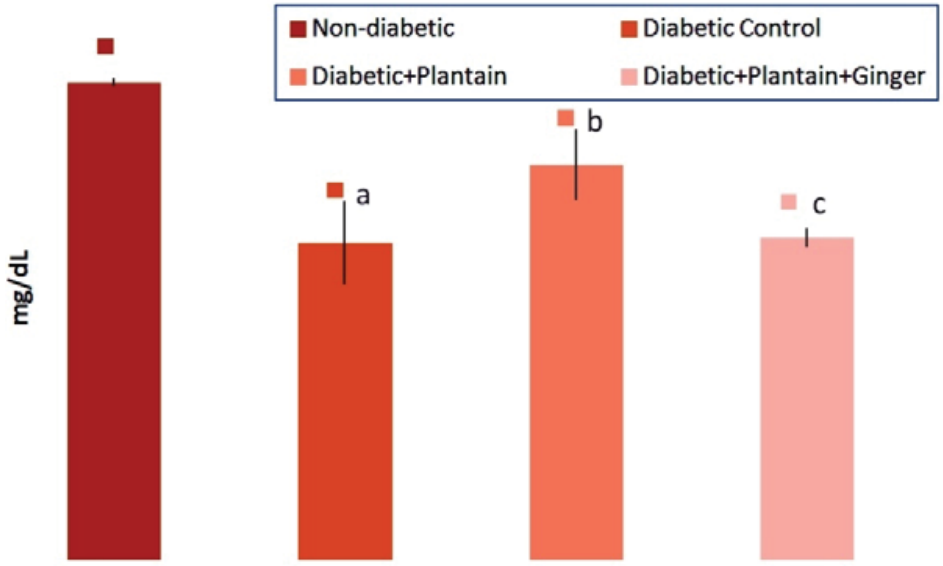
The serum urea and creatinine levels of the diabetic control rats (Group 2) were significantly increased (P=0.045) compared with the non-diabetic control rats (Group 1) while the serum urea and creatinine levels of the diabetic rats fed unripe plantain (Group 3) or a combination of unripe plantain and ginger (Group 4) were significantly decreased (P=0.033) compared with the diabetic control rats (Group 2) (Table 1).

The diabetic control rats (Group 2) had significant decrease (P=0.045) of their serum protein level compared with the non-diabetic control rats (Group 1) (Table 1).

Table 1. Renal function parameters in the sera of rats.

Groups	Animals	Urea (mg/dL)	Creatinine (mg/dL)	Protein (g/dL)
Group 1	Non-diabetic control	37.33±1.58	0.68±0.21	7.64±0.44
Group 2	Diabetic control	66.50±14.99[a]	1.47±0.03[a]	5.37±0.61[a]
Group 3	Diabetic + unripe plantain	43.94±15.28[b]	0.70±0.16[b]	6.67±0.20[b]
Group 4	Diabetic + unripe plantain + ginger	57.35±5.21[b]	0.86±0.35[b]	5.73±1.63[c]

Values are means±SD.
[a] P=0.045 *versus* Group 1 (non-diabetic control)
[b] P=0.033 *versus* Group 2 (diabetic control)
[c] P=0.056 *versus* Group 2 (diabetic control)



[a] P=0.045 *versus* Group 1 (non-diabetic control)
[b] P=0.033 *versus* Group 2 (diabetic control)
[c] P=0.065 *versus* Group 2 (diabetic control)

Figure 1. Serum albumin levels of rats. Values are means±SD.

The diabetic rats of Group 3 fed unripe plantain had significant increase (P=0.033) of their serum protein levels compared with the diabetic control rats (Group 2) (Table 1) while the protein contents of the diabetic rats fed a combination of unripe plantain and ginger (Group 4) did not differ significantly (P=0.056) from the protein contents of the diabetic control rats (Group 2) (Table 1).

The serum albumin levels of the rats in the four groups decreased as follows: non-diabetic (3.53±0.03 mg/dL), diabetic control (2.34±0.31 mg/dL), diabetic rats fed unripe plantain (2.92±0.26 mg/dL) and diabetic rats fed unripe plantain and ginger (2.38 ±0.07 mg/dL) (Figure 1). The diabetic control rats (Group 2) recorded significant decrease (P=0.045) of their serum albumin levels compared with the non-diabetic rats (Group 1). Feeding of unripe plantain to the diabetic rats of Group 3 resulted in significant increase (P=0.033) of their serum albumin levels compared with the diabetic control rats (Group 2) while the serum albumin levels of the diabetic rats fed a combination of unripe plantain and ginger feed (Group 4) did not differ significantly (P=0.065) from that of the diabetic control rats (Group 2) (Figure 1).

DISCUSSION

Creatinine, a metabolite of creatine is generated from muscle metabolism. As the kidneys become impaired, the creatinine levels in the blood increase due to poor clearance by the kidney [11].

The liver forms urea but it is the kidney's function to remove it from the blood stream. When kidney functions are impaired, the urea level increases because the kidneys are less able to clear the urea from the blood stream [11].

The increase in the serum urea and creatinine levels of the diabetic control rats is indicative of impairment of renal function while the decrease in the serum urea and creatinine levels of the diabetic rats fed unripe plantain or a combination of unripe plantain and ginger incorporated feed suggests that unripe plantain or a combination of unripe plantain and ginger (at the dose used) may have the potentials to ameliorate repair renal dysfunction in diabetics. However, unripe plantain showed better potentials in the management of renal dysfunction compared with its combination with ginger at the dosage used in this study.

The decrease in the serum protein of the diabetic control rats is an indication of microproteinuria which is an important clinical marker of diabetic nephropathy and this decrease can be attributed to increase protein catabolism while the increase in the serum protein levels of the diabetic rats fed unripe plantain incorporated feed is an indication of the protective action of unripe plantain against nephrotoxicity

[12]. On the other hand, the serum protein levels of the diabetic rats fed unripe plantain and ginger incorporated feed compared with the diabetic control rats may be indicative of increased protein catabolism for the rats of this group. Hypoalbuminemia is seen in several conditions such as liver disease, malnutrition and renal disease.

The low serum albumin levels of the diabetic control and diabetic rats fed unripe plantain and ginger could be attributed to their low serum protein levels suggesting impaired renal function for the rats of these groups or it may also suggest impaired liver function for these groups of rats. The elevation of the serum albumin levels of the diabetic rats fed unripe plantain suggests better management of renal dysfunction with unripe plantain alone unlike its combination with ginger at the dosage used in this study.

CONCLUSION

Unripe plantain alone was more effective in the management of renal dysfunction compared with its combination with ginger at the dosage used in this study. Further studies are therefore recommended to give some detailed explanation regarding this.

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Conflict of Interest

Authors declare to have no conflict of interest

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