NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 53 Number 1, April 2022 Pg. 369-374
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng

Determination of Proximate and Nutritional Value Properties of NERICA Rice Varieties Produced Under Sawah Technology in Ebonyi State, Nigeria

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Abstract
The study investigated the proximate and nutritional value of NERICA rice varieties produced under Sawah Technology in Ebonyi State of Nigeria. Samples of the rice varieties were collected from the Sawah technology rice field located at Ishieke annex of Ebonyi State University. The samples were tested for moisture, ash, fat, fibre, protein and carbohydrate contents at the Department of Food Science and Technology laboratory in Ebonyi State University, Abakaliki, Ebonyi State, Nigeria. The findings of the study indicate that the ranges of the moisture, ash, fat, fibre, protein, and carbohydrate contents are 12.20 – 12.50 %, 1.00 – 1.50 %, 1.60 – 2.40 %, 6.00 – 13.00 %, 10.21 – 17.33 %, and 53.10 - 64.60 % respectively. The result showed variations of proximate properties of the NERICA rice varieties. The findings of the study portray that rice cultivated under sawah technology showed that the protein content was enhanced, while the fat content and the carbohydrate content was reduced, also other proximate parameters like the fiber, ash were within the findings of other researchers. However, the reduced carbohydrate content of the varieties indicates the fact that rice cultivated under Sawah technology possesses better proximate characteristics, since it lowers carbohydrate content towards sustainable human health. The Sipi692033 variety has the highest moisture, ash, fat, fibre and protein contents, and the lowest carbohydrate content relative to other varieties. Therefore, it is recommended that the Sipi692033 variety should be the best rice seed for rice farmers under Sawah technology in Ebonyi State Nigeria.

Keywords: NERICA Rice, Sawah Technology, Proximate Characteristics, Nutritional Value, Moisture Content

Introduction

Apart from maize and wheat that constitute a major cereal crop for greater percentage of the world's population, rice is seen as a leading crop (USD, 2020). Rice has the potentials that promote some region economically, politically stable and reduce food insecurity. China is the largest producer of rice, accounting for 30% of the production, followed by India (24%), Bangladesh (7%), Indonesia (7%), Vietnam (5%) and Thailand (4%) of the world (FAO, 2018). Rice is one of the important food crops with high nutritional value that alleviate poverty and reduces food insecurity in Nigeria (Edu and Eze, 2021). Rice is the world's most important human food crop, hence the theme of the International Year of Rice 2004 was 'Rice is Life,' highlighting its enormous importance as a source of food and commerce (Akhilesh *et al.*, 2014). Rice significance prompted the United Nations General Assembly to declare that it is the staple meal of more than half of the world's population. The assembly underlined the need to raise awareness of rice's role in reducing poverty and hunger, as well as the need to focus world attention on rice's role in ensuring food security and eradicating poverty, and then announced 2004 to be the International Year of Rice (Gnanamanickam, 2009). It is not just a major calorie source, but also a significant source of money and employment (FAO, 2006; Kinyumu, 2009; IRRI, 2013; FAOSAT, 2018). Rice can come in different forms such as brown rice, milled rice and parboiled milled rice. Rice is a very rich source of Carbohydrate with substantial amount of fat, protein, mineral, fibre and vitamins that vary based on the varieties (Zubair *et al.*, 2015). The nutritional content of rice can be determined through proximate analysis.
Proximate analysis is the determination of the compounds contained in a mixture of closely related component as distinguished from ultimate analysis, by heating the samples under specified conditions

(Mbatchou and Dawda, 2013). Proximate analysis of rice involves separation of nutrition content such as carbohydrate, protein, lipid, vitamin, fibre, and minerals. Some research findings have reported negative effects of certain practices on rice production and processing. Chen *et al.* (1998) and Doesthale *et al.* (1979) in Zubair, *et al.* (2015) observed that milling and polishing processes change rice color and destroy 67% of Vitamin B3, 80% of Vitamin B1, 90% of vitamin B6, 50% of Magannse and Phosphorus, 60% of iron and all fibre and essential fatty acid. Fibre and important oil in bran prevent heart diseases (Jeyanth and Mohamed, 2009). Rice grains contains 80% starch, 12% water, and 7% protein, which is highly digestible and has a high biological value and protein efficiency ratio due to the presence of a greater concentration (4%) of lysine (FAO and WHO, 1998). Calcium, magnesium, and phosphorus, as well as traces of iron, copper, zinc, and manganese, are all present in rice (Yousaf, 1992). Starch, glucose, sucrose, dextrin, and other carbohydrates are found in around 80% of freshly harvested rice grains. Genetic engineering has resulted in rice varieties with high protein and vitamin content (Yousaf, 1992).

Moreover, rice production in Nigeria is generally hindered by so many challenges such as poor irrigation and drainage practices, and environmental factors such as topography, soil type and soil manipulations for rice planting (Edu, 2017). The practice of tree planting has been adopted to resolve the irrigation and drainage challenges, but tree planting on rice farm is not advisable. On the other hand, terracing has always been recommended on rice farm against environmental challenges like topography, soil erosion and manipulations, but terracing can be effective on sloping environment only. Consequently, any technology that can improve rice production is a welcome idea, hence the emergence of Sawah Technology. Wakatsuki and Masuraga (2005), Kolawole *et al*. (2011), and Nwite *et al*. (2012) indicated in their studies that Sawah Technology is one of the technologies for sustainability and profitability of rice production in Nigeria. However, the variation in agro-ecological soil type/conditions and the effects of the above challenging factors/indicators requires the knowledge and practice of Sawah technology system for increase and efficient production of NERICA rice in Nigeria. Although, previous researchers have adopted Sawah Technology as a panacea of rice production challenges, yet there is limited data of Sawah Technology application on some soil types and geographical locations.

Past researchers have established that Sawah field technology is a new technology for rice production (Wakatsuki *et al*., 1998; Wakatsuki and Buri, 2008; Oladele and Wakatsuki, 2010; Defoer *et al*., 2017; Wakatsuki *et al*., 2018; Ademiluyi *et al*., 2018). Sawah Technology boosted rice yield, but it is still being studied for adoption and adaptation under different field condition and agro zones of Africa. Similarly, the New Rice for Africa (NERICA) is undergoing series of research studies for food quality taste, and characteristics under different processing condition, soil condition and agronomic practices (Okeke and Oluka, 2017; Eze and Oluka, 2014; Eze and Oluka, 2013). Understanding the field performance, proximate and nutritional value characteristics of NERICA rice under Sawah field conditions of some southeast States could boast the adoptive and adaptation of Sawah Technology in the NERICA rice fields of the study area. Some technology can help to improve productivity but has negative effect on the end use like deep milling and polishing. Therefore, this study seeks to determine the proximate and nutritional value signatures of different NERICA rice varieties produced under Sawah Technology in Ishieke Sawah Technology rice farm. It also seeks to conduct a comparative analysis of nutritional values of the NERICA rice varieties produced under Sawah Technology condition.

Materials and Methods

Grain rice of six different NERICA rice varieties were used in this study to determine the proximate and nutritional value. The study was conducted at the laboratory of the Department of Food Science and Technology, Faculty of Agriculture Science, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria. The six NERICA rice varieties collected were Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19. Each of the Six samples were collected in triplicate and the average used. The samples were parboiled in different containers well labeled, sun dried and milled differently. It was grinded into powdered form for proximate analysis. They were tested for moisture content, ash, fat, fibre, protein and carbohydrate content adopting AOAC (2004) method apart from carbohydrate that was determined using FAO (2004) method.

Percentage of Moisture Content Determination

Crucible plate was washed and dried in an oven, cooled in a desiccator and weighed (w_1). Exactly 5.0 grams of sample was measured and put into the crucible and weighed again (w_2) then transferred the crucible with sample into the oven at 100°C for 5 hours. The sample was transferred from the oven to a desiccator and weighed (w_3) after attained room temperature. The percentage of moisture content was calculated according AOAC (2004) as follows:

$$\text{Moisture content (\%)} = \frac{w_2 - w_3}{w_2 - w_1} \times \frac{100}{1} = \frac{\text{weight of dry sample}}{\text{weight of sample}} \times \frac{100}{1}$$

Where, W_1 =Weight of crucible plate, W_2= Weight of crucible plate + sample, W_3 = Weight of dried sample with crucible plate

Percentage of Ash Content Determinations

Silica dish was cleaned and ignited, cooled in desiccator and weighed (w_1), 5.0 grams of samples put into the silica dish was weighed (w_2). The sample was ignited gently until smoking ceases at 500°C in a furnace for five hours leaving a white ash. Then crucible tong was used to transfer it to a desiccator and finally weighed (w_3). The percentage of Ash according AOAC (2004) was calculated as follows:

$$\text{Ash}(\%) = \frac{w_3 - w_1}{w_2 - w_1} \times \frac{100}{1} = \frac{\text{weight of dry sample}}{\text{weight of sample}} \times \frac{100}{1}$$

Where; W_1= Weight of silica dish, W_2 = Weight of silica dish + sample, W_3 = Weight of white ash + silica dish.

Percentage of Fat Determination (Soxhlet Extraction)

Tissue paper weighed (w_1) was used, 5.0 grams of the sample was rapped with the paper and weighed (w_2). The tissue with the sample was carefully placed into the soxhlet chamber. The apparatus was set very well, measured the quantity of solvent [Hexane] and transferred it into the round bottom flask. It was heated over a heating mantle at the temperature of 50°C for three hours until the solvent was evaporated. The tissue was removed and placed into a beaker to dry. It was dried with the sample at 50°C until a constant weight is gotten. It was allowed to cool in a desiccator and reweighed (w_3). The percentage of fat was calculated according AOAC (2004) as follows:

$$\text{Fat}(\%) = \frac{w_2 - w_3}{w_2 - w_1} \times \frac{100}{1} = \frac{\text{weight of dry sample}}{\text{weight of sample}} \times \frac{100}{1}$$

Where; W_1 =Weight of tissue paper, W_2 =Weight of sample rapped with tissue paper, W_3 = Weight of dried sample rapped with tissue paper.

Percentage of Fibre Content Determination

It was determined by adopting AOAC (2004) method. The percentage was calculated using the formular thus:

$$\text{Fibre content}(\%) = \frac{\text{weight loss}}{\text{weight of sample}} \times \frac{100}{1}$$

Percentage Protein Determination (Kiddahi Method)

Sample weighed 5 grams was transferred to Kialdahi digestion plastic and added 5ml of conc. H_2SO_4 and 2g of K_2SO_4 catalyst. It was clamped with the plastic on an inclined position in a hood. The mixture was heated until the H_2SO_4 is boiling. The heating continued until the solution becomes colourless. The process lasted for 2 hours. A portion of the sample was converted to ammonia, then to ammonium sulphate $(NH)_4SO_4$ during the digestion. The flask was removed and allowed to cool. It was diluted with 5ml of distilled water and cool to room temperature under water ammonia into boric acid and remove the condenser and delivery tube after washing into the receiver. It was titrated from distillate with 0.05ml H_2SO_4 of 0.01ml HCl using screened methyl red indicator. The titre value was used for calculating the percentage nitrogen obtained adopting AOAC (2004).

$$\text{Nitrogen}(\%) = \frac{\text{Titire value} \times 0.0014}{\text{weight of sample}} \times \frac{100}{1}$$

Then the percentage value for nitrogen was multiplied with appropriate protein factor, which is 5.95.

Percentage of Carbohydrate Determination

Sample weighed 20g was transferred to 100ml graduated cylinder and 10ml of water was added and stirred after which 13ml of perchloric acid was added and stirred with glass rod for about 15 minutes. It was transferred into a 250ml volumetric flask, and cylinder was washed and stirrer into the flask and make up to 250ml mark and it was shook thoroughly and filtrated 5mls into a test tube and Pipette 1ml of the filtrate into a test tube in duplicate. 1ml of distilled water was pipette in duplicate as a blank. 1ml of glucose was also pipette as standard solution. Exactly 5mls of freshly prepared anthrone reagent was pipette into all the tubes and mix thoroughly. It was placed in a boiling water bath for exactly 12 minutes and then cools quickly to room temperature, then matched the two cuvettes, and take the reading of the distilled water in both cuvettes to determine the differences for use in calculation. The solution was transferred in turn, to one glass cuvette washing the cuvette in between readings. The percentage carbohydrate from reading the optical densities of the sample and standards at 630mm against the reagent blanks According to FAO (2004) as follows:

$$\%\ \text{Carbohydrate} = \frac{2.5 \times b}{a \times w} \times \frac{100}{1}$$

Where; w =weight of sample, b = optical density of sample, a = optical density of standard

Results and Discussion

The results were presented to address the two objectives, which are to determine the proximate and nutritional value signatures of different NERICA rice varieties produced under Sawah Technology and to conduct a comparative analysis of nutritional values of the NERICA rice varieties produced under Sawah Technology condition.

Proximate and Nutritional Value Signatures of NERICA Rice Varieties

The proximate and nutritional value signatures of different NERICA rice varieties produced under Sawah Technology are presented in Table 1. Sipi692033, WITA 4 and NERICA 34 have the same moisture content of 12.50 %. NERICA 1, NERICA 7, and NERICA 19 have moisture content of 12.30 %, 12.20 % and 12.40 %. The findings of the study indicate that the moisture content of all the NERICA rice varieties used for the study lie between 12.20 – 12.40 %, which is considered appropriate. It implies that NERICA rice varieties have adequate moisture content storage condition, which conforms to the submission of Islam *et al*. (2001) that moisture content of 12 – 14 % for grains is adequate against decay. Sipi692033 and NERICA 34 and NERICA 19 have the same ash content of 1.50 %. NERICA 1 has 1.40 %, NERICA 7 has 1.30 % and the least WITA 4 has 1.00 %. The result of NERICA 7 is the same with the findings of Saleh *et al*. (2013) in Yankah (2020) for ash content, which is 1.3%. Sipi692033 has the highest fat content of 2.40 %. WITA 4 and NERICA 7 have the same fat content of 2.20 %, NERICA 1 has 2.00 %, NERICA 19 has 1.80%, and NERICA 34 has 1.60%. All the NERICA rice varieties for the study were between 1.80 % – 2.40 %, which disagree with the study of Yankah (2020) that Fat content of rice was 2.7 %. It implies that rice produced under Sawah technology has a reduced fat content, which is an advantage to weight loss. Sipi692033 also has the highest fibre content of 13.00 %, NERICA 34 has 6.00 %, NERICA 7 has 9.80 %, NERICA 19 has 8.90 %, WITA 4 has 8.50 % and finally NERICA 1 has 10.20 %. The result is in line with the submission of Anjum, (2007) that fibre content of cereal crops were within the range of 6 – 15 %. Sipi692033 also has the protein content of 17.33 %, NERICA 34 has 15.93 %, WITA 4 has 14.87 %, NERICA 19 has 10.50 %, NERICA 1 has 10.45 %, and finally NERICA 7 has 10.21 %. All the NERICA rice varieties for the study lie between 10.21% - 17.33% that are above the submission of Eggum (1979) that the protein content of rice is 8.5 %. The findings of the study connotes that the protein content of rice can be enhanced through Sawah technology. NERICA 34 has the highest carbohydrate content of 64.60 %, WITA 4 has 60.75 %, NERICA 19 has 57.22 %, NERICA 7 has 56.13 %, and NERICA 1 has 54.20% and finally Sipi692033 has the least Carbohydrate content of 53.10 %. The result of the study revealed that carbohydrate content lie between 53 % - 64.60 %, which differs from the submission of Kumar *et al*., (2016), that the carbohydrate content of rice is 76.2 %. The comparative analysis of the NERICA rice varieties produced under Sawah Technology that is presented in Table 2 showed variations of moisture, fat, fibre, protein, ash, and carbohydrate contents of the different NERICA rice varieties. However, the results indicate reduction of carbohydrate content in all the varieties in the range of 53.10 – 64.60 % when compared to the submission of previous researchers (Zubair *et al*, 2015 and Devi *et al.*, 2015), which is above 70 %. The findings of the study portray that rice cultivated under sawah technology showed that the protein content was enhanced while the fat content and the carbohydrate content was reduced also other proximate parameters like the fiber, ash were within the findings of other researchers. The Sipi692033 variety has the highest moisture, ash, fat, fibre and protein contents, and the lowest carbohydrate content relative to other varieties. It implies that Sipi692033 has the best proximate value in the Sawah technology rice field.

Conclusion

The research study investigated the proximate composition value of Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19 rice varieties under Sawah Technology in Ebonyi State University. Samples of the varieties were collected from the Sawah technology rice field located at Ishieke annex of Ebonyi State University. The samples were tested for moisture, ash, fat, fibre, protein and carbohydrate content at the Department of Food science and Technology laboratory in Ebonyi State University, Abakaliki, Ebonyi State, Nigeria. The findings of the study indicate that the moisture content of all the NERICA rice varieties used for the study lie between 12.20 – 12.50 %. The ranges of the ash, fat, fibre, protein, and carbohydrate contents are 1.00 – 1.50 %, 1.60 – 2.40 %, 6.00 – 13.00 %, 10.21 – 17.33 %, and 53.10 -64.60 % respectively. The result showed variations of moisture, fat, fibre, protein, ash, and carbohydrate contents of the different NERICA rice varieties. However, it indicates reduction of carbohydrate content in all the varieties, which portrays the fact that rice cultivated under Sawah technology possesses better proximate characteristics, since it lowers carbohydrate content towards sustainable human health. The Sipi692033 variety has the highest moisture, ash, fat, fibre and protein contents, and the lowest carbohydrate content relative to other varieties. It implies that Sipi692033 has the best proximate value in the Sawah technology rice field. From the findings of the study, it is recommended that the Sipi692033 variety should be the best rice seed for rice farmers under Sawah technology in Ebonyi State Nigeria.

Table 1: Proximate and Nutritional Value Properties of NERICA Rice Varieties

S/N	Samples	Moisture Content (%)	Ash Content (%)	Fat Content (%)	Fibre Content (%)	Protein Content (%)	Carbohydrates Content (%)
1	Sipi692033	12.50 ± 0.10^a	1.50 ± 0.12^a	2.40 ± 0.20^a	13.00 ± 0.50^a	17.33 ± 0.48^a	53.10 ± 0.17^a
2	WITA 4	12.50 ± 0.20^a	1.00 ± 0.10^a	2.20 ± 0.10^a	8.50 ± 0.23^a	14.87 ± 0.24^a	60.75 ± 0.25^a
3	NERICA 34	12.50 ± 0.06^a	1.50 ± 0.12^a	1.60 ± 0.12^a	6.00 ± 0.45^a	15.93 ± 0.38^a	64.60 ± 0.27^a
4	NERICA 1	12.30 ± 0.15^a	1.40 ± 0.05^a	2.00 ± 0.11^a	10.20 ± 0.20^a	10.45 ± 0.30^a	54.20 ± 0.15^a
5	NERICA 7	12.20 ± 0.15^a	1.30 ± 0.01^a	2.20 ± 0.13^a	9.80 ± 0.10^a	10.21 ± 0.19^a	56.13 ± 0.18^a
6	NERICA 19	12.40 ± 0.20^a	1.50 ± 0.22^a	1.80 ± 0.09^a	8.90 ± 0.15^a	10.50 ± 0.31^a	57.22 ± 0.23^a

Values are the mean and standard deviation of the six NERICA varieties
Same superscript value in the column to indicate not significantly (P>0.05) different

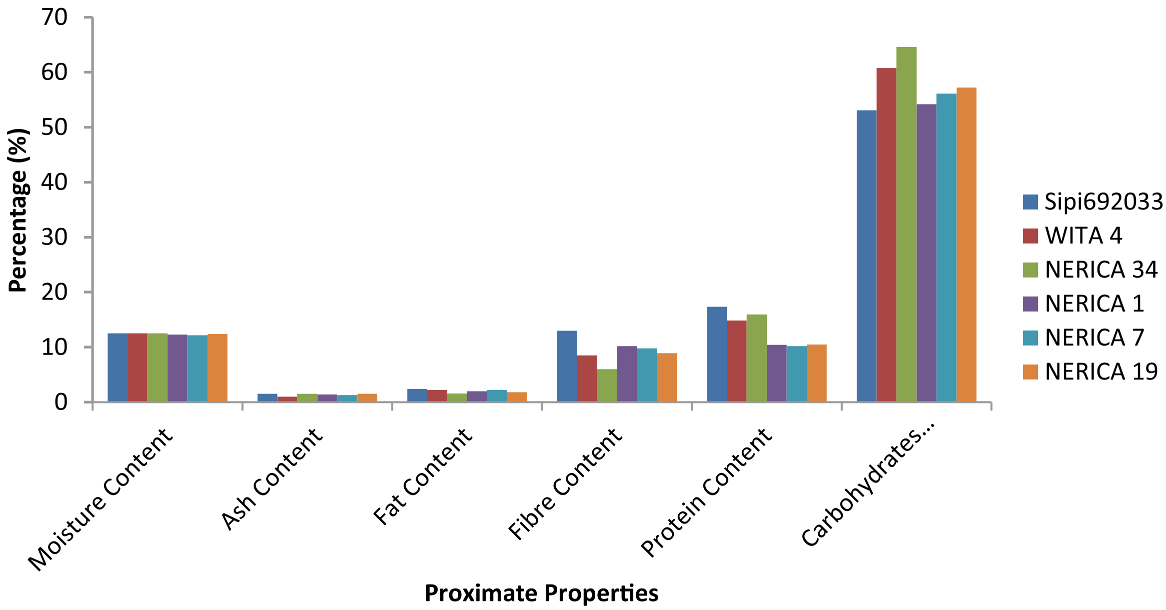

Figure 1: Comparative Analysis of Nutritional Values of the NERICA Rice Varieties

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