Management of Post-Prandial Blood Glucose Level using Some Common Nigerian Thickeners

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Abstract

BACKGROUND

Diabetes mellitus is a common chronic metabolic disorder in sub-Saharan Africa which is characterized by high blood glucose levels. The prevalence of this disorder in Africa is closely related to diet. Most rural dwellers whose diet consists majorly of some common Nigerian food thickeners have been observed to have clean records of all the nutritionally associated diseases and conditions such as obesity, diabetes. This study, therefore, aimed to determine the effect of some common food thickeners on the postprandial blood glucose level of healthy subjects.

MATERIALS AND METHODS

We investigated the effect of the food thickeners made from *Brachystegia eurycoma* (*achi*), *Detarium microcarpum* (*ofor*), *Irvingia gabonensis* (*ogbono*), *Colocasia esculenta* (*taro*) and *Citrullus vulgaries* (*egusi*) on the post-prandial blood glucose level of healthy subjects. The soup thickeners were processed into flour and paste using the usual traditional processing method. The soups were consumed on separate days by five subjects after an overnight fast. Three days interval was allowed between the consumption of each test soup. Fasting venous blood glucose was taken at fasting (0 min), and post-prandial blood glucose levels were taken at 30 min intervals for 3 hours, and the blood was analyzed for glucose using FineTest™ strips and glucometer.

RESULTS

Compared with the control, *Irvingia gabonensis* soup elicited a significant reduction ($p \leq 0.05$) in plasma glucose levels at 90 and 180 min; while the *Brachystegia eurycoma* had a significant reduction only at 180 min. Proximate analysis was also carried out on the six different soup samples used in this study. The percentage of crude fibre in the soups compared to the control soup (6.53%) was highest in *Irvingia gabonensi* soup (6.59%), while in *Brachystegia eurycoma* soup it was (2.0%), *Detarium eurycoma* soup (1.30%), *colocasia esculenta* soup (4.0%) and *Citrullus vulgaries* soup (2.80%).

CONCLUSION AND RECOMMENDATION

***Irvingia gabonensi* and *Citrullus vulgaries* were more potent in the reduction of blood glucose levels when compared with the control group; and reduced the blood glucose levels without any deleterious effects. Nevertheless, before they can be adopted formally as antidiabetic foods recommended for the dietary management of Type 2 diabetes, we recommended that their effect on glycated haemoglobin should be assayed.**

Keywords: *Irvingia gabonensis, Citrullus vulgaries, Colocasia esculenta, Brachystegia eurycoma and Detarium microcarpum*

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Introduction

Diabetes mellitus is defined as a chronic metabolic disorder characterized by high blood glucose (hyperglycaemia) and associated with impaired carbohydrate, fat and protein metabolism, resulting from either insufficient or no release of insulin by the pancreas in the body [1]. Type II diabetes is predominant, accounting for over ninety per cent (90%) of cases in sub-Saharan Africa. Among low and middle-income countries such as Nigeria, diabetes has been on the increase contributing to eighty per cent (80%) of deaths [2]. A shift in eating habits decreased physical activities and emulation of a westernized lifestyle has been reported by the World Health Organization (WHO) and Food and Agricultural Organization (FAO) as the major factor leading to the rapid change in diabetes pattern.

Glycaemic index is a system that characterizes how fast carbohydrate is metabolized in a diet, and how fast it can raise postprandial blood glucose in the body. Dietary studies carried out have shown that the carbohydrate contents of lower glycaemic index foods are slowly broken down in the body, and move into the bloodstream at a slower rate. Foods rich in dietary fibre have been accepted to be suitable for diabetics, this is as a result of their low glycaemic index content and minimal rapidly digestible starch content, consumption of such foods has been said to be important in the treatment and prevention of diet-related chronic diseases such as diabetes and also shown to cause an improvement in the intestinal mobility[3][4]. Experiments involving both humans and animals encouraged the view that soluble dietary fibre such as guar gum is an important component of our diet, and this importance has been attributed to its ability to modulate the postprandial blood glucose and insulin response in diabetic and non-diabetic individuals[5].

Thickeners are hydrocolloids or guar gums used to thicken beverages, gravies, sauces and soups. Hydrocolloids are a diverse group of long-chain polymers with the characteristic of forming viscous dispersion or gel when dispersed in water; they have a neutral taste and aroma[6]. In Nigeria, a wide range of thickening agents are available for use by millions of Nigerians, they include; *Brachystegia eurycoma* (*achi*), *Detarium microcarpum* (ofor), *Irvingia gabonensis* (*Ogbono*), *Colocasia esculenta* (*taro*) and *Citrullus vulgaries* (*egusi*) [7][8][9]. Most rural dwellers who diet majorly on these seeds have been observed to have clean records of all the nutritional associated diseases and conditions such as obesity, diabetes and so on[10]. Therefore, there is a need for more research work to be carried out on these thickeners. The main purpose of this work was to determine the effect of these thickeners on the postprandial blood glucose level of healthy subjects.

Materials and Methods

The research was carried out using healthy young adults whose age is between 25-40 years [16][17]. Five healthy subjects were selected to take part in this study. All were in good physical condition and had a family history of diabetes or metabolic disorders. This was verified from the medical records of these subjects. Also, they were not currently under any medication as stated by their medical records. Every participant provided informed written consent.

Procurement of ingredients

The thickeners and other soup condiments were purchased from the popular oil mill market in Port Harcourt, Rivers State.

Preparation of soup samples

The procedures used in the preparation of the soups were as close as possible to the traditional method used by people in the rural

areas of Nigeria. Soup condiments used (none thickening agents) include:

i. Two cooking spoons of red oil
ii. Half kilogram beef
iii. Two stock cubes
iv. One medium size stock fish
v. Three tablespoons ground crayfish
vi. One tablespoon of ground pepper
vii. Pumpkin leaf
viii. Water
ix. Salt to taste

The procedure for the preparation of the soups is summarized in the flow chart given in Figure 1. The meat and the stockfish were washed and steamed for 10 min.

Grouping of test meals

The study consisted of six groups of five individuals, with each group representing one of the six soup samples, all prepared as they are locally prepared in Igbo land.

The goups were:

i. Group one (control soup) contained no thickener.
ii. Group two (*egusi* soup) contained the seed flour of Citrullus vulgaries '*egusi'*.
iii. Group three (*ofo* soup) contained the seed flour of Detarium microcarpum '*ofor'*.
iv. Group four (cocoyam soup) contained the cormel paste of Colocasia esculenta '*taro'*.
v. Group five (*achi* soup) contained the seed flour of Brachystegia eurycoma '*achi'*.
vi. Group six (*ogbono* soup) contained the seed flour of Irvingia gabonensis '*ogbono'*.

Randomization of subjects

Groups of five volunteers were drawn from a pool of 5 (4 men, and one woman). They each took part in two or more experiments, one of which was a control, which was performed in randomized order at least three days apart. The meals were taken over 10 minutes in the morning after an overnight fast.

Determination of the post-prandial blood glucose level

On arrival on the test days, subjects rested for 10min before the experiment began to enable the blood volume to stabilize.

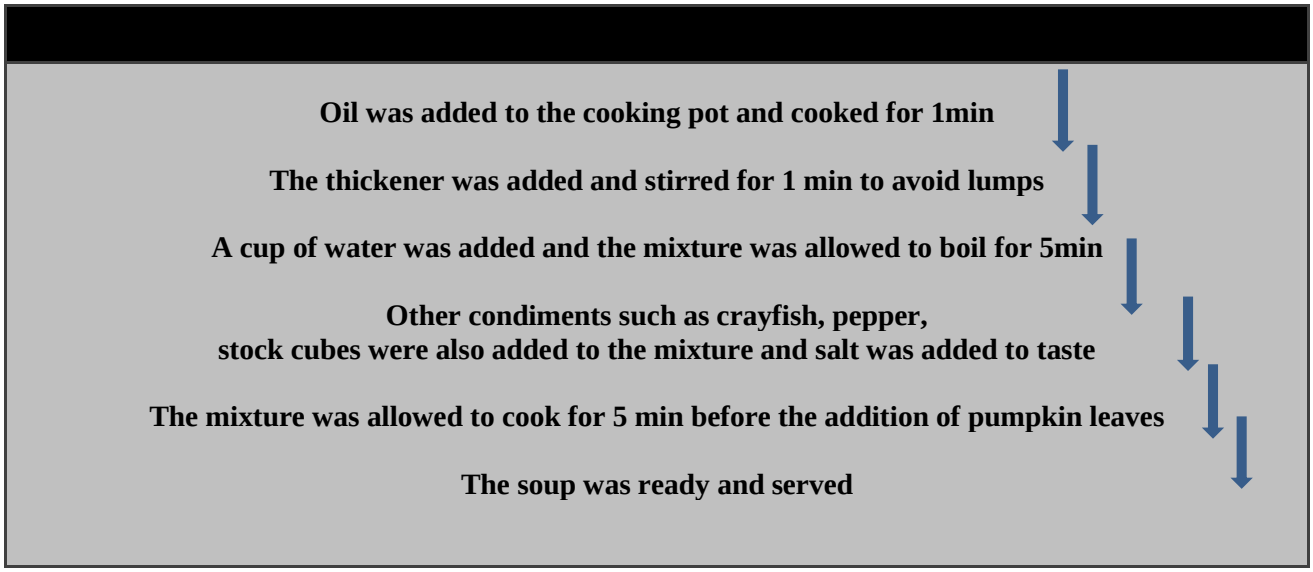

Figure 1:
Flow chart for the preparation of the soups

It was ascertained that the subjects had nothing to eat for 12hrs. Cotton wool was used to apply methylated spirit on the fingertips, usually the thumb. A blood lancet was used to prick the fingers; a drop of blood was applied to the circular portion on the test trip. This was displayed on the screen and the result was given after 45 seconds from the glucometer.

Fasting blood glucose was taken and subsequently, postprandial blood glucose was measured every 30 min for 3 h. Blood glucose was measured using one FineTest glucometer and test strips, with a measuring range of 0 to 600 mg/dL (0 to 33.3 mmol/L).

Analysis

The proximate analysis of the samples, that is the ash content, crude fibre, protein, moisture, fat and carbohydrate contents were determined using the standard method as described by the Association of Official Analytical Chemists 1984.

Data obtained were statistically analyzed using one-way ANOVA at a 95% confidence interval ($p \leq 0.05$).

Ethical approval

The experimental protocol was approved by the ethical committee of the University of Port Harcourt, Rivers State and ethical approval was granted.

Results

Table 1 shows the results of the proximate analysis of the six soup samples. The percentage of crude protein in the samples ranged from 5.25% (control soup) to 19.25% (*Brachystegia eurycoma* soup). Compared to the control soup, *Brachystegia eurycoma* soup contained the highest percentage of crude protein followed by *Citrullus vulgaries* soup (13.13%), *Colocasia esculenta* soup (11.81%), *Irvingia gabonensis* soup (9.63%) and *Detarium microcarpum* soup (8.75%).

The lipid content of the various soups differed from the control sample (2.2%) with the Brachystegia eurycoma soup containing the highest percentage of lipid (8.89%); while *Citrullus vulgaries* soup was the second highest with 6.63%, followed by *Detarium microcarpum* soup (6.50%), *Irvingia gabonensis* soup (5.15%) and *Colocasia esculenta* soup (1.43%).

The *Irvingia gabonensis* soup had the highest percentage of ash content with 9.48% as compared to the control sample which had 6.89%.

Table 1:
Proximate Analysis of the Soup Samples

S/N	Sample identity	Moisture (g/100g)	Ash (g/100g)	Carbohydrate (g/100g)	Crude protein (g/100g)	Lipid (g/100g)	Crude fibre (g/100g)	Energy value (kcal/100g)
1	Control soup	75.92	6.89	3.21	5.25	2.20	6.53	53.64
2	Egusi soup	48.93	2.87	25.64	13.13	6.63	2.80	214.75
3	Ofo soup	78.94	1.30	3.21	8.75	6.50	1.3	106.34
4	Cocoyam soup	67.59	3.63	11.54	11.81	1.43	4.00	106.27
5	Achi soup	53.57	2.19	14.10	19.25	8.89	2.00	173.41
6	Ogbono soup	64.66	9.48	4.49	9.63	5.15	6.59	102.83

The dietary fibre contents of the soups were compared and *Irvingia gabonensis* soup had the highest dietary fibre of 6.59% while *Detarium microcarpum* soup had the lowest percentage of dietary fibre of 1.30%. The total carbohydrate content was highest in egusi soup with 25.64% and least in *Detarium microcarpum* soup and the control soup with 3.21% each. *Detarium microcarpum* soup had the highest moisture content of 78.94% whereas *Brachystegia eurycoma* soup had a total of 53.57%, *Colocasia esculenta* soup 67.59%, control soup 75.97% and *Irvingia gabonensis* soup 64.66%.

Figure 2 showed the effect of the test soups on the post-prandial blood glucose level of healthy subjects fed after 30 min. There was an upsurge in the post-prandial blood glucose level of the subjects after 30 min of consumption of the test soups. *Citrullus vulgaries* soup had a great increase of 29.6 mg/dL and *Irvingia gabonensis* soup had the least upsurge with 15.2 mg/dL. Statistically, there was no significant difference ($p \leq 0.05$) between the various soups and the control soup.

Figure 3 represents the effect of the soups on the post-prandial glucose level of the subjects after 60 min. All the thickeners produced a substantial reduction effect in the post-prandial blood glucose level of the subjects after 60 min of consumption of test soups compared to the control. *Detarium microcarpum* soup produced the highest reduction effect with 6 mg/dL. The statistical analysis showed that there was no significant difference between the soups with thickeners and the control soup.

Figure 4 is showing the effect of the thickeners on the post-prandial blood glucose level of the subjects after 90 min. After 90 min of consumption of the test soups, *Irvingia gabonensis* soup was able to effect a reduction in the post-prandial blood glucose level of the subjects while the soups of Detarium microcarpum, Brachystegia eurycoma and the control soup greatly increased the post-prandial blood glucose level of the subjects.

Statistically, the soups of *Irvingia gabonensis* and *Detarium microcarpum* were significantly different at $p \leq 0.05$.

All the soups were not significantly different from the control soup. The effect of the soups on the post-prandial blood glucose level of the subjects after 120 min is shown in figure 5.

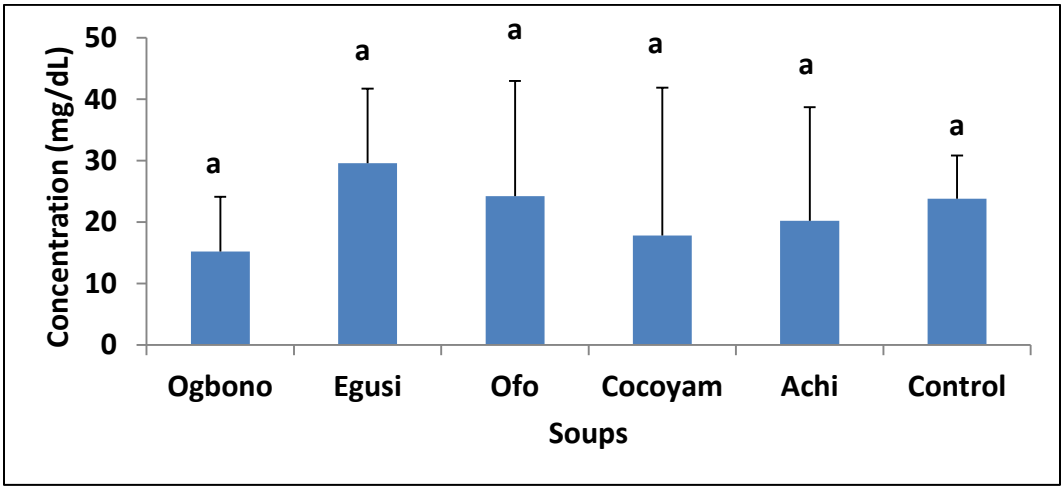

Figure 2: Effect of the soups on the post-prandial blood glucose level of the subjects after 30 min. Values are means ±standard deviation, n =5 per group. Bars with different letters (a,…) are significantly different at p≤0.05

The soups of *Irvingia gabonensis, Citrullus vulgaries, Detarium microcarpum and Colocasia esculenta* produced great reductions in the post-prandial blood glucose level of the subjects except for *Brachystegia eurycoma* and the control soups which showed an affected a rise in the post-prandial blood glucose levels of the subjects.

The soup thickeners are significantly not different at $p \leq 0.05$ when compared with the control sample. Figure 6 is showing the effect of the soup thickeners on the post-prandial blood glucose level of the subjects after 180 min of consumption of the test soups. All the soups are not significantly different when compared with the control sample. *Irvingia gabonensis* soup and *Brachystegia eurycoma* soup are significantly different at $p \leq 0.05$. Except for *Irvingia gabonensis* soup and *Citrullus vulgaries* soup which showed a modest reduction, all of the soups produced a substantial increase in the post-prandial blood glucose level of the subjects.

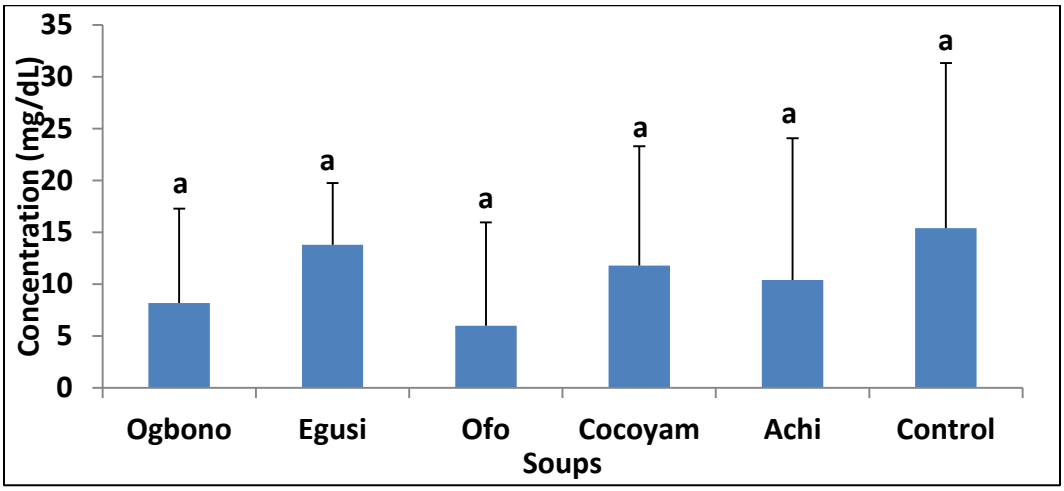

Figure 3: Effect of the soups on the post-prandial blood glucose level of the subjects after 60 min. Values are means ±standard deviation, n=5 per group. Bars with different letters (a,…) are significantly different at p≤0.05

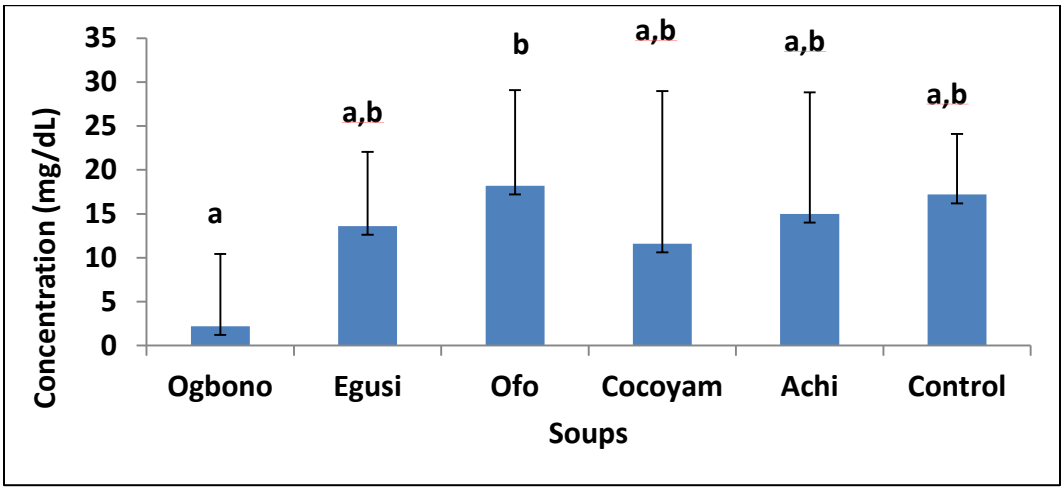

Figure 4: Effect of the soups on the post-prandial blood glucose level of the subjects after 90 min. Values are means ±standard deviation, n = 5 per group. Bars with different letters (a,b…) are significantly different at p≤0.05

Discussion

In this study, the *Irvingia gabonensis*, *Colocasia esculenta* and *Citrullus vulgaries* soups consistently produced lower post-prandial glucose levels in the participants, compared to the control soup. This could be attributable to their high crude fibre contents (Table 1.2). Studies have shown that soluble viscous fibres have a positive effect on reducing postprandial glycaemia and thus may have a role in managing and preventing type 2 diabetes [11][12][13]. Amongst the crude fibres are the hydrocolloids or gums, which are a diverse group of long-chain polymers characterized by their property of forming viscous dispersions and gels when dispersed in water [6].

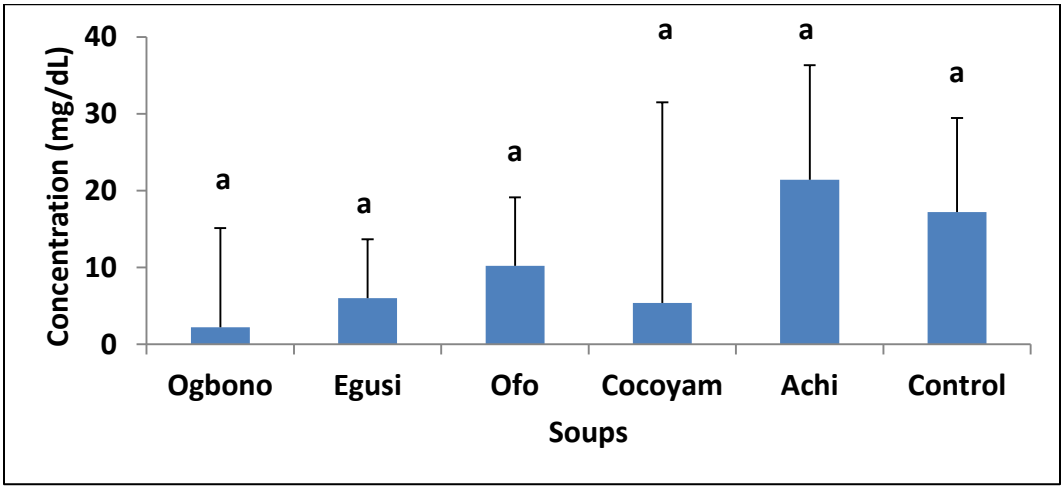

Figure 5: Effect of the soups on the post-prandial blood glucose level of the subjects after 120 min. Values are means ±standard deviation, n=5 per group. Bars with different letters (a,…) are significantly different at p≤0.05

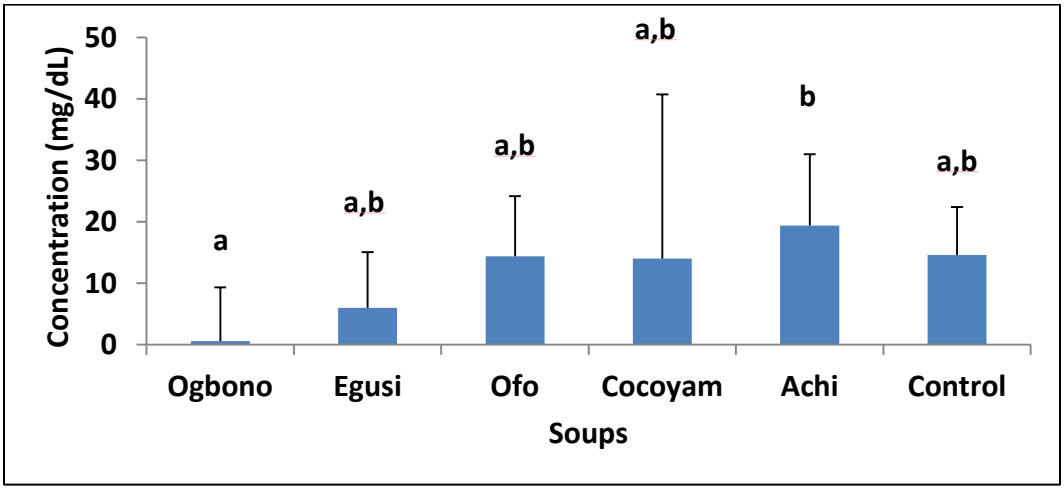

Figure 6: Effect of the soups on the post-prandial blood glucose level of the subjects after 180 min. Values are means ±standard deviation, n=5 per group. Bars with different letters (a,b…) are significantly different at p≤0.05

According to [14], the digestive and viscosity characteristics of dietary fibres appear to be the likely modes of action, through which they decrease nutrient absorption, and thereby, decreasing metabolizable energy. The finding of this study, concerning the *Irvingia gabonensis* soup (ogbono soup) conforms with the findings of [15], who reported that hydrocholloids physically function as soluble fibre when ingested and as such are effective in reducing blood cholesterol levels and moderating glucose response in diabetics. The findings from this work agree with the research work of [18]. Also [19] supports the fact that food thickeners impart positively on post-prandial glucose levels.

Study limitations

Local beliefs and customs made it difficult to get subjects of a wide age range to enable a comparative effect of its efficiency.

Conclusion

In conclusion, the results obtained in this study indicated that the above-uncharacterized plant foods indigenous to Nigeria have potential as dietary supplements for improving glycemic control. As these foods are cheap, easily available and commonly used as food thickeners in rural Nigeria, they could be exploited for the treatment of diabetes in the more urban areas of Nigeria and other parts of Africa where the prevalence of diabetes is currently a serious health problem. The *Irvingia gabonensis* in particular showed considerable promise. *Irvingia gabonensis* is likely to have other interesting nutritional properties that need investigating in human subjects.

Recommendations

The following are hereby recommended:

i. That the effect of the soup thickeners on glycated haemoglobin should be assayed.
ii. That the impact of gender and race on the effects of the soup thickeners be investigated.
iii. Further research should be carried out on the glycemic index and glycemic load of these thickeners.
iv. More studies can be carried out on the effect of these thickeners on the glucose level of the aged

Authors contribution

The research work was designed by both Ikewuchi J.C. and Onuoha S.C. Chinaka O.J. and Okari A.K. and carried out the statistical analysis. The work was read and approved by all the authors.

Conflict of Interest

There is no conflict of interest and the data obtained are readily available.

Source of funding

The research was funded personally by the authors involved

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