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A Comparative Study of The Glycaemic Index of Orange-Fleshed Sweet Potato (*Ipomoea batatas*) with the Indigenous Sweet Potato Commonly Consumed in Abeokuta Metropolis, Ogun State, Nigeria

*Opeyemi S. Oyesanya, Ibiyemi O. Olayiwola, Ebenezer P. John and Gbenga S. Oladosu

Department of Nutrition and Dietetics, College of Food Science and Human Ecology,
Federal University of Agriculture, Abeokuta, Ogun State. Nigeria. P.M.B. 2240,
Abeokuta, Ogun State, Nigeria.

*Corresponding Author: Oyesanya O. S
Email: oyesanya.opeyemi@yahoo.com

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ABSTRACT

Background: Advocacy of orange-fleshed sweet potato (OFSP) consumption as an essential crop in many developing countries to alleviate vitamin A deficiency due to its beta carotene bio-fortification. It is crucial to assess its glycaemic index (GI) compared to the indigenous sweet potato (ISP) for therapeutic meal planning.
Objective: This study aimed to determine and compare the GI of orange-fleshed sweet potato and indigenous sweet potato commonly consumed in Ogun State, Nigeria.
Materials and Method: OFSP and ISP were obtained from a farmers' market at Abeokuta, Nigeria. Ten healthy individuals within the age range of 18 and 24 years were recruited. Volunteers were served with equivalent test foods (250g of OFSP and 200g of ISP) to give 50g of available carbohydrates. The boiled potatoes were served plain after 11-12 hours overnight fast and tested the subject's blood glucose at different times. The incremental area under the curve (IAUC) was determined using Microsoft Excel, and the GI was calculated. Statistical Package for Social Sciences was used to calculate the mean, standard deviation, and correlation. Statistical tests were significant at $p \leq 0.05$.
Results: ISP had greater carbohydrate content (24.33g±0.20) than OFSP (18.87g±0.26). The mean GI of OFSP was 81.36g±7.17, while that of ISP was 85.50g±7.26. There was no significant difference ($p>0.05$) between the GI of OFSP and ISP at 30, 60, and 120 minutes, whereas found a significant difference (CI-95%) between the GI of OFSP, ISP, and glucose at 90 minutes.
Conclusion: The OFSP and ISP consumed in Ogun state have a high GI, although OFSP had lower GI compared to ISP. However, the GI values for these test foods were not significantly different.
Key Words: Orange-Fleshed Sweet Potato, Indigenous Sweet Potato, Glycaemic Index, and Glycaemic Load.

INTRODUCTION

Carbohydrates are the major influential dietary component since they comprise sugars and starches broken down in the digestive system into glucose that enters the bloodstream (2). The Glycaemic Index (GI) is a scale that ranks carbohydrate-rich foods by how much they raise blood glucose levels compared to a standard food (1). Foods with a low GI have been suggested to reduce postprandial blood glucose and insulin responses instead of those with a high GI (3).
Glycaemic Load (GL) is an equation that considers the planned portion size of food and the glycaemic index of that food (1). A high dietary glycaemic load from carbohydrates has been associated with an increased risk of diabetes mellitus (4, 2, 5). Thus, GI and GL concepts have considered the carbohydrate quality and quantity in influencing postprandial glucose levels (6). The knowledge of the GI of starchy foods is vital in the dietary management of diabetes mellitus (7) because some of these foods with low and medium GI may be beneficial to people suffering from diabetes mellitus (8, 9).
Deficiency in vitamin A is one of the most prevalent problems in developing countries and the most common cause of childhood blindness, with its severity having high fatality rates (11). Sweet potatoes have become a research focus due to their unique, versatile nutrient (10). Orange-fleshed sweet potato is now considered an essential bio-fortified crop in many developing countries in tackling the problem of vitamin A deficiency (a significant public health concern of the poor section). It has emerged as one of the most promising plant sources of beta-carotene, the pro-vitamin A (12). Thus, this study aimed to fill the gap in knowledge on the GI of orange-fleshed sweet potato and indigenous sweet potato commonly consumed in Abeokuta Metropolis, Ogun State, Nigeria, for better healthy food selection in therapeutic meal planning.

MATERIALS AND METHODS

Study design: This study is experimental and cross-sectional in design.

Sample preparation: The Orange-Fleshed Sweet Potato was gotten from the Federal University of Agriculture, Abeokuta farm. In contrast, the indigenous sweet potato was obtained from the farmers' market at Asero. The Orange Fleshed Sweet Potato and Indigenous Sweet Potato were peeled, cleaned, and boiled in water until tender without adding salt and drained water. The sweet potatoes were washed thoroughly in 2500ml water thrice before being cooked. The potatoes were served without stew.

Subject selection: Ten (5 males and 5 females) healthy nondiabetic volunteers were randomly selected using standard recommendations (13, 18, 25). The data of the subjects were obtained on socio-economic characteristics, anthropometric measurement, and oral glucose tolerant test (OGTT).

Inclusion and exclusion criteria: Healthy volunteers within the age range 18-24years, average Body Mass Index (BMI) range 18.50-24.99kg/m2, normal blood glucose level range (fasting blood glucose ≤ 126 mg/dL or 7.0mmol/L), who are non-pregnant, not on medication and with no metabolic disorder were included in the study.

Experimental procedure: The subjects were served orange-fleshed sweet potato (OFSP), indigenous sweet potato (ISP), and glucose separately. This was done each day after a 10-12 hour overnight fast. Subjects were asked to avoid strenuous physical activity and alcohol the day before the experiment. The proximate analysis revealed that the Available Carbohydrate (AC) composition of test foods per 100g sample was 18.9g and 24.3g for orange-fleshed sweet potato and indigenous sweet potatoes, respectively. Therefore, the subjects were served 250g of orange-fleshed sweet potatoes and 200g of indigenous sweet potatoes (containing 50g of available carbohydrate), and glucose of 50g was given as a reference food (18). All samples were consumed with 50cl of water. Blood glucose was recorded at different time intervals for a total period of 2 hours.

Measurement of glucose level

After consuming the indigenous sweet potato (ISP) and orange-fleshed sweet potato (OFSP), the blood samples were taken at 30 minutes, 60 minutes, 90 minutes, and 120 minutes. The blood sample of the respondent was taken by prickling the hand with a lancet, and it was used to stain the stripes, which were placed on a test strip and inserted into a calibrated glucometer (Accu-check), and the readings were recorded. Incremental areas and the glycaemic response were calculated geometrically.

Calculation of glycaemic index

Blood sugar against time was plotted using Microsoft Excel spreadsheets using a scatter diagram. The IAUC (Incremental Area Under the Curve) was then calculated using the trapezoidal rule (2, 14, and 15). The glycaemic index (GI) was computed using the formula:

Note: IAUC(a) = For test food
IAUC(b) = For reference food.

Data were presented by graphs, means, and standard deviation values (17). The glycaemic index of the food was obtained as a mean of the glycaemic index of the food by different subjects (16). The graph was plotted for each subject, and the geometric calculation method in excel was used to calculate the respondent's glycaemic index. The difference in the GI values was computed using the Statistical Package for the Social Sciences (SPSS) version 20.0. The linear mixed-effects model procedure was adopted, and the significance level for this test was set at CI-95%.

Statistical Analysis

Microsoft Office Excel version 2010 was used for coding the questionnaire and figure presentation while Statistical package for social science (SPSS) version 20.0 was used for further data analysis such as Correlation, Chi-square (for comparing the relationship between the test foods), Analysis of Variance (ANOVA) (for Comparing the mean value of indigenous sweet potato, orange-fleshed sweet potato (*Ipomoea batatas*) and glucose at different times).

RESULTS

Characteristics of the Subject

Five males and five females were recruited for the study. The age of subjects recruited for the study ranges from 18 to 24 years, and the mean ± SD age of subjects was 21.40 ± 2.22. All the subjects recruited for the study had tertiary education, were unmarried, and unemployed. Five Christians and five Muslims were recruited for this study. The mean±SD of the subject BMI was 21.61±2.41.

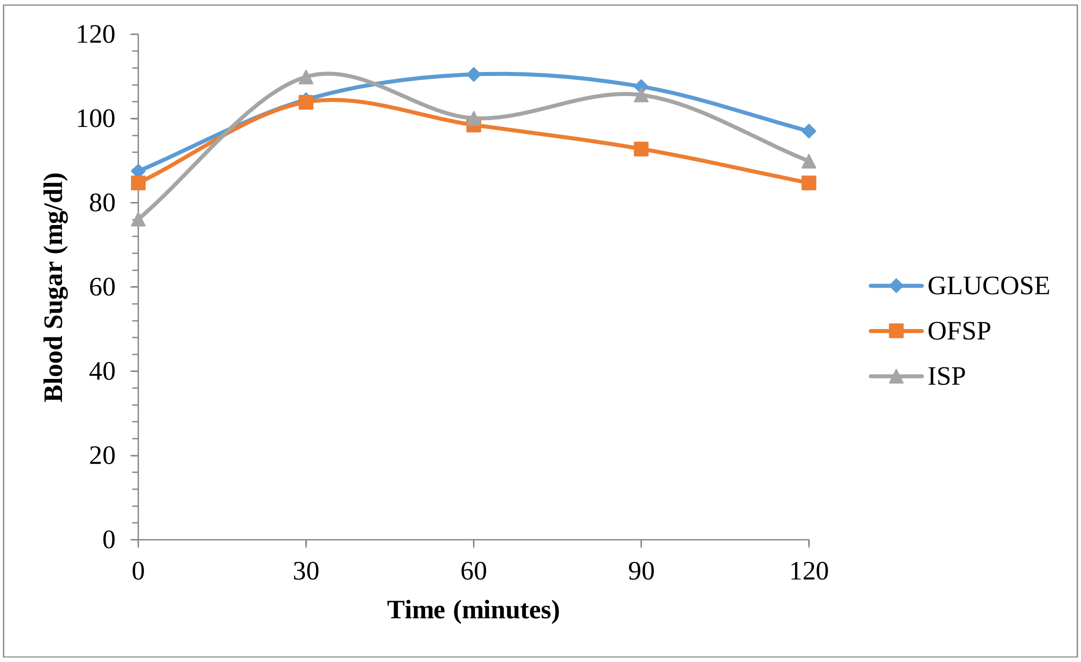
Incremental area under the curve for test foods by different subjects

The Incremental areas under the curve (IAUC) were calculated for each subject for the test foods and the standard (glucose) (Figure 1). Table 1 shows the glycaemic index of the ten subjects after consuming OFSP and ISP. The mean glycaemic index of orange-fleshed sweet potato was 81.36±7.17 for the ten subjects, while that of indigenous sweet potato was 85.50±7.26. Although the mean glycaemic index for the subjects was high according to ranking, that of indigenous sweet potato was higher than that of orange-fleshed sweet potato.

Table 1: Incremental area under the curve for orange-fleshed sweet potato and indigenous sweet potato by different subjects

	Orange Fleshed Sweet Potato			Indigenous Sweet Potato		
Subjects	**IAUC (mg/dl)**	**Glucose(mg/dl)**	**GI**	**IAUC (mg/dl)**	**Glucose(mg/dl)**	**GI**
1	10515	13125	80.11	11280	13125	85.94
2	10710	12975	82.54	10935	12975	84.28
3	11280	13500	83.56	12135	13500	89.89
4	12570	13950	90.11	10920	13950	78.28
5	11115	14775	75.23	14280	14775	96.65
6	11775	13875	84.86	12285	13875	88.54
7	9615	13725	70.05	12915	13725	94.10
8	12240	14250	85.89	12255	14250	86.00
9	10515	14775	71.17	11160	14775	75.53
10	13635	15135	90.09	11475	15135	75.82
Mean±SD	**11397±1180.14**	**14008.5±723.51**	**81.36±7.17**	**11964±1053.43**	**14008.5±723.51**	**85.50±7.26**

IAUC: Incremental area under the curve
GI: Glycaemic index
Mean±SD: Mean ± Standard Deviation



OFSP: Orange-Fleshed Sweet Potato
ISP: Indigenous Sweet Potato
Figure 1: Change in blood glucose level of subjects for experimental foods

Glycaemic index of the test foods

To provide an equivalent of 50 g of available carbohydrates, 250 g of orange-fleshed sweet potato and 200g of indigenous sweet potato were served to the subjects. These results are summarized in Table 2. Orange-fleshed sweet potato and indigenous sweet potato both had a high glycaemic index. Indigenous sweet potato had a higher glycaemic index than orange-fleshed sweet potato and was ranked as a high GI food. However, the GI values for these test foods were not significantly different.

Mean value of the test food at different time

Table 3 shows that at a 95% confidence level, there was no significant difference between the mean value of OFSP and ISP glycaemic index at 30, 60, and 120minutes. Still, there was a significant difference between the mean value of OFSP, ISP, and glucose glycaemic index at 30, 60, and 120 minutes. Also, there was a significant difference between the mean value of OFSP, ISP, and glucose at 90minutes.

Table 2: Glycaemic index of orange-fleshed sweet potato and indigenous sweet potato

Test Foods	Serving Size (g)	GI (Mean±SD)	GI Ranking	P-value
Orange Fleshed Sweet potato	250	81.36±7.17	High	0.307
Indigenous Sweet potato	200	85.50±7.26	High	

There is no significant difference between the GI of the test foods at $p<0.05$

Table 3: Mean value of the test food at different time

Time (minutes)	Type of Food	Mean±Sd
T1 (30 minutes)	OFSP	103.90 ± 11.96^{a}
	ISP	109.90 ± 16.59^{a}
	GLUCOSE	124.50 ± 10.39^{b}
T2 (60 minutes)	OFSP	98.50 ± 18.95^{a}
	ISP	100.10 ± 13.54^{a}
	GLUCOSE	124.70 ± 4.69^{b}
T3 (90 minutes)	OFSP	92.80 ± 13.36^{a}
	ISP	105.60 ± 12.36^{b}
	GLUCOSE	118.50 ± 5.30^{c}
T4 (120 minutes)	OFSP	84.70 ± 12.43^{a}
	ISP	89.90 ± 11.74^{a}
	GLUCOSE	111.00 ± 7.38^{b}

Mean±SD with different superscripts along the column for each time has a significant difference at $p<0.05$.
OFSP: Orange fleshed sweet potato
ISP: Indigenous sweet potato

DISCUSSION

Nutritional Composition

Orange fleshed sweet potato (OFSP), and indigenous sweet potato (ISP) are generally carbohydrate-rich foods. From the results of this present study, the carbohydrate content of the boiled indigenous sweet potato was 24.33%, while that of boiled orange-fleshed sweet potato was 18.87%. This corroborates a study conducted in Kenya where the boiled sweet potato had a carbohydrate content of 23.35% (18).

The study carried out in Australia (19) on orange-fleshed sweet potato reported a carbohydrate content of 18%, which corroborates this study's carbohydrate content. These little differences in carbohydrate content reported by different studies conducted in other parts of the world could also be attributable to the variety since starch content has been found to vary widely among different varieties (20). The slight variation may result from environmental factors such as geographical location and soil nutrient composition.

Glycaemic Index of Indigenous Sweet Potato and Orange-Fleshed Sweet Potato

The GI of indigenous sweet potato (ISP) (85.50) was high in this study, similar to (21), which recorded 88 compared to the reported values of 63 in Australia (22), 84 in Canada (23), and 111 in New Zealand (24). This discrepancy between studies may be due partly to various cooking methods. However, another study recorded a low GI for boiled sweet potato in Jamaica (25), which does not corroborate with the result obtained in this study; this may be due to variations in the gram of food that yield 50g of available carbohydrates, and sweet potato varieties, etc. A medium GI was recorded for boiled sweet potato, which does not corroborate with the result obtained in this study for boiled indigenous sweet potato (ISP) (23, 17, 18). This could be due to the sweet potato variety (25), origin (26, 17), and the gram of available carbohydrate used.

The GI of orange-fleshed sweet potato (OFSP) 81.36 was high in this study. Thus, it does not corroborate with the result reported in Australia, showing a medium GI of 61 (19). This could be due to the cultivars of the potato and the gram of available carbohydrates.

Due to this high GI, the results of this study support the previous review, which recommended the consumption of sweet potatoes in moderation by diabetic individuals (27), possibly because sweet potatoes can cause a higher rise in blood sugar among diabetic patients (28).

CONCLUSION

Orange fleshed sweet potato (OFSP) and indigenous sweet potato (ISP) consumed in Abeokuta Metropolis, Ogun state, Nigeria, have high glycaemic index despite orange-fleshed sweet potato (OFSP) having a lower glycaemic index compared to the indigenous sweet potato (ISP). People suffering from diabetes mellitus should therefore consume these foods in moderation. Further research should investigate the effect of the cooking method on the glycaemic index of orange-fleshed sweet potato (OFSP) and indigenous sweet potato (ISP).

Informed Consent

The subjects' written informed consent was obtained by asking them to sign after introducing and explaining the study and its objectives to the subjects.

Ethical clearance

Prior to the study, permission to embark on the study was obtained from the Department of Nutrition and Dietetics, Federal University of Agriculture, Abeokuta.

Declaration of interest

There is no conflict of interest.

Author's contribution

Oyesanya O.S. brought the research idea, and wrote the manuscript, Olayiwola I.O. supervised the work, John E.P. assisted in the data analysis and reviewed the manuscript and Oladosu G.S. was the student that collected the data.

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