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Hypoglycaemic Effect and Proximate Composition of Some Selected Nigerian Traditional Diets Used in Management of Diabetes Mellitus

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Research Article

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ABSTRACT

Selected traditional Nigerian diets: *Garri* with *afang* soup, pounded yam with *edikang ikong* soup and *ekpang nkukwo* alongside a reference diet, plantain with beans porridge, were investigated for their efficacy for use in management of diabetes mellitus. The proximate composition of the diets was analysed using standard methods and thereafter fed to alloxanized rats for 15 days, while monitoring the changes in weight and blood glucose. Fasting blood glucose (FBG) results was significantly reduced ($p<0.05$) (initial and final) upon feeding *garri* with *afang* soup (25.61%) and pounded yam with *edikang ekong* soup (25.19%) relative to the diabetic control (5.19%). These reductions compared well with the reference diet, although its extent of glycaemic control was higher (37.22%). Body and relative liver weight changes over the period animals received the traditional diets were not significantly different ($p>0.05$) from that of the reference diet. Whereas the proximate composition components including crude proteins, fibre, ash and carbohydrate were not significantly different ($p>0.05$) compared to the reference diet; only crude fat and hence caloric value was significantly higher ($p<0.05$) in reference diet compared to the three traditional diets. From the results of this investigation, it is clear that the traditional diets studied can be effective in glycaemic control, hence could serve as effective substitutes for

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plantain with beans, usually recommended by health care givers.

Keywords: Hypogycaemic action; diabetes mellitus; proximate composition; traditional diets;

1. INTRODUCTION

Diabetes is a chronic disorder of carbohydrate metabolism whose prevalence is rising globally, including the rural Nigeria populations (John et al., 2005). The chronic hyperglycaemia of diabetes mellitus is associated with long term complications and poses huge social and financial burdens on countries ill-equipped to meet them. As such, dietary modification is the simplest and cheapest form of diabetes treatment and is the recommended primary therapy in type 2 diabetes (Mshelia et al., 2005). Africa and other developing countries have poorly developed standards for dietary therapy in diabetes management (Mshelia et al., 2005).

Patients with diabetes need nutrition recommendations that are supported by scientific evidence and that can be easily understood and translated into everyday life by the diabetics. Just as changes have occurred over the past decades in conventional medications used for treatment of diabetes, changes have also occurred in medical nutrition therapy for diabetes (Franz et al., 2003). To achieve the goals and objectives of dietary therapy, it is important that diabetic patients are provided with dietary guidelines appropriate to their cultural backgronds; vis-a-vis a consideration of availability and affordability of the food types.

A typical Nigerian meal from the South is heavy with starchy items, light on meat and generous on fat (Umoh, 1972). A semi-solid starchy mass (pounded yam), garri (made with cassava) is served with soups. Most Nigerian soup meals have as their constituents, meat, fish, palm oil, vegetables, crayfish, seasonings and water; soup is a mixture of ingredients obtained from both plants and animals (Umoh, 1972). For instance the soups used in the present study, afang soup contains these ingredients and a major vegetable, Gnetum africanum as well as water leaf (*Talinum triangulare*) while in edikang ikong soup *Telfaria occidentalis* only replaces *Gnetum africanum*. The soups generally are consumed as cooked complements of major staples like cassava (e.g., garri) and yam (e.g., pounded yam). Ekpang nkuwo is a porridge made from *Xanthosoma mafaffa* schott (cocoyam) tubers and the leaves, with the listed soup ingredients. It is a traditional diet served in homes and restaurants in the Southern and Eastern Nigeria.

The present study therefore investigated the suitability or otherwise of these traditional diets of the South- and South Eastern States of Nigeria in diabetic management.

2. MATERIALS AND METHODS

2.1 PREPARATION AND PROCESSING OF THE DIETS

The foodstuffs used for the preparation of the various traditional diets were bought at Ika Ika Oqua Market in Calabar, Cross River State, Nigeria. After initial washing and draining, these were used to prepare the diets according to the traditional/indigenous methods, including *garri* with *afang* soup, pounded yam with *edikang ikong* soup, *ekpang nkukwo* and plantain porridge with beans. The proportions of the condiments used were modified from "A taste of Calabar" selected recipes by Ana (2000). Each of the diets was oven dried at 60^0C to constant weight and thereafter homogenized with an electric blender. The homogenized diets were wrapped in aluminum foils and stored in microwaves from where aliquots were withdrawn daily for animal feeding.

2.2 PROXIMATE COMPOSITION DETERMINATION

Proximate analyses were carried out on the experimental diets and rat pellet in triplicates. Crude protein, crude fat, crude fibre and ash contents were determined using methods of Association of Analytical Chemists (AOAC, 2000). Carbohydrate content was estimated by simple difference. The caloric value was calculated by multiplying values obtained for carbohydrate, fat and protein by Atwater factors of 4, 9 and 4 kilocalories, respectively and taking the sum of the products.

2.3 ANIMALS AND EXPERIMENTAL DESIGN

Male Wistar rats (140-240g) obtained from the animal house, Department of Biochemistry, Faculty of Basic Medical Sciences, University of Calabar, Nigeria, were used for the study. The animals were kept in wooden cages with stainless wire mesh top in well ventilated animal house. Diabetes was induced by a single dose intra-peritoneal injection of 150mg/kg body weight of alloxan after an overnight fast (Esmerino et al., 1998). A week after injection of alloxan, diabetes was confirmed in alloxan-treated rats showing fasting blood glucose levels ≥ 200mg/dl (Kim et al., 2006). The experimental animals were then divided into six (6) sub-groups and accordingly treated:

1. Normal rats fed normal rat pellets (normal control)
2. Diabetic rats fed normal rat pellets (diabetic control)
3. Diabetic rats fed *garri* with *afang* soup (test diet 1).
4. Diabetic rats fed *pounded yam* with *edikang ikong* soup (test diet 2).
5. Diabetic rats fed *ekpang nkukwo* (test diet 3).
6. Diabetic rats fed plantain porridge with beans (diet 4 - reference diet).

The diets and water were both given *ad libitum* for fifteen (15) days after which the animals were sacrificed and liver tissues collected for evaluation. FBG was measured using One Touch Glucometer analyzer prior to the commencement of dietary feeding and at end of the 15- day treatment. Similarly, initial and final body weights were measured with an electronic weighing balance. From these, % FBG reduction and % weight change were calculated thus:

$$\text{\% Weight change:} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100$$

$$\text{\% Change in FBG} = \frac{\text{Initial FBG level} - \text{Final FBG level}}{\text{Initial FBG level}} \times 100$$

and

$$\text{\% Growth Rate calculated:} = \frac{\text{Final Weight} - \text{Initial Weight}}{\text{Experimental Duration (15)}} \times 100$$

2.4 STATISTICAL ANALYSIS

The results were analysed for statistical significance by one way ANOVA using the SPSS statistical program and Post Hoc Test (LSD) between groups using MS excel program. All data were expressed as Mean ± SD; p values < 0.05 were considered significant.

3. RESULTS

Table 1 shows result of proximate composition of the selected Nigerian traditional diets fed alloxan diabetic animals for 15 days. The crude protein (%) of the four diets ranged from 14.37±0.20 (*ekpang nkukwo*) to 18.37±0.17 (pounded yam with *edikang ikong* soup. However these varied non significantly (p<0.05) from each other. Values for crude fibre (%) varied from 12.25±0.24 for pounded yam to 24.50±0.38 of the reference diet, which was significantly higher (p<0.05) compared to the other diets. There were no significant differences in the determined crude fibre values and ash content of the traditional diets (p>0.05). The carbohydrate levels which ranged from 59.88±2.04 for *garri* with *afang* soup to 64.63±3.00 for *ekpang nkukwo,* were not significantly different from each other (p<0.05). There were no significant differences (p>0.05) among the carbohydrate levels of the traditional diets studied. The calculated caloric values for the traditional diets were 470.25±6.14 for *garri* with *afang* soup, 442.25±3.08 for pounded yam and *edikang ikong* soup, 455.5±5.10 for *ekpang nkukwo* and 505.50±4.11 for plantain porridge with beans. Body weight increase and growth rate of the diabetic subjects fed traditional diets over the period (Table 2) showed nonsignificant difference when compared to the reference diet (p>0.05). A similar trend was observed with the % change in the animals' internal organ weights (Table 3). Most dramatic however, was significant reduction (p<0.05) in FBG (Table 4) of animals fed *garri* with *afang* soup (25.61%) and pounded yam with *edikang ikong* soup (25.19%) relative to the diabetic control (5.19%). This effect was similar and compared well with the reference diet, although the extent of reduction was higher with the reference diet (37.22%).

4. DISCUSSION

The result of this study indicates clearly that diabetic patients can reasonably consume other traditional diets besides plantain and beans. Diet is the cornerstone in the management of diabetes mellitus, and the patients are eager and more willing to consume food combinations which they are familiar with. Plantain and legumes have been found to be the most acceptably used and have enjoyed this dominant position for decades now. However there is need for diversification and provision of choice for the patients. This experiment was conducted in an attempt to compare some of the traditional diets with plantain and beans and also to provide a scientific basis for recommendations of the use of these traditional diets for diabetic individuals. Chandalia et al. (2000) had noted that until the advent of insulin in the 1920s, the only treatment for diabetes was dietary. Ntui et al. (2006) observed that there was no significant difference in the mean glycemic indices of the group of diabetics fed plantain and the others that used different carbohydrate sources. This they attributed to the fact that glycaemic effect of carbohydrate is dependent more on the amount of carbohydrate intake rather than on the source of carbohydrates (Franz et al., 2003), as was also earlier explained by Coulston (1990). Mshelia et al. (2005) showed that many local staple foods were excluded by diabetic individuals, thus the potential options is already limited diets. The major sources of carbohydrates in this study were from cassava, yam, cocoayam and plantain, which provided between 55 to 65% carbohydrate from the total calorie.

Table 1. Proximate composition of some selected Nigerian traditional diets

Diets	Crude Protein (%)	Crude fat (%)	Crude Fibre (%)	Ash (%)	Carbohydrate	Caloric value (kcal/100gm)
Garri with *afang* soup	16.62 ± 0.24	18.25 ± 0.18*	1.25 ± 0.04	4.00±0.17	59.88 ± 2.04	470.25 ± 6.14
Pounded yam with *Edikang Ikong* soup	18.37±0.17	12.25 ± 0.24	1.25 ± 0.02	3.5 ± 0.11	64 .63 ± 2.04	442.25 ± 3.08
Ekpang Nkukwo	14.37 ± 0.20*	15.5 ± 0.41	1.00 ± 0.004	4.5 ± 0.20	64.63 ± 3.00	455.5 ± 5.10
Plantain porridge with Beans	16.62 ± 0.28	24 .5 ± 0.38*	1.00 ± 0.01	3.00 ± 0.18	54.88 ± 2.11	506.5 ± 4.11*

*Values are expressed as mean ± standard deviation of 3 determinations; * p<0.05 significantly different within the group (column).*

Table 2. Body weights and growth rates of non-diabetic and diabetic rats

Parameter	Non-diabetic Control	Diabetic Control	***Garri* with *afang soup***	**Pounded yam with *edikang ikong soup***	***Ekpang nkukwo***	Plantain porridge with beans (reference diet)
Initial body weight (IBW) gm	187.86±30.74	172.14±19.17	178.14±39.06	178.00±26.68	160.85±4.67	192.42±28.50
Final body weight (FBW) gm	193.29±30.02	163.29±16.37	171.86±34.35	172.00±29.29	154.00±6.90	181.57±24.83
Weight increase (W1) (%)	3.00±1.22	-4.99±2.94*	-3.90±3.90*	-3.65±3.09*	-4.81±2.38*	-5.46±2.75*
Growth rate (GR) (%)	36.19±13.80	-59.04±38.18*	-41.90±55.33*	-39.99±33.99*	-45.70±31.83*	-72.37±41.35*

*Values are expressed as mean + standard deviation, n = 7; * p<0.05 significantly different within the group (column).*

Table 3. Liver weight and percent liver weight/body weight of non-diabetic and diabetic rats

Parameter	Non-diabetic Control	Diabetic Control	*Garri* with *afang soup*	Pounded yam with *edikang ikong soup*	*Ekpang nkukwo*	Plantain porridgewith beans (reference diet)
Total liver weight (TLW) (gm)	8.10±0.80	7.14±0.55	7.03±0.84	7.44±0.96	6.80±0.48	7.71±0.89
Final body weight (FBW) (gm)	193.29±30.02	163.29±16.37	171.86±34.35	172.00±29.29	154.00±6.90	181.57±24.83
TLW x 100 (%) FBW	4.16±0.29	4.38±0.12*	4.17±0.38*	4.24±0.23*	4.40±0.10*	4.26±0.21*

*Values are expressed as mean + standard deviation, n= 7; * p<0.05 not significantly different from each other within the row.*

Table 4. Fasting blood glucose of non-diabetic and diabetic rats

Group	Initial fasting blood glucose (mg/dl)	Final fasting blood glucose (mg/dl)	% Change (decrease) in FBG
Non-Diabetic control	43.85 ± 8.27	37.42 ±3.77	14.66
Diabetic control	242.14 ± 61.02	229.57± 26.69	5.19*
Garri with *afang soup*	282.85 ± 45.16	210.42±32.64	25.61*
Pounded yam with e*dikang ikong soup*	265.42 ± 51.48	198.57 ± 40.69	25.19
Ekpang nkukwo	292.71 ± 97.36	279.35±50.13	4.56
Plantain porridge with beans (reference diet)	261.00 ± 73.00	163.85±51.73	37.22*

*Values are expressed as mean + standard deviation, n= 7; * p<0.05 vs diabetic control*

Food and Agriculture Organization/World Health Organization (1998), recommends good food choices such as carbohydrates rich in non starchy polysaccharides, with a low glycaemic index, and appropriately processed cereals, vegetables, legumes and fruits. Story et al. (1982) instructed 14 men with diabetes, all of whom were using insulin to consume a high carbohydrate, high fibre diet and monitored their glycaemic control, consumption of whole grain breads and cereals, dried beans, vegetables and fruit was encouraged. Insulin therapy was thereafter discontinued in all of the type II subjects.

In the present study the crude fibre contents of the diets were lower than those reported elsewhere; this was probably due to the processing. The vegetables and carbohydrate sources in this study are known to be high in fibre. Chandalia et al. (2000) reported that an increased intake of dietary fibre, predominantly of the soluble type, by type II diabetes mellitus patients, improved glycaemic control and decreased hyperinsulinemia in addition to the expected lowering of plasma lipid concentrations. While there are several plausible mechanisms by which whole grain foods and legumes might reduce diabetes risk and improve glycaemic control, it is possible that this protection is afforded by the intact structure of the cereal grains and pulses showing digestion and partially restricting absorption of the glycaemic carbohydrate.

In this study, the crude proteins from the different traditional diets were between 14 to 18% of the total calorie; this is within the recommended dietary allowance for diabetic patients by American Diabetic Association. Protein is still the most misunderstood nutrient with inaccurate advice frequently given. However it is known that excess dietary amino acids even in subjects with controlled diabetes may undergo gluconeogenesis, to produce glucose which enters into general circulation thereby aggravating the hyperglycemia. Furthermore, protein does not slow the absorption of carbohydrate and yet does not also help in the treatment of hypoglycaemia, particularly those of animal origin (Franz et al., 2003). It is advised therefore that proteins from plant sources be eaten rather than animal sources; this is also due to the fact that the later tends to be high in saturated fat as was the case in the study. All of the test diets have vegetables components.

The major-fat source of the traditional diets in this study was from palm oil. Crude fat provided 12 to 24% of the total calorie. The recommended allowance for fat is 30 to 35%, and it should be higher in polyunsaturated fat. Palm oil consists mostly of a mixture of triglycerides upon which its physical and chemical characteristics depend. The most important minor constituents of palm oil are the carotenoids (Umoh, 1998).

There was a significant drop in fasting blood glucose (FBG) in the present study, after fifteen days of rats being on traditional diets. Pastors et al. (2002) reported from randomized controlled trials, observational studies and meta-analyses that nutrition intervention improves metabolic outcomes, such as blood glucose in individuals with diabetes. More than 400 plant species with reported hypoglycemic activity are available in literature (Kim et al., 2006); the traditional diets in this study were all plant-based. Alloxan induces chemical diabetes in a wide variety of animal species by damaging the insulin secreting pancreatic β-cells, resulting in decreased endogenous insulin release. Numerous studies have demonstrated a variety of plant extracts which effectively lowered the glucose levels in alloxan-induced diabetic animals (Gidado et al., 2005), including the consumption of garlic (Jelodar et al., 2005).

5. CONCLUSION

The phytochemicals in these plant-based traditional diets and proximate components that are comparable with those of the reference diet can impact hypyglycaemia in diabetes to the benefit of the patient. Therefore, other traditional diets can be used effectively in lieu of plantain with beans by diabetic individuals.

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