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Determination of the Proximate Composition and Amylose Content of New Rice for Africa (NERICA) Flour

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ABSTRACT

Some NERICA varieties were studied to assess their proximate composition and amylose content. These varieties include; FARO 44, FARO 52, FARO 57, FARO 60, and FARO 61. Results obtained showed that the proximate composition were recorded as, ash content; 0.84 to 1.08 (%), crude fat; 1.32 to 1.73 (%), crude fibre; 0.58 to 2.06 (%), crude protein; 7.58 to 10.29 (%), CHO; 79.11 to 81.34 (%), starch; 76.55 to 82.48 (%), and sugar content; 2.42 to 4.44 (%). Also, the amylose content was assessed and the recorded result ranged from 21.34 to 25.04 (%). All recorded samples were significantly difference (p<0.05). FARO 61 recorded highest point of 1.08 (%), 2.06 (%), 82.48 (%), in ash content, crude fibre, and starch respectively, while the highest crude protein, sugar and amylose content was observed in FARO 60 as 10.29 (%), 4.44 (%), and 25.04 (%) respectively. The highest value of crude fat was also recorded in FARO 52. Study on these properties of NERICA flour varieties has revealed some vital informations of the new rice varieties and these generated results will find their way in determining their suitability in food and other relevant industries

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INTRODUCTION

Rice is a very common foodstuff in Nigeria, and indeed, the world. It is scientifically known as "Oryza" and it is one of the most popular grain eaten by human beings. Apart from eating rice as normal meal, it is regarded as one of the best foods for ceremonies in the sub-Saharan part of Africa. Naturally, rice cultivated in this part of Africa is called "Oryza Glaberrima Steud", before the introduction of NERICA. NERICA means new "New Rice for Africa", (WARDA, 2008). This is used to represent inborn products developed from the effective crossing of two rice cultivars; the Asian rice, *Oryza Sativa* L., and the African rice, *Oryza glaberrima* S., in order to generate offspring which brings together the first-class qualities of the two parentages (WARDA, 2008; Eze and Oluka, 2014). These involves high-level vintages from the Asian specie and the capability from the African specie to grow vigorously in an unpleasant and difficult environment.

NERICA was developed by normal cross breeding and on that ground, they are not hereditarily improved rice (WARDA, 2008). NERICA varieties are new class of highland varieties of rice which ideally accommodate to the rain-fed highland environment in the Sub-Saharan Africa (SSA), where poor farmers do not have access to irrigation, chemical fertilizers or pesticides. Reports from the Rice centre, WARDA, 2008 showed that NERICA varieties also react positively than the local varieties to greater inputs. However, the increasing demand for rice, both in quantity and quality, far overshadowed local production. Thus, the need to increase production and improve the locally produced rice to make it more competitive with imported rice led to the discovery of NERICA (Udemezue, 2018).

The intensifying cost-effective significance of agricultural food resources, coupled with the technicality of the contemporaneous technology for the processing, and storage, premium assessment and dispensation, marketing and consumption of food, requires wide-ranging knowledge on engineering properties of these agricultural materials pertinent to their processing, handling, storage, and preservation, (Eze et al., 2020).

The proximate composition of agricultural materials are sets of processes used derive information concerning the nutritional essentialities of the biomaterials. It is also used to examine if an animal feed or food product is within its normal or standard compositional parameters or in some way befallen contaminated. This method of analysis splits the food sample into six fractions, these include; moisture, ash, crude fibre, crude protein, nitrogen extracts, and ether (Jideani, 2011).

The flour from rice, usually derived from rice grain, is extensively used as substitute in numerous food produce, and these include food thickeners, beverages, baby cereal food, bakeries. In such case, the proximate composition of NERICA must be carried out. Several researches concerning the qualities of various flour from rice have been documented, but not much have been reported on NERICA flour. Therefore, this study aims to determine the proximate analyses and amylose content of NERIA flour varietes relevant to its processing and storage.

MATERIAL and METHODS

Research Materials and Sample Preparation

The research materials used in this study include five varieties of NERICA, and they are; FAROs 44, 52, 57, 60, and 61. These varieties of NERICA were collected from the Ebonyi State Agricultural Development Programme (EBADEP), Abakaliki, at storage moisture content of 12.5% (db). Some of the paddy from each variety were parboiled and dehulled using a rice dehulling machine to obtain parboiled-milled samples of the NERICA varieties. The methods used in the parboiling and dehulling were in line with the rice parboiling and dehulling standard, and these processes are cleaning, soaking, steaming, drying and milling (Ituen and Ukpakha, 2011). The flour samples were conditioned by grinding the grain samples in powdered form using a hammer mill. The powdered samples were sieved using a 250 µm mesh sieve, and then packed in an air-exhausted water proofed bags for further analysis.

Proximate Analyses and Amylose Content Determination of NERICA Flour

Crude Ash Content

Crude ash is described as the mass of a product sample determined after heating at 550-600°C for 2 hours to burn in a container. Approach as stated by AOAC (2005) was used to determine the crude ash content of NERICA flour. In the approach, 5 g of the sample product each was measured in replicate into a container, where the sample product was enflamed in a soundproof furnace at virtually 550°C till ash of light grey colour was observed, and an invariable weight realized. The sample product was then chilled in a dessicator in order to prevent moisture absorption and reweighed to procure the ash content.

Crude Fat Content

Crude fat of the sample NERICA flour was measured using the Automated (Soxtec System HT) approach as stated in AOAC (2005). In the process, virtually 10 g of the sample product enclosed in a sift paper was weighed in an analytical weighing balance. After that, the sample was then deposited in an extraction vessel. This vessel, before usage, must be neatly cleaned and oven dried, and then chilled in a desiccator before weighing. Then 25 ml of solvent petroleum ether was measured into flask and the crude fat content taken out. After the extraction was achieved, the solvent was expunged by oven drying, the flask and its contained material were then chilled in a desiccator and reweighed. The crude fat content percentage was then estimated by using equation 1:

$$Percentage\ of\ total\ fat\ content\ =\frac{weight\ of\ fat\ extracted}{weight\ of\ food\ sample}\ x\ 100 \qquad (1)$$

Crude Fibre

The crude fiber of the NERICA flour samples was determined by an approach as described by AOAC (2005). In the experiment, 5 g of NERICA sample flour each was measured in an Erlenmeyer 500 ml flask, and TCA digestion agent of 100 ml added. The mixture was then boiled and allowed to reflux for about 40 mins starting from the initial stage of boiling. It was then allowed to get chilled a little, then filtered through Whiteman paper of 15.0 cm number 4. The remnant was then rinsed with hot water, turned once with a spatula, and later transferred into a dish made of porcelain, and the sample product was oven dried overnight at 105^{0}C. After the process of drying, the sample was then poured in a desiccator and weighed as W_1. After that, it was then burnt at 500°C in a soundproofed furnace for 6 hours, allowed to chill, then reweighed as W_2. Thus:

$$Percentage\ crude\ fibre\ =\frac{w_1-w_2}{w_0}\ x\ 100\% \qquad (2)$$

Where; W_1 is the weight of the crucible, fiber and ash, W_2 is the weight of the crucible and ash, while W_0 is the dry weight of the sample food.

Protein Content

An approach as described by AOAC (2005), was used to determine the protein content of the NERICA flour samples. This approach involves wet digestion of the sample material, distillation and titration. 3 g of the sample product was measured into a boiling tube which also contained concentrated sulphuric acid of 25 ml, and a cube of catalyst tablet comprising of 0.15 g of TiO_2, 5 g of K_2SO_4, and 0.15 g of $CuSO_4$. Tube was heated at very low temperature to allow digestion to take place. The digested sample was then diluted with distilled water of 100 ml, $Na_2S_2O_3$ of 5 ml, and 40% NaOH of 10 ml. Anti-growth agent was added, and then, the product sample was again diluted with boric acid of 10 ml. The content NH_4 in the distillate was estimated by titrating with HCl of 0.1 N standards using a burette of 25 ml. A bare was condition without the product sample. The valued protein captured was then multiplied by a conversion factor, and the result indicated as the amount of crude protein. Thus:

$$\%\ crude\ protein = \frac{ATV - TOTB\ x\ 0.1N\ HCl\ x\ 0.014\ x\ CF}{Weight\ of\ the\ sample}\ x\ 100 \qquad (3)$$

Where; *ATV* = actual titre value; *TOTB* = titre of the blank; *CF* = conversion factor; *HCl* = hydrogen chloride (ml).

Starch Determination

The starch content of NERICA sample flour was assessed using and approach as described by the ICC (2017) generic methods. The sample material was dissolved in a diluted hydrochloric acid of 0.1 N standards using a burette of 25 ml, and the starch content of NERICA flour evaluated by using optic rotational equipment, which was measured by the use of a polarimetric tool. The soluble was then extracted using a 10% ethanol and carefully removed either by filtering, or centrifugation processes. The remaining starch in the remnant was then dissolved in a hot, diluted HCl acid. The dissolved content was then precipitated with Carrez solution I and II and followed by filtration. Carrez solution I contains dissolved 21.9 g of zinc acetate Zn $(CH_3COO)_2H_2O$ and 3 g of glacial acetic acid in water making up to 100 ml with water, and Carrez solution II contains dissolved 10.6 g of potassium ferrocyanide $[K_4(Fe(CN)_6]$. The starch solution in the filtrate was then calculated using the ICC (2017) generic approach.

Sugar Determination

The content sugar of NERICA sample flour was assessed using Anthrone approach as reported by Iwe *et al.* (2016). Anthrone approach is a type of a colourimetric processes that involves the determination of the concentration of the total amount of sugars in a product. In the approach, the NERICA sample flour was mixed with an anthrone agent and sulphuric acid. The mixture was then boiled until the reaction is completed. The solution was then allowed to chill, and its absorbance was measured at 620 nm. Sugars react with the anthrone reagent under acidic conditions to yield a blue green colour.

Total Carbohydrate Content

The carbohydrate content of NERICA flour was assessed by using the method of difference as reported by Egounlety and Awoh (1990). The total percentage of the sample's moisture, crude fiber, ash content, and the protein content was subtracted from 100%, thereby having the remnant as the total carbohydrate content determined.

Amylose Content Determination

The amylose content of NERICA flour was assessed using ISO 6647 according to Singh and Goswami (2000). In the course of the experiment, 1ml of ethyl alcohol was treated with a 100mg (db) of the NERICA flour sample into 50ml conical flask and was stirred slowly. Again, sodium hydroxide of 9ml, and the solution was heated in a boiling water for 10 min, with occasional stirring. After that, the product sample was poured into a flask of 100 ml after cooling to room temperature. The sample was then washed, and transferred again, then finally filled with water to the volume. The dispersed sample of 5 ml were collected and added in a water of 50ml mixed with 1N of acetic acid of 1ml. The sample contents were shaken and potassium iodide solution of 2% mixed with iodine of 0.2% was added and kept at 27^{0}C for 20 minutes after making up of volume with water. A UV - spectrophotometer was and measured at 620 nm, and colour was assessed, and amylose evaluated through the calibration curve.

Statistical Analysis

All obtained results were analysed by the use of ANOVA analysis, with the averages evaluated by Duncan's test at 5% of significance confidence level (P<0.05). All calculated results were stated as the average values standard error (SE) of triplicate observations.

RESULTS and DISCUSSION

Proximate Composition

The NERICA flour moisture content were shown in Table 1 and Figure 1 and these ranged from 6.48 to 7.94% with flour from FARO 57 having the highest moisture content of 7.94%, followed by FARO 52 (7.61%), while FARO 60 recorded the lowest moisture content of 6.48%.

Table 1. Results showing the proximate analysis and amylose content of NERICA flour varieties.

Sample	Moisture content (%)	Ash (%)	Crude fat (%)	Crude fibre (%)	Crude protein (%)	CHO (%)	Starch (%)	Sugar (%)	Amylose content (%)
FARO 44	6.88 (0.34)	0.87 (0.03)	1.37 (0.09)	0.58 (0.06)	9.51 (0.34)	80.82 (2.05)	78.56 (1.21)	2.42 (0.88)	21.59 (1.06)
FARO 52	7.61 (1.02)	0.85 (0.03)	1.73 (0.32)	0.95 (0.04)	8.56 (0.45)	80.32 (2.11)	79.33 (0.89)	3.59 (0.34)	25.01 (1.99)
FARO 57	7.94 (1.06)	0.84 (0.11)	1.37 (0.14)	0.94 (0.09)	7.58 (0.18)	81.34 (1.78)	76.55 (0.77)	3.41 (0.16)	21.34 (2.01)
FARO 60	6.48 (0.45)	0.92 (0.02)	1.32 (0.88)	1.91 (0.16)	10.29 (1.04)	79.11 (0.99)	80.92 (1.11)	4.44 (0.73)	25.04 (2.11)
FARO 61	7.45 (1.10)	1.08 (0.12)	1.52 (0.17)	2.06 (0.15)	8.75 (0.47)	79.14 (1.53)	82.48 (2.03)	2.67 (0.09)	22.72 (1.97)
Average	7.27 (0.79)	0.91 (0.06)	1.46 (0.32)	1.29 (0.11)	8.94 (0.51)	80.15 (1.69)	79.57 (1.20)	3.31 (0.44)	23.14 (1.83)

NB: CHO = Total Carbohydrate. Numbers in Parenthesis represents the standard deviation.

According to Iwe *et al.* (2016), low moisture content relatively, was as a result of storage stability, and this could lead to the production of a more shelf stable product. There was significant difference (p<0.05) observed in the flour moisture content. These findings were in accordance with reported values by Kraithong *et al.* (2018) and Adebayo-Oyetoro *et al.* (2011). According to AACC (2001), analytical approaches for flour properties, and as reported by Iwe *et al* (2016), increase in moisture contents results to the decrease of the dry solids of the flour. Generally, flour descriptions normally limits the flour moisture to 14% or less. This indicates that flour that has more moisture higher than 14% are not stable at room temperature, and basically giving room for organisms existing in them to start growing, thereby generating flavours and smelly odours (Iwe *et al.*, 2016).

The NERICA ash content was assessed and recorded with FARO 61 having the highest ash content value of 1.08%, followed by FARO 60 with 0.92%, while FARO 57 is the variety with the lowest ash content of 0.84% in Table 1 and Figure 1. This range was in accordance with Kraithong *et al.* (2018) and Iwe *et al.* (2016). According to Iwe *et al.* (2016), ash content of a sample food, generally unveils the mineral elements such food consists of. This also expressess the substance of inorganic segments after natural materials such as proteins, fats, sugars and even moisture contents, have been disposed of by burning. It is additionally the necessary mineral piece of a nourishment test (Iwe *et al.*, 2016).

The fat content of the NERICA flour for the five varieties of NERICA samples are generally low, Table 1 and Figure 1, and ranged from 1.32 to 1.73%. This might be because of the way that grains, vegetables and tubers store vitality as starch instead of lipid. Food materials with low levels of fat are more essential as this guarantees higher timeframe of realistic usability for the items, Reebe *et al.* (2000). In light of the fact that all food that contains fats contains some undissolved fats, therefore are very undoubtedly sensitive to oxidative rancidity (Iwe *et al.*, 2016).

The crude fibre of the NERICA flour varietes was also assessed and recorded. The results obtained ranged from 0.58 to 2.06%. FARO 61 recorded highest number of crude fibres with 2.06%, followed by FARO 60 with 1.91%, Table 1 and Figure 1. The lowest point was recorded by FARO 44 with 0.58%. These results obtained showed a very composition of crude fibre in NERICA varieties. This decrease concurs with Kraithong *et al.* (2018), Iwe *et al* (2016), and Sotelo *et al.* (1990). Be that as it may, Iwe *et al.* (2016), revealed that, crude fiber hinders the arrival of glucose into the blood and diminishes colonic weight of the digestive system, subsequently decreasing the danger of colon malignant growth in people.

Crude protein was also conducted as one of the proximate compositions of NERICA flour. In Table 1 and Figure 1, the results for crude protein for NERICA flour varieties were recorded as 9.51%; 8.56%; 7.58%; 10.29%; and 8.75% for FAROs 44; 52; 57; 60; and 61 respectively. FARO 60 recorded highest number of crude proteins with 10.29%, followed by FARO 44 with 9.51%. The crude protein was recorded lowest by FARO 57 with 7.58% value. The crude protein is regarded as the total protein material of a food product as been defined by its nitrogen proportion. From the recorded results, it will be observed that NERICA contains much protein due to their high crude protein content. Normal African rice protein comprises of globulin (12%), albumin (5%), glutelin (80%), and prolamin (3%), which break down in water, salt, ethanol, and soluble base, individually (Wani *et al.*, 2012). These proteins are soluble in a solvent medium; in this way, basic soaking has been traditionally utilized concerning rice starch separation with a very great recuperation together with low left-over content protein (Wani *et al.*, 2012).

Results of carbohydrate content of NERICA sample flour was recorded as 80.82%; 80.32%; 81.34%; 79.11% and 79.14% for FAROs 44, 52, 57, 60 and 61 respectively as shown in Table 1 and Figure 1. The recorded results showed FARO 57 had highest carbohydrate content of 81.34%, followed by FARO 44 with 80.82%, while FARO 60 recorded the lowest carbohydrate content of 79.11%. Significant difference (p<0.05) was observed in results of the carbohydrate contents of the sample flours. The carbohydrate contents of these flour tests are a pointer that the items produced using them will be acceptable wellsprings of vitality.

Starch from rice is among the most essential cereal starches with excellent functional properties of the fundamental part of rice and it represents over 80% of the absolute constituents (Wani *et al*., 2012). The recorded starch results of the NERICA varieties were 78.56%; 79.33%; 76.55%; 80.92%; and 82.48% for FAROs 44, 52, 57, 60, and 61 respectively, Table 1 and Figure 1. FARO 61 recorded highest number of starch (82.48%) followed by FARO 60 (80.90%), while FARO 57 recorded the lowest value of starch with 76.55%. Starch can be utilized as a benchmark material for the creation of different chemicals which includes D-lactic acid which was combined by the fermentation of rice starch using micro organisms, and this was seen as of high visual virtue (Fukushima *et al*., 2004). Starch is one of the most considerable and surplus nourishment elements of mass nourishments, for example, noodle and bread making Funami *et al* (2005), just as thickening applications, moisture retention, film formation, gelling, texturing, stabilizing, foam strengthening, glazing, adhesion, dusting, clouding, and binding (Whistler and BeMiller, 1997). Starches are commonly portrayed as the most generous parts of cereals as far as gluing conduct, gelatinization, pasting behaviour, retrogradation, and other utilitarian traits which attributes item quality (Hagenimana and Ding, 2005). Rice starch discovers its applications in both the agro and non-agro industries and it is utilized as a thickening or gelling operator, a glossing over in confectionery items. The non-nourishment applications incorporate restorative tidying powder, clothing hardening operator, and paper and photographic powder (Wani *et al*., 2012).

Sugar component was also conducted on the NERICA flour varieties. Results obtained were 2.42%; 3.59%; 3.41%; 4.44%; and 2.67% for FAROs 44, 52, 57, 60, and 61 respectively, Table 1 and Figure 1. FARO 60 recorded highest number of sugar (4.44%) followed by FARO 52 (3.59%), while FARO 44 recorded the lowest value of sugar with 2.42%. As it is known that diabetes is an ailment that naturally occurs as a result of sugar, the more sugar content gets higher, the more the food substance becomes unfriendly to the sosciety. But from the recorded results of sugar on the NERICA flour varieties, it can be seen that all the varieties had low sugar content.

Amylose Content

Recorded results of amylose content of NERICA flour varieties ranged from 21.34 to 25.04% with FARO 60 having the highest content of amylose of 25.04%, followed by FARO 52 with 25.01% and FARO 57 flour recording the lowest amylose content of 21.34% as shown in Table 1 and Figure 1. Increase in the swelling power of rice flour because of low support of internal work by amylose particles, was due to low amylose composition in rice material (Hoover, 2001). Significant difference (p<0.05) was observed in the amylose content of the NERICA flour samples. Amylose content is described as the essential straight sub-atomic property of starch in flour, (Raja and

Ramakrishma, 1990). It can also seen as a significant element as regards to final destination of properties of different food materials, for example, dough, and noodles, (Sievert and Holm, 1993). Amylose is considered to have high pasting characteristics in material and thus requires a great deal of force in breaking down to digest and this is because of its high structural compactment (Iwe *et al*, 2016). Amylose content impacts rice surface which is the most predominant factor to influence rice taste. Higher amylose content corresponds to harder texture in general (Hu *et al*., 2012). As indicated by WARDA (2008) on NERICA varieties, amylose substance of WAB56-104, the O. sativa parent, and CG 14, the O. glaberrima parent, was accounted for to be 21.7% and 26.0%, respectively. NERICA lines show a wide scope of amylose content from 15.4% to 28.5%, with average of 25.0%. WARDA (2008) additionally reported that rice utilization preferences differ from one country to another, that consumers in Nigeria appear to prefer varieties of about 25% amylose content, while in Côte d'Ivoire, the favored worth fluctuates somewhere in the range of 20 and 25%. Higher measures of carbohydrate will in general increase amylose content, yet this likewise brings about low estimations of different parts, for example, ash, protein, lipid, and fiber, (Oko and Ugwu, 2011). Low amylose rice flour for the most varieties offers dampness, softness, and chewiness to product textures. These characteristics can likewise be applied in meat items, puddings, and delicate cakes, (Falade and Christopher, 2015). High amylose rice can give firmness and freshness to items because of a three-dimensional system development, (Wang *et al*., 2016). Thus, it could be utilized in nourishment items that need a hard surface including bites, noodles, and expelled items (Kraithong *et al*., 2018).

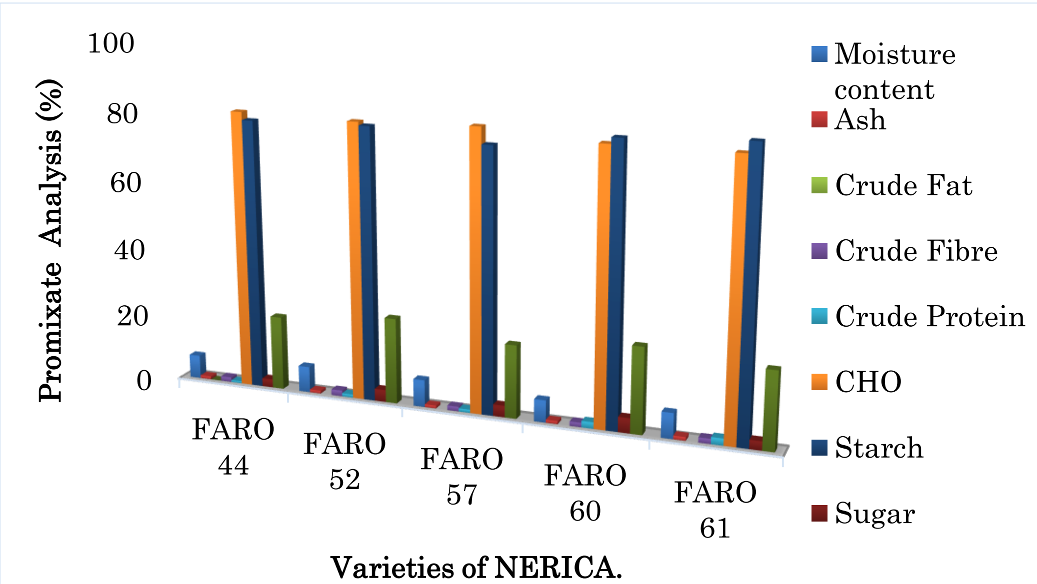

Figure 1. A chart of proximate composition and amylose content of NERICA flour

CONCLUSION

The results of the proximate composition and the amylose content of NERICA flour indicated significant difference (p<0.05) in all the parameters assessed. Moisture content ranged from 6.48 to 7.94 % with FARO 57 having the highest moisture content of 7.94%, followed by FARO 52 (7.61%), while FARO 60 (6.48%) has the lowest moisture content. Indication of low moisture signifies storage capability of the food material and this could lead to more shelf life of the product. The ash content ranged from 0.84 to 1.08%. Ash content of agricultural product creates an insight of the element of minerals available in the food product. The crude fat of NERICA studied are generally low and ranged from 1.32 to 1.73%. Low level fat of NERICA are healtful as this will guarantee maximum stability for the product. The crude fibre of the NERICA flour ranged from 0.58 to 2.06%. These results obtained showed a very composition of crude fibre in NERICA varieties. Crude protein was also conducted and the recorded results ranged from 7.58 to 10.29%. It is observed that NERICA contains much protein due to their high crude protein content. Results of the carbohydrate content ranged from 79.11 to 81.34%, and high carbohydrate indicates that products made from NERICA flour will provide high quality energy sources. The recorded starch results of the NERICA varieties ranged from 76.55 to 82.48%. NERICA starch will find its applications in both agro and non agro-industries. Sugar component obtained ranged from 2.42 to 4.44%. Low sugar content in NERICA flour will make favourable for consumption, as it is known that sugar is one of the major causes of disease called diabetes. It is a known fact that food with high sugar content is always unfavourable to the society. Recorded results of the amylose content ranged from 21.34 to 25.04%. Result indicated that NERICA recorded less degree of amylose content and this attributes to its swelling capability due to the frail support of the internal work by amylose molecules. In summary, the study on the proximate compsition and amylose content of NERICA flour varieties has revealed some vital informations of the new rice varieties and these generated results will find their way in determining their suitability in food and other relevant industries.

DECLARATION OF COMPETING INTEREST

The author declare no competing interest.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

The research work was solely initiated and carried out by the author following the standard procedures. Investigation, Methodology, Conceptualization, Formal analysis, Data curation, Validation, Writing-original draft, Review, and Editing, Visualization).

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