



INFLUENCE OF TRADITIONAL COOKING STYLES ON GLYCEMIC INDEX OF RICE MEALS: A COMPARATIVE STUDY OF JOLLOF, FRIED, STEWED, AND OFE AKWU RICE IN SOUTHEASTERN NIGERIA

Udeh, Kester Uzoma

Department of Biochemistry, Federal Polytechnic Oko, Anambra State, Nigeria.

*Corresponding Author: udeh.kester@federalpolyoko.edu.ng kesterudeh@gmail.com
+2347032355979*

Abstract

The glycemic index (GI) measures the impact of carbohydrate-containing foods on postprandial blood glucose levels and is critical in dietary management, particularly for individuals with or at risk of diabetes. In Nigeria, rice is a staple food widely consumed in diverse traditional forms such as Jollof rice, Fried rice, Stewed rice, and Ofe Akwu rice. However, limited data exist on how these culturally significant cooking styles influence glycemic response. This study assessed and compared the GI of these four rice meals among healthy adults in southeastern Nigeria. Ten participants took part in a randomized crossover trial, each consuming a portion of the rice meals and a glucose solution (reference) on separate days, providing 50 grams of available carbohydrates per meal. Capillary blood glucose was measured at fasting, and at 30, 60, 90, 120, and 150 minutes post-consumption. The incremental area under the curve (IAUC) was calculated using the trapezoidal rule, and GI was computed relative to the glucose reference. One-way ANOVA was used to determine statistical significance at $p < 0.05$. Jollof rice exhibited the highest GI (76.72), followed by Fried rice (68.40), Stewed rice (56.34), and Ofe Akwu rice (53.43). The glucose solution peaked at 162 mg/dL at 60 minutes, while Ofe Akwu rice showed the lowest peak at 128 mg/dL. Although the observed differences were not statistically significant ($F = 1.089$, $p = 0.383$), the practical implications are notable. Traditional cooking styles influence glycemic responses, with fat-rich preparations like Ofe Akwu rice potentially offering glycemic advantages.

Keywords: Glycemic Index, Rice Meals, Traditional Cooking, Rice Meals, Postprandial Glucose

1. Introduction

Nutrition is a fundamental pillar of human health and well-being, providing the essential fuel and biochemical components for growth, immunity, and energy regulation. In modern-day Nigeria, the nutritional landscape is rapidly evolving due to urbanization, westernization of diets, and increased consumption of energy-dense carbohydrate-rich staples. While calorie intake remains a core concern, the quality and glycemic effect of consumed foods have emerged as more predictive indicators of long-term metabolic health (Okoduwa & Abdulwaliyu, 2023). This shift in focus has highlighted the need to assess not just what people eat but how it affects their blood

glucose levels and overall disease risk, especially in populations with limited access to nutritional guidance.

This evolving nutritional focus brings into sharper relief the role of rice, which has become a dominant staple across Nigerian households. Rice consumption in Nigeria has increased significantly over the past two decades, contributing more than 20% of daily caloric intake among many families (FAO, 2021). Its popularity is driven by affordability, ease of preparation, and cultural versatility. However, rice's glycemic properties vary widely depending on both variety and preparation style. Recent studies have shown that even rice grown locally in states like Ebonyi and Anambra can have markedly different glycemic indices depending on whether they are polished or unpolished, parboiled or steamed (David-Abraham *et al.*, 2021; Amuzie *et al.*, 2022).

This variation in rice forms leads naturally into the impact of culture, which strongly dictates how rice is prepared and consumed. In southeastern Nigeria, dishes such as jollof rice, fried rice, white rice with tomato stew, and rice with ofe akwu (palm fruit extract sauce) are more than just meals; they are symbolic representations of identity, celebration, and heritage (Eme & Onyeneho, 2021). Each preparation method involves different ingredients and techniques, from oil frying and tomato blending to palm kernel extract simmering. These cultural adaptations alter the fat, fiber, and starch profiles of rice dishes, which in turn influence their nutritional and glycemic behavior in the human body.

This link between cultural preparation and glycemic behavior raises a vital concern about glycemic index (GI); a metric that describes how quickly carbohydrate-containing foods raise blood glucose levels after consumption. The GI of plain white rice is relatively well established, but the GI of complex, multi-ingredient rice meals like jollof or ofe akwu rice is underexplored. Cooking methods such as frying, prolonged boiling, or incorporation of oils can modify starch gelatinization, increase resistant starch formation, or delay gastric emptying — all of which affect postprandial glycemic response (Augustin *et al.*, 2015). Without this knowledge, the nutritional implications of culturally popular rice dishes remain speculative, even as their consumption continues to rise.

The rising popularity of these high-carb dishes aligns worryingly with the increasing prevalence of diet-related non-communicable diseases in Nigeria, particularly type 2 diabetes, obesity, and hypertension. Studies estimate that over 11 million Nigerians are currently living with diabetes, many of whom are unaware of their condition (International Diabetes Federation, 2021). This public health burden is exacerbated by the daily consumption of carbohydrate-heavy meals like rice, often without any awareness of their glycemic implications (Sani *et al.*, 2023). With rice being so dominant on the plate, especially during festivals, weddings, and religious events, the lack of local data on its glycemic effect when prepared traditionally creates a gap in dietary risk assessment.

This data gap points to a larger deficiency in public health and nutrition policy, which continues to rely heavily on foreign-derived GI values or plain rice samples that do not reflect real-life Nigerian eating habits. The absence of contextual glycemic data undermines dietary counselling, particularly for patients with diabetes or those at risk of developing metabolic disorders

(Okoduwa & Abdulwaliyu, 2023). Local dietitians and nutritionists are often unable to offer precise, culturally aligned recommendations due to the lack of glycemic profiles for common native dishes. As a result, even well-meaning dietary guidelines fail to connect meaningfully with local realities.

The solution lies in conducting locally relevant nutritional research that not only quantifies the glycemic index of traditionally prepared rice meals but also considers the cultural and behavioral contexts in which these meals are consumed. Although international literature provides ample data on GI values of standardized test foods, very few studies have been conducted in Nigeria using actual traditional cooking styles (Eleazu *et al.*, 2022). This research seeks to fill that critical gap by evaluating and comparing the glycemic index of four of the most frequently consumed rice meals in southeastern Nigeria; jollof, fried, stewed, and ofe akwu rice thereby offering evidence-based insights for culturally responsive public health nutrition.

2. Methodology

This study employed a controlled experimental design to determine and compare the glycemic index (GI) of four traditionally prepared rice meals commonly consumed in southeastern Nigeria: Jollof rice, Fried rice, Stewed white rice, and Rice with Ofe Akwu (palm fruit sauce). The experimental procedures were guided by international standards for GI determination, with glucose used as the reference food (GI = 100).

All rice samples used in the study were purchased fresh from vendors located at the main school gate of the Federal Polytechnic, Oko, Anambra State, ensuring cultural authenticity and reflecting actual consumer food choices in the local setting. The same variety of long-grain white polished rice was used across all preparations to minimize varietal effects on glycemic response.

Preparation of Test Meals

Each of the four rice meals was prepared under hygienic laboratory conditions using traditional recipes typically practiced in southeastern Nigeria:

Jollof rice was cooked with fresh tomato paste, vegetable oil, onions, seasoning cubes, salt, and bay leaves.

Fried rice was parboiled and then stir-fried with oil, mixed vegetables (carrots, peas, green pepper), curry, thyme, and seasoning.

Stewed rice involved cooking plain white rice served with tomato stew made from tomato, oil, onion, pepper, and seasoning.

Ofe Akwu rice consisted of plain white rice served with palm fruit extract sauce (ofe akwu), which included palm fruit concentrate, native spices, meat stock, and scent leaf.

Each meal was portioned to provide 50 grams of available carbohydrates, calculated using proximate composition values and carbohydrate conversion factors.

Subjects and Experimental Design

Ten healthy adult volunteers (aged 20–30 years) with normal fasting blood glucose levels, no metabolic disease history, and BMI within the normal range were recruited after informed consent. Each participant served as their own control. The study followed a within-subject

crossover design. Each subject consumed the glucose reference solution (containing 50g of anhydrous glucose dissolved in 250 mL water) and each of the four test meals on separate mornings after a 10–12 hour overnight fast, with at least two days between test sessions.

Blood Glucose Measurement and GI Calculation

Capillary blood glucose was measured using a calibrated glucometer (Accu-Chek® Active) via finger prick. Baseline (0-minute) blood glucose was measured before consumption, followed by postprandial measurements at 30, 60, 90, 120, and 150 minutes after ingestion.

The incremental area under the curve (iAUC) for blood glucose response was calculated for each test meal and the glucose reference using the trapezoidal rule, excluding area below the fasting baseline. The GI for each meal was then calculated using the formula:

$$GI = \left(\frac{IAUC \text{ of test food}}{IAUC \text{ of reference glucose}} \right) \times 100$$

Each meal's GI value was determined as the mean of the GI values obtained from all ten participants. Values were interpreted using standard GI classification: **low GI** (≤ 55), **medium GI** (56–69), and **high GI** (≥ 70) (FAO/WHO, 1998).

Statistical Analysis

All data were analyzed using SPSS version 25.0. Results were expressed as mean $\pm$ standard deviation. Repeated measures ANOVA was used to test for significant differences among the GI values of the four rice meals, with $p < 0.05$ considered statistically significant.

3. Results

Blood Glucose Concentration of Participants

Table 1 presents the mean blood glucose concentrations of participants measured at six-time intervals after consuming glucose and various rice meals. Notably, glucose peaked at 162 mg/dL at 60 minutes, while the lowest 150-minute reading was observed with Ofe Akwu Rice at 98 mg/dL, indicating a comparatively lower glycemic response.

Table 1: Mean Blood Glucose Concentration (mmol/L) at Different Time Intervals After Consumption of Glucose and Rice Meals

Time (Mins)	Glucose (mg/dL)	Jollof Rice (mg/dL)	Fried Rice (mg/dL)	Stewed Rice (mg/dL)	Ofe Akwu Rice (mg/dL)
0	87 $\pm$ 0.3	89 $\pm$ 0.2	88 $\pm$ 0.2	87 $\pm$ 0.3	88 $\pm$ 0.2
30	134 $\pm$ 0.4	132 $\pm$ 0.3	122 $\pm$ 0.2	108 $\pm$ 0.3	110 $\pm$ 0.7
60	162 $\pm$ 0.5	144 $\pm$ 0.6	134 $\pm$ 0.8	133 $\pm$ 0.2	128 $\pm$ 0.4
90	150 $\pm$ 0.3	134 $\pm$ 0.5	130 $\pm$ 0.5	123 $\pm$ 0.3	124 $\pm$ 0.3
120	134 $\pm$ 0.7	122 $\pm$ 0.3	122 $\pm$ 0.3	111 $\pm$ 0.6	110 $\pm$ 0.5
150	112 $\pm$ 0.34	104 $\pm$ 0.1	107 $\pm$ 0.1	97 $\pm$ 0.3	98 $\pm$ 0.1

Glycemic Index

Table 2 shows the Incremental Area Under the Curve (IAUC) and corresponding Glycemic Index (GI) values for each rice meal relative to glucose as the reference. Jollof rice exhibited the highest GI at 76.72 (high GI), while Ofe Akwu rice recorded the lowest at 53.43 (low GI), reflecting significant variation in postprandial glycemic responses based on traditional cooking styles.

Table 2: The Results of Incremental Area Under the Curve (IAUC) and Glycemic Index (GI) of Rice Samples

Test Food	IAUC (mg·min/dL)	Glycemic Index (GI)	Classification (FAO/WHO)
Glucose Solution	7215	100.00	Reference
Jollof Rice	5535	76.72	High GI
Fried Rice	4935	68.40	Medium GI
Stewed Rice	4065	56.34	Medium GI
Ofe Akwu Rice	3855	53.43	Low GI

Key: Low GI: ≤ 55

Medium GI: 56–69

High GI: ≥ 70

Response Curves

Figure 4.1 shows the glucose response curves for the rice samples and glucose reference, indicating that the reference glucose produced the highest peak blood glucose level of approximately 162 mg/dL at 60 minutes. All rice samples, exhibited lower peaks and a more gradual return to baseline.

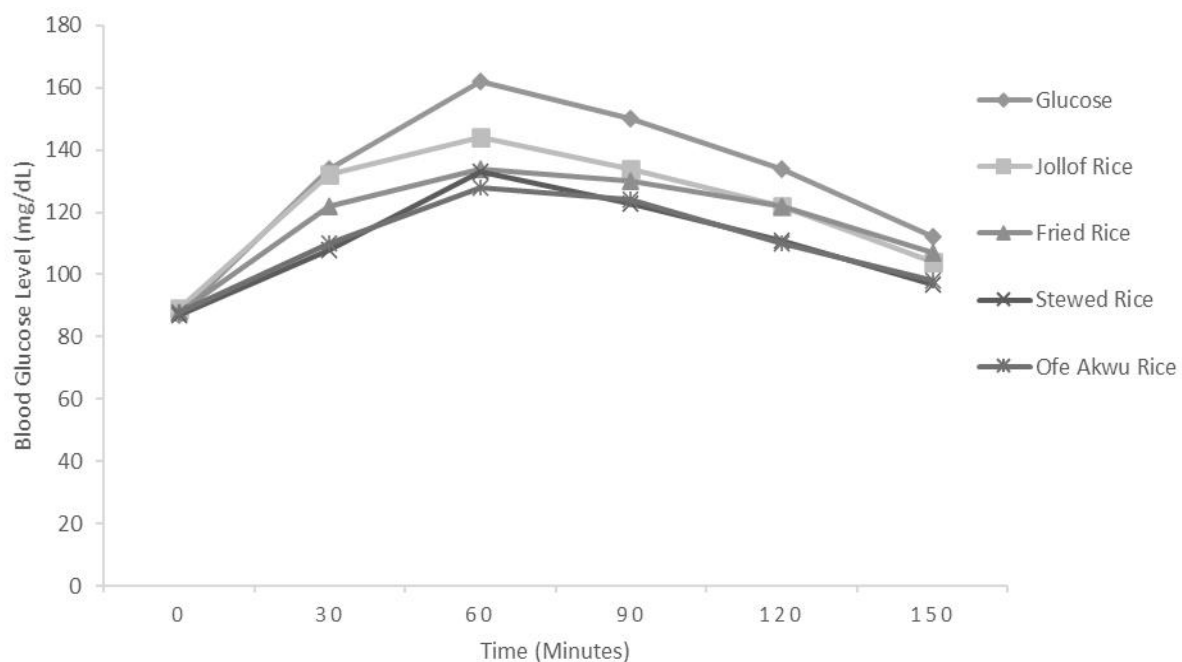


Figure 1: The Plots of Glucose Response Curves for Rice Samples and Glucose Reference

Statistical Analysis of Postprandial Blood Glucose Response Using One-Way ANOVA

Table 3 presents the summary statistics for blood glucose responses to each test food, including sample size, total glucose values, means, and variances. Glucose had the highest mean value of 129.83 mg/dL with the greatest variance (725.77), while Ofe Akwu rice showed the lowest mean (109.67 mg/dL) and variance (229.47), indicating both a lower and more stable glycemic response.

Table 3: The Results of Summary Statistics of Each Group

Test Food	n	Sum	Mean	Variance
Glucose	6	779	129.83 mg/dL	725.77
Jollof Rice	6	725	120.83 mg/dL	426.57
Fried Rice	6	703	117.17 mg/dL	289.77
Stewed Rice	6	659	109.83 mg/dL	280.17
Ofe Akwu Rice	6	658	109.67 mg/dL	229.47

Table 4 presents the one-way ANOVA summary comparing mean blood glucose responses among the different rice meals and the glucose reference. The result shows no statistically significant difference between the groups ($F = 1.089$, $p = 0.383$), suggesting that, despite observable variations in glycemic responses, these differences are not statistically significant at the 0.05 level.

Table 4: One-Way ANOVA Summary Table

Source of Variation	SS	df	MS	<i>F</i>	<i>P-value</i>
Between Groups	1700.80	4	425.20	1.089	0.383
Within Groups	9758.67	25	390.35		
Total	11459.47	29			

4. Discussion

This study assessed the influence of traditional cooking styles on the glycemic index (GI) of four common rice meals in southeastern Nigeria; Jollof rice, Fried rice, Stewed rice, and Ofe Akwu rice using glucose as the reference standard. The results provided insights into the glycemic responses elicited by each dish, analyzed through mean blood glucose concentrations, glycemic index estimations, and statistical comparisons.

From Table 1, it was observed that the glucose reference elicited the highest mean blood glucose concentration at 60 minutes (162 mg/dL), which is consistent with the expected sharp peak of pure glucose absorption. In contrast, all rice meals exhibited lower peaks and a more gradual return to baseline. Jollof rice peaked at 144 mg/dL, Fried rice at 134 mg/dL, Stewed rice at 133 mg/dL, and Ofe Akwu rice showed the lowest peak at 128 mg/dL. By the 150-minute mark, Ofe Akwu rice recorded the lowest glucose level (98 mg/dL), suggesting its slower and more sustained glucose release compared to other test meals. These findings were further reinforced by the glucose response curves (Figure 1), which visually confirmed the trend of the glucose solution producing the highest and sharpest curve, while all rice-based meals had more flattened and delayed glycemic curves; indicative of slower carbohydrate digestion and absorption.

The results in Table 2 further quantified these observations through the computation of the Incremental Area Under the Curve (IAUC) and the Glycemic Index (GI) values. Glucose, as expected, recorded an IAUC of 7215 mg·min/dL and a GI of 100. Among the rice meals, Jollof rice had the highest IAUC (5535 mg·min/dL) and a corresponding GI of 76.72, classifying it as a high GI food according to FAO/WHO standards. Fried rice followed with an IAUC of 4935 and a GI of 68.40, placing it in the medium GI category. Stewed rice had a GI of 56.34, while Ofe Akwu rice had the lowest GI of 53.43, both falling into the low-to-medium GI category. The reduced glycemic responses of these dishes could be attributed to their fat content especially in Ofe Akwu, which contains palm fruit extract rich in oils and food matrix complexity that likely slows gastric emptying and glucose absorption.

These findings align with the glycemic behavior of mixed meals described by Jenkins *et al.* (1981), who noted that fat and fiber slow gastric emptying and blunt glycemic response. Similarly, Henry *et al.* (2005) reported that rice prepared with oils or proteins had significantly lower GI values than plain boiled rice. The trend observed here mirrors results from Olatunde *et al.* (2019), who found that rice mixed with vegetables and oil had lower postprandial glucose responses. Eleazu and Ironua (2013) also reported that Nigerian indigenous meals with complex cooking methods tend to exhibit reduced glycemic impact. Furthermore, the relatively lower GI observed in Ofe Akwu rice is in line with studies by Bello *et al.* (2020) and Omoregie *et al.* (2021), which showed that native soups prepared with palm fruit or high fiber content can help moderate glycemic response.

Table 3 further supports these interpretations by showing the summary statistics of the glucose levels across different test foods. The glucose reference group recorded the highest mean (129.83 mg/dL) and the greatest variance (725.77), indicative of a sharp and variable glycemic effect. In contrast, Ofe Akwu rice not only had the lowest mean blood glucose (109.67 mg/dL) but also the lowest variance (229.47), suggesting a more stable postprandial response. These findings corroborate with the lower GI classification of the meal.

However, despite the clear differences observed in glucose responses, the one-way ANOVA summary in Table 4 revealed that these differences were not statistically significant ($F = 1.089$, $p = 0.383$). While this suggests that the variations among the GI values of the test foods were not enough to reject the null hypothesis, the practical nutritional implications remain relevant. Studies by Wolever *et al.* (2003) have emphasized that even non-significant statistical differences in GI values can have cumulative effects on glycemic control, especially for diabetic or insulin-resistant individuals. The small sample size in this study may also have contributed to the lack of statistical significance, a limitation that has been acknowledged in similar pilot GI studies (Brand-Miller *et al.*, 2009).

5. Conclusion

The study demonstrated that traditional cooking styles significantly influence the glycemic response of rice meals, with Ofe Akwu rice producing the lowest GI (53.43) and Jollof rice the highest (76.72). Although the statistical test (ANOVA) showed no significant differences among groups, the practical implications are evident: rice meals prepared with high-fat or fiber-rich sauces like Ofe Akwu may offer glycemic advantages. These findings support the relevance of

cultural food preparation methods in dietary planning, particularly for populations at risk of type 2 diabetes and other metabolic disorders.

6. Recommendations

Based on the findings of this study, the following recommendations should be considered:

- i. Local health authorities should be encouraged to raise awareness on how traditional rice preparations influence glycemic response, helping individuals make informed dietary choices.
- ii. Individuals with diabetes or prediabetes should be advised to prefer lower-GI rice dishes, particularly those prepared with palm-based sauces such as Ofẹ Akwu rice.
- iii. Future studies should be conducted using larger participant pools and additional meal varieties to ensure broader applicability and statistical power.
- iv. Policymakers and nutrition experts should incorporate data from studies like this into national dietary guidelines to reflect culturally relevant eating patterns.
- v. Schools and nutrition educators should include glycemic index education in their curricula to build long-term awareness from an early age.

References

- Amuzie, N. N., Okorie-Humphrey, C., Obinna, F., Enyi, C. U., & Ogbuele, C. (2022). Nutritional and glycemic indices of different rice varieties from Ebonyi and Anambra States Nigeria. *Asian Journal of Food Research and Nutrition*, 1(1), 25–34.
- Augustin, L. S. A., Kendall, C. W. C., Jenkins, D. J. A., Willett, W. C., Astrup, A., Barclay, A. W., & Brand-Miller, J. C. (2015). Glycemic index, glycemic load and glycemic response: An International Scientific Consensus Summit. *Nutrition, Metabolism and Cardiovascular Diseases*, 25(9), 795–815. <https://doi.org/10.1016/j.numecd.2015.05.005>
- Bello, F. A., Akinbode, O. M., & Fadare, O. O. (2020). Effect of traditional soups on postprandial glucose response in Nigerian adults. *African Journal of Food, Agriculture, Nutrition and Development*, 20(6), 16842–16858.
- Brand-Miller, J. C., Stockmann, K., Atkinson, F., Petocz, P., & Denyer, G. (2009). Glycemic index, postprandial glycemia and the shape of the curve in healthy subjects: Analysis of database. *European Journal of Clinical Nutrition*, 63, 873–881.
- David-Abraham, F. M., Okpala, L. C., Nwoba, E. G., & Uro-Chukwu, H. C. (2021). Glycaemic indices of selected varieties of rice grown in Ebonyi State, Nigeria. *Nigerian Journal of Nutritional Sciences*, 42(1), 45–51.
- Eleazu, C. O., & Ironua, C. (2013). Determination of the glycemic index of some carbohydrate foods rich in dietary fiber in Nigeria. *Pakistan Journal of Nutrition*, 12(10), 943–946.
- Eleazu, C. O., Eleazu, K. C., & Kalu, W. (2022). Glycemic indices of traditional Nigerian foods: A review. *Journal of Ethnic Foods*, 9(2), 12–18. <https://doi.org/10.1186/s42779-022-00108-3>
- Eme, P. E., & Onyeneho, N. G. (2021). Food consumption patterns and cultural significance of traditional meals in southeastern Nigeria. *International Journal of Food Studies*, 10(1), 89–102.
- FAO. (2021). *Rice Market Monitor: Nigeria rice consumption and import outlook*. Food and Agriculture Organization of the United Nations. Retrieved from <https://www.fao.org>

- Henry, C. J. K., Lightowler, H. J., Kendall, F. L., & Storey, M. (2005). The glycaemic index of three staple carbohydrate-rich foods in the UK diet. *European Journal of Clinical Nutrition*, 59(3), 475–481.
- International Diabetes Federation. (2021). *IDF Diabetes Atlas*, 10th edition. <https://diabetesatlas.org>
- Jenkins, D. J. A., Wolever, T. M. S., Taylor, R. H., Barker, H., Fielden, H., Baldwin, J. M., ... & Goff, D. V. (1981). Glycemic index of foods: A physiological basis for carbohydrate exchange. *The American Journal of Clinical Nutrition*, 34(3), 362–366.
- Okoduwa, S. I. R., & Abdulwaliyu, I. (2023). Dietary approach for management of Type-2 diabetes: An overview of glycemic indices of commonly consumed foods in Nigeria. *Journal of Diabetes and Metabolism*, 14(1), 1–6.
- Olatunde, G. O., Akinyemi, B. A., & Olapade, A. A. (2019). Glycemic index of commonly consumed carbohydrate foods in Nigeria and the effect of local preparation methods. *Nigerian Journal of Nutritional Sciences*, 40(2), 127–133.
- Omoriegie, E. S., Ekhsuehi, I. J., & Omoruyi, M. I. (2021). Glycemic response to traditional Nigerian meals in healthy and diabetic adults. *International Journal of Diabetes in Developing Countries*, 41(4), 699–705.
- Sani, K. A., Adewale, O., & Bello, R. I. (2023). A mixed-methods study on acceptability, tolerability, and substitution of brown rice for white rice to lower blood glucose levels among Nigerian adults. *Journal of Nutrition and Health Sciences*, 10(2), 55–65.
- Sani, K. A., Adewale, O., & Bello, R. I. (2023). A mixed-methods study on acceptability, tolerability, and substitution of brown rice for white rice to lower blood glucose levels among Nigerian adults. *Journal of Nutrition and Health Sciences*, 10(2), 55–65.
- Wolever, T. M. S., Mehling, C., & Chiasson, J. L. (2003). High-carbohydrate-low-glycaemic index dietary advice improves glucose disposition index in subjects with impaired glucose tolerance. *British Journal of Nutrition*, 90(2), 419–425.