



NUTRITIONAL VARIABILITY OF FARO RICE SERIES AS INFLUENCED BY GRAIN LENGTHS AND LOCATIONS: IMPLICATIONS FOR FOOD SECURITY AND PUBLIC HEALTH IN SOUTHEAST NIGERIA

Emmanuel Ikechukwu Nnamonu*, Amos Ejike Edeh, Innocent Ezeorah Ezeaku, & Samuel N. Odo

Federal College of Education, Eha-Amufu.

Corresponding email: *nnamonue@gmail.com

Abstract

This study investigates the nutritional variability of FARO rice series across grain lengths and locations in Southeast Nigeria, aimed at filling existing knowledge gaps in the nutritional composition of this staple food. Samples of short and long FARO rice series were collected from six selected locations across three states renowned for rice cultivation: Anambra, Ebonyi, and Enugu. Proximate constituents, mineral contents, and vitamin levels were analyzed using standard methods. The results revealed significant variations in the nutritional composition of short and long FARO grains across different locations and grain lengths. Short-grained (FARO 44) rice generally exhibited higher protein, moisture, and ash content, while long-grained (FARO 52) rice showed elevated concentrations of specific vitamins and minerals, notably magnesium and manganese. These findings suggest potential genetic, environmental, and agronomic influences on rice nutritional quality. The study underscores the importance of considering these factors in rice breeding programs, agricultural practices, and policy interventions aimed at enhancing the nutritional quality of rice, thereby contributing to improved food security and public health in Southeast Nigeria.

Keywords: Rice, food security, grain length, public health

Introduction

Despite rice being a staple food for over half of the world's population, comprehensive studies focusing on the nutritional variability of specific rice seed lots across diverse geographical locations remain limited (Eze *et al.*, 2023), especially within the context of Southeast Nigeria. Understanding this variability is crucial for enhancing food security and addressing public health challenges, given the significant role rice plays in the diets of many Nigerians (FAO, 2021).

Rice is not just a source of carbohydrates; it also provides essential nutrients, including proteins, vitamins, and minerals, which are vital for human health (FAO, 2022). Nutritional variability across rice seed lots in terms of seed size and grain length can influence the health status of populations dependent on rice as a primary food source (FAO, 2022). The FARO rice varieties, especially FARO 44 and FARO 52 which are cultivated extensively in Southeast Nigeria, serves as an essential staple for millions and they manifests different seed size and length (Eze *et al.*, 2023), making its nutritional composition of paramount importance. While previous studies have explored the performance of rice varieties across seasons (Manasseh *et al.*, 2018), there is limited information on the nutritional variability of FARO rice series with regards to their grain lengths and geographical

locations within Southeast Nigeria. Such information is vital for guiding rice breeding programs, agricultural practices, and policy interventions aimed at improving rice quality and enhancing food security (FAO, 2021). Understanding the nutritional variability of FARO rice series such as FARO 44 and FARO 52 with contrasting grain lengths will not only improve rice breeding programs, nutritional status and end use quality of rice but will also contribute to improve food security and public health in Southeast Nigeria (FAO, 2022).

This study aims to investigate the influence of different rice grain lengths and locations on nutritional status of FARO rice series in Southeast Nigeria. Specifically, the study seeks to: examine the proximate contents, the vitamin contents, and the mineral contents of FARO rice series across selected locations. This study will provide valuable insights that can guide policymakers, agriculturalists, nutritionists, and other stakeholders in making informed decisions to address malnutrition and promote sustainable food systems. By addressing these objectives, this study aims to fill the existing knowledge gap and provide a foundation for further research and interventions aimed at improving the nutritional quality of rice seed lots cultivated in Southeast Nigeria.

Materials and Methods

Study Area

The research was conducted across multiple sites in southeast Nigeria, specifically in Omasi (Latitude: 6° 42' 14" N, Longitude: 6° 58' 46" E), Omar (Latitude: 6° 30' 37" N, Longitude: 6° 57' 32" E), Ikwo (Latitude: 6.0659° N, Longitude: 8.0953° E), Izzi (Latitude: 6.5792° N, Longitude: 8.0475° E), Adani (Latitude: 6.7340° N, Longitude: 7.0095° E), and Eha-Amufu (Latitude: 6.6590° N, Longitude: 7.7607° E). These regions have a tropical humid climate, with distinct wet and dry seasons and annual rainfall between 1300-3000mm. The areas are characterized by high temperatures, rainfall, and humidity. Ikwo LGA spans 500 square kilometers, with an average temperature of 27 degrees Celsius, an average humidity level of 68%, and annual rainfall ranging from 1613.8 mm to 2136.27 mm. Izzi LGA covers an area of 2,264 square kilometers, with an average temperature of 27 degrees Celsius, guinea savannah vegetation, and an average elevation of 140 meters above sea level. The average humidity level in Izzi is 70%. Uzo-Uwani LGA has a tropical wet-and-dry (savanna) climate, with annual rainfall varying from approximately 1,650mm on the northeast plateau to 147mm in the western lowland. It covers 855 square kilometers with an average temperature of 28 degrees Celsius. Eha-Amufu, located at an elevation of 109 meters above sea level, has an average temperature of 27.0 degrees Celsius and an average precipitation of 1669 mm.

Field Sampling, Experimental Design, and Sample Preparation

Samples were gathered from three states renowned for rice cultivation in southeast Nigeria: Anambra, Ebonyi, and Enugu. Two farming communities were chosen in each state based on their rice yield. In Anambra state, Omasi and Omar in Ayamelum local government area were chosen. In Ebonyi state, Ikwo and Izzi in their respective local government area were selected. In Enugu state, Adani and Eha-Amufu in Uzo-Uwani and Isi-Uzo local government area were chosen. The study concentrated on the widely grown FARO rice series in Nigeria which possess both short and long-grain types. A total of 18 samples of each of FARO 44 and FARO 52 rice varieties were collected from the six selected sites, resulting in 36 samples. The samples were transported to the laboratory within 48 hours, shade-dried, ground to powder, sieved through a 2 mm mesh, and stored in airtight containers. They were then kept in sacks for lab testing at the Soil Science Laboratory, University of Nigeria, Nsukka, Enugu state,

Nutritional Variability of Faro 44 Rice Seed Loys as Influenced by Grain Lengths and Locations: Implications for Food Security and Public Health in Southeast Nigeria

where proximate constituents, mineral contents, and vitamin levels were assessed (Eze *et al.*, 2023).

Determination of Proximate Compositions

The proximate compositions were assessed following the methods outlined by the Association of Official Agricultural Chemists (AOAC) in 2016.

Determination of Mineral Contents

Mineral contents were determined using a microwave digestion system (Ethos easy). Each 200-milligram sample was placed in Teflon vessels, followed by the addition of 7 mg of HNO₃, 2 ml of H₂O₂, and 1 ml of HClO₄. These vessels were then processed in the microwave digestion system according to the specified program for plant tissue. After digestion, the samples were filtered using Whatman filter paper and diluted to a 50 ml volume. A 2 ml solution from each sample was then analyzed for mineral content using Micro-Plasma Atomic Emission Spectroscopy (MP-AES) (Eze *et al.*, 2023).

Determination of Vitamin E, B1, B2, C, and β-Carotene Contents

The vitamin levels were determined based on the method described by Umar *et al.* in 2013.

Statistical Analysis

Data analysis was conducted using analysis of variance (ANOVA) with GENSTAT Release 7.22 DE (2012). The least significant difference was used to identify significant differences between treatment means at a 5% probability level.

Results

Table 1 shows the effect of different locations and grain lengths on the proximate contents of FARO riceseries.

In Eha-Amufu, generally, short-grained rice had higher protein and moisture content compared to long-grained rice. The ash content was higher in the long-grained variety. In Adani, the short-grained rice had higher protein content but significantly higher moisture and ash content compared to the long-grained variety. In Omasi, short-grained rice had slightly higher protein and fibre content, while the long-grained variety had a significantly lower ash content and higher fat content. In Omor, the short-grained rice exhibited higher protein and moisture content compared to the long-grained rice. In Izzi, long-grained rice had higher protein content, while short-grained rice had higher moisture, ash, and fibre content. In Ikwo, short-grained rice had remarkably higher protein content compared to the long-grained variety. Long-grained rice had a higher moisture content.

The grain length effect revealed that short-grained rice generally showed higher protein, moisture, and ash content across most locations. However, it had lower fat and carbohydrate content. Long-grained rice had variable effects depending on the location but often had lower protein and moisture content compared to short-grained rice. The ash content was also inconsistent across locations.

The LSD values indicate that differences in carbohydrate content were not significant (n.s) across the locations and grain lengths..

Table 1: Effect of different locations and grain lengths on the proximate contents of FARO rice seed

Locations	Grain length	Protein (%)	Moisture (%)	Ash (%)	Fat (%)	Fibre (%)	CHO (%)	Dry matter (%)
Eha-Amufu	Short	6.25	8.34	3.50	4.08	3.50	82.77	92.50
	Long	6.26	7.50	4.00	3.50	3.50	76.56	93.33
Adani	Short	6.10	12.50	4.67	3.50	3.57	80.04	92.50
	Long	5.72	11.30	3.50	3.50	3.50	83.59	93.37
Omasi	Short	7.07	11.33	3.50	3.50	4.00	80.59	93.33
	Long	7.07	12.33	0.75	4.67	4.00	78.65	92.50
Omor	Short	6.77	11.00	3.50	5.00	3.50	81.17	93.83
	Long	6.46	11.50	3.84	3.50	3.50	81.24	93.50
Izzi	Short	8.23	12.47	4.67	4.50	2.45	76.39	91.90
	Long	9.29	10.67	4.50	3.50	3.88	78.57	94.50
Ikwo	Short	13.20	11.00	3.50	3.50	3.50	75.39	93.67
	Long	10.05	7.50	3.84	3.50	3.84	78.57	92.50
LSD(0.05)		n.s	n.s	n.s	n.s	n.s	4.24	n.s

n.s = non-significant, CHOM = Carbohydrate

The table shows the effect of different locations and grain lengths on selected vitamin contents of FARO rice series.

In Eha-Amufu, long-grained rice generally exhibited higher vitamin contents compared to short-grained rice. Vitamin E, B1, B2, and B-CAROTENE were significantly higher in long grained rice. In Adani, long-grained rice had slightly higher vitamin E and B2 content but was comparable to short-grained rice in B1 and C vitamins. In Omasi, short-grained rice had higher vitamin E, B1, and C content. However, long-grained rice had a significantly higher B-CAROTENE content. In Omor, short-grained rice showed higher vitamin E and BCAROTENE content, while long-grained rice had higher B2 content. In Izzi, short-grained rice had higher vitamin E, B1, C, and B-CAROTENE content. The long-grained rice showed higher vitamin B2 content. In Ikwo, both grain types showed similar vitamin contents, except for B-CAROTENE, which was significantly higher in long-grained rice.

The LSD values indicate that differences in vitamin C and B-CAROTENE content were significant across the locations and grain lengths, while other differences were not significant (n.s).

Table 2: Effect of different locations and grain lengths on some selected vitamin contents of FARO rice series

Locations	Grain length	VIT E (mg/100g)	VIT B1 (mg/100g)	VIT B2 (mg/100g)	VIT C (mg/100g)	B-CAROTENE (µ)
Eha-Amufu	Short	0.83	1.93	3.63	26.67	30.83
	Long	3.77	3.90	4.77	45.67	97.50
Adani	Short	3.77	0.65	0.80	14.67	102.50
	Long	3.64	0.65	0.80	14.67	64.17
Omasi	Short	5.73	3.5	3.84	27.67	197.50
	Long	3.64	0.85	2.90	20.67	65.84
Omor	Short	5.30	0.45	00.45	8.67	130.83
	Long	4.06	0.45	0.70	8.67	231.00
Izzi	Short	6.80	3.57	4.05	38.67	235.83
	Long	4.90	3.87	4.77	45.67	135.83
Ikwo	Short	6.80	2.03	3.64	26.67	236.00
	Long	8.50	3.50	3.83	27.67	330.83
LSD(0.05)		n.s	n.s	n.s	4.24	4.10

LSD= Least significant difference, n.s= non-significant

The table provides information on the effect of different locations and grain lengths on selected mineral contents of FARO rice series.

In Eha-Amufu, long-grained rice showed slightly higher levels of Ca, Cu, Fe, Na, and Zn compared to short-grained rice. P content was higher in short-grained rice. In Adani, shortgrained rice had higher levels of Ca, Cu, Na, and K compared to long-grained rice. Longgrained rice had higher P content. In Omasi, short-grained rice exhibited higher levels of Ca, Cu, Na, and K compared to long-grained rice. Long-grained rice had slightly higher levels of Mn. In Omor, long-grained rice showed higher levels of Ca, Fe, Mn, and K compared to short-grained rice. In Izzi, long-grained rice had higher levels of Ca, Cu, Fe, and K compared to short-grained rice. Short-grained rice had higher Na content. In Ikwo, long-grained rice had higher levels of Ca, Cu, Fe, P, and K compared to short-grained rice. Short-grained rice had higher levels of Mg and Mn.

The grain length effect showed that short-grained rice generally exhibited higher levels of Ca, Cu, Na, and K across most locations. However, Mg and Mn levels were often higher in longgrained rice. Long-grained rice frequently had higher levels of Fe, Mn, and K across locations but was comparable or slightly lower in other minerals compared to short-grained rice.

The LSD values indicate that differences in Cu, P, and K content were significant across the locations and grain lengths, while other differences were not significant (n.s).

Table 3: Effect of locations and grain length on some selected mineral contents of FARO rice series

Loca- tions	Grain length	Ca mg/100g	Cu mg/ 100g	Fe mg/100g	Mg mg/100g	Mn mg/100g	Na ppm	P mg/100g	Zn mg/100g	K ppm
Eha- Amufu	Short	3.47	48.96	3.19	2.62	3.11	3.67	4.30	302.67	6.66
	Long	3.47	48.96	3.47	2.62	3.11	3.57	4.87	302.67	4.79
Adani	Short	3,72	25.73	3.19	2.64	3.22	3.46	4.30	602.67	6.93
	Long	3.47	48.79	3.19	2.62	3.08	3.46	5.20	602.67	6.12
Omasi	Short	3.47	14.12	3.47	2.62	3.08	3.57	4.87	802.67	6.66
	Long	3.47	14.12	3.19	2.62	3.11	3.67	4.87	602.67	6.24
Omor	Short	4.41	48.96	2.91	2.73	3.08	3.57	2.59	602.67	6.38
	Long	4.94	37.35	3.47	2.79	3.22	3.67	3.49	602.67	6.93
Izzi	Short	3.96	48.96	2.91	2.68	3.11	3.25	3.80	302.67	6.24
	Long	4.45	48.96	3.35	2.73	3.11	5.10	4.30	102.67	16.63
Ikwo	Short	3.47	25.73	2.91	2.62	3.22	3.26	4.30	202.67	10.26
	Long	4.94	48.96	3.19	2.73	3.08	3.46	5.20	402.33	11.23
LSD (0.05)		n.s	4.22	n.s	n.s	n.s	n.s	n.s	4.24	4.08

An LSD-Least significant difference, n.s-non-significant, Ca-Calcium, Cu-Copper, Fe-Iron, Mg-Magnesium, Mn-Magnese, Na-Sodium, P-Phosphorus, Zn-Zinc, K-Potassium.

Discussion

The observed variations in proximate contents of FARO rice series across locations and grain lengths highlight the influence of environmental factors and genetic characteristics on rice quality. The higher protein and moisture content in short-grained rice, particularly in certain locations, may be attributed to genetic factors favoring the accumulation of these components

(Thomas *et al.*, 2016, Mohammed *et al.*, 2019). Conversely, the lower protein and moisture content in long-grained rice suggest potential trade-offs between grain length and nutritional composition (Oko & Ugwu, 2017, Verma & Srivastav, 2017). The findings of this study have implications for rice breeding programs and agricultural practices aimed at improving grain quality and yield. Breeders may prioritize the selection of short-grained rice seed lots in regions where higher protein and moisture content are desirable while considering the trade-offs in carbohydrate and fat content. Furthermore, agricultural management practices, such as soil nutrient management and water irrigation, may be tailored to optimize the proximate composition of rice grains based on specific environmental conditions. The observed variations in vitamin contents of FARO rice series across locations and grain lengths highlight the intricate interactions between genetic, environmental, and agronomic factors influencing rice nutritional quality (Oko & Ugwu, 2017, Mohammed *et al.*, 2019, Vunain *et al.*, 2020, Eze *et al.*, 2023). Long-grained, FARO 52 rice exhibited higher vitamin contents in specific locations, particularly in Eha-Amufu, suggesting potential genetic factors favoring vitamin accumulation in these varieties. On the other hand, short-grained, FARO 44 rice demonstrated advantages in vitamin content in certain locations, such as Omasi and Izzi, indicating the influence of environmental and agronomic factors on vitamin accumulation. The significant differences in vitamin C and B-carotene content across locations and grain lengths emphasize the importance of considering these factors in rice breeding programs and agricultural practices aimed at enhancing vitamin-rich rice seed lots.

The observed variations in mineral contents of FARO rice series across locations and grain lengths highlight the complex interactions between genetic, environmental, and agronomic factors influencing rice nutritional quality (Mohammed *et al.*, 2019, Adekola, 2022, Eze *et al.*, 2023). Short-grained rice generally exhibited advantages in Ca, Cu, Na, and K content in most locations, suggesting potential genetic predispositions or environmental influences favoring mineral accumulation in these varieties. Conversely, long-grained rice demonstrated advantages in Mg and Mn levels across locations, indicating the influence of genetic or environmental factors promoting the accumulation of these minerals. The significant differences in Cu, P, and K content across locations and grain lengths emphasize the importance of considering these factors in rice breeding programs and agricultural practices aimed at enhancing mineral-rich rice seed lots.

Conclusion

This investigation provides invaluable understanding of the intricate relationships between grain morphology, geographical origins, and the nutritional composition of FARO rice series. FARO 44 a short-grained rice consistently manifested elevated levels of protein, moisture, ash, and select minerals such as calcium, copper, sodium, and potassium across diverse locales, while FARO 52 a long-grained counterparts exhibited heightened concentrations of specific vitamins and minerals, notably magnesium and manganese, in certain geographical contexts. These insights are pivotal in advancing agricultural strategies and rice breeding initiatives tailored to optimize both the yield and nutritional profile of rice cultivars. Furthermore, this research underscores the critical role of rice in global food security and public health, advocating for the cultivation and consumption of nutritionally enriched rice seed as a cornerstone in addressing malnutrition and ensuring sustainable food systems for future generations.

References

Adekola, M. B. (2022). Comparative Analysis of the Proximate Composition, Vitamins Contents, and Metals Profile of Nigerian Rice (*Oryza glaberrima*) and Imported Rice

Nutritional Variability of Faro 44 Rice Seed Loys as Influenced by Grain Lengths and Locations: Implications for Food Security and Public Health in Southeast Nigeria

(*Oryza sativa*). *Makerere University Journal of Agricultural and Environmental Sciences*, 11(1), 25- 39.

Eze CC, Nnamonu EI, Ikwuegbu PN (2023). In-depth assessment of Proximate, Vitamin, and Mineral Composition Analysis of Locally Cultivated Rice in South-Eastern Nigeria. *Journal of Biology, Agriculture and Healthcare*. 13(14): 7-11.

Food and Agricultural Organisation of United Nations (2021). The State of Food Security and Nutrition in the World 2021. The world is at a critical juncture.

Food and Agricultural Organisation of United Nations (2022). The state of food security and nutrition in the world. Repurposing food and agricultural policies to make healthy diets more affordable. <https://doi.org/10.1016/j.rsci.2016.05.005>.

Manasseh EA, Abimiku SE, Zidafamor EJ, Ishiak OK (2018). Evaluation of four rice (*oryza sativa* l.) varieties under dry season production in Jega, Kebbi State- Nigeria. *Journal of Agriculture and Environment*, 14(2):187-191.

Mohammed, U. A., Hayatu, M. & Ibrahim, S. (2019). Preliminary Response of Some Rice varieties to Soil P^H and Texture in Parts Kano State, Nigeria. *Dutse Journal of Pure and Applied Sciences (DUJOPAS)*, 5(1), 183–189.

Oko, A. O. & Ugwu, S. I. (2017). The proximate and mineral compositions of five major rice seed lots in Abakaliki, South-Eastern Nigeria. *African Journal of Botany*, 6(3), 1-3.

Thomas, A., Olayinka, A., & Kayode, A. (2016). Comparative Study of Nutrient Composition and Retention of Raw and Cooked Imported and Local Rice (*Oryza sativa*) Varieties. *British Journal of Applied Science & Technology*, 16(2), 1–9. <https://doi.org/10.9734/ bjust/ 2016/25875>.

Verma, D. K., & Srivastav, P. P. (2017). Proximate Composition, Mineral Content, and Fatty Acids Analyses of Aromatic and Non-Aromatic Indian Rice. *Rice Science*, 24(1), 21–31.

Vunain, E., Chirambo, F., Sajidu, S. & Mguntha, T. T. (2020). Proximate Composition, Mineral Composition, and Phytic Acid in Three Common Malawian White Rice Grains, *Malawi Journal of Science and Technology*, 12(1), 87-10.