Effect of Cooking Method and the Nutritional Quality of Some Rice (Oryza Sativa) Varieties Consumed in Minna, Niger State, Nigeria,

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ABSTRACT

The study investigated the effect of different cooking methods on nutritional composition of selected rice (*Oryza sativa*) varieties consumed in Minna, Niger state. The samples were cooked by parboiled method and ordinary cooking method and proximate composition different varieties of local rice, Nigerian bagged rice and foreign rice were evaluated and compared. The results showed that the moisture content of the raw, parboiled, ordinary cooked for foreign rice were (12.067±0.167, 13.500±0.288, 13.167±0.167) and for local rice were (11.000±0.577, 11.867±0.333, 11.833±0.167) there was no significance difference (P< 0.05). The carbohydrate content was found to record a significant increase with both cooking methods for all varieties of rice. For foreign rice recorded 77.613±0.470 for raw, 81.340±1.320 for parboiled, 83.750±0.645 for ordinary cooked and for Local rice recorded 73.983±0.130 for raw, 75.617±0.792 for parboiled and 77.617±0.792 for ordinary cooked. Also, there was a significant loss of nutrients between the two cooking methods, but the ordinary cooking methods recorded a higher retention of nutrient than the parboiling methods. It is therefore important to encourage the best cooking practices that will ensure retention of nutrients

INTRODUCTION

Rice (*Oryza sativa* L.) is an economic crop which is important in household food security, ceremonies and nutrition diversification (Otemuyiwa *et al.*, 2018). It is considered the main staple food in most of the countries and according to World Health Organization (WHO), it is an important cereal crop that feeds more than half of the world's population (WHO, 2005).

Local consumption of rice is estimated at six million metric tonnes per year. In Nigeria, rice is mostly consumed in the form of milled rice, boiled, jollof, fried or rice paste (tuwo shinkafa) with or without stew or soup. It is cooked by boiling in water, or first boiled for a few minutes (parboiling), the cooking broth is drained and then water is added to cook to soft edible rice.

Processing of food is generally a prerequisite for improving the digestibility and palatability of foodstuffs. The methods involved in the processing of foods vary widely, and the nutritive value of food may be improved or diminished depending on the methods employed. Recently, both domestic and industrial cooking utilizes media that conserve time and energy such as microwave and pressure cooker. Although there are several reports on the effect of processing and storage on the nutrient content as well as nutrient availability in rice and rice products, one of such reports by Ebuechi and Oyewole, 2007 was on the effect of cooking and soaking on nutrient composition of indigenous rice varieties in Nigeria, they observed that soaking and cooking improved the protein, fat and fibre content of rice. They explained that the process of parboiling rice results in the inward infusion of water-soluble vitamins to the endosperm, thus caused increased in the amounts of B-vitamin. Although there are several reports on the effect of processing and storage on the nutrient content as well as nutrient availability in rice and rice products, one of such reports by Ebuechi and Oyewole, 2007 was on the effect of cooking and soaking on nutrient composition of indigenous rice varieties in Nigeria, they observed that soaking and cooking improved the protein, fat and fibre content of rice. They explained that the process of parboiling rice results in the inward infusion of water-soluble vitamins to the endosperm, thus caused increased in the amounts of B-vitamin. Cooking methods employed in food preparation has been found to lead to nutrient loss. Nutrients may be lost during cooking in two ways: first, by degradation which can occur by chemical changes such as oxidation and secondly by leaching into the cooking medium (Berechet and Segal, 2007). As a result of cooking, foods which are otherwise rich in some essential nutrients may have lost them or such nutrients may not be available when the food is consumed.

There is little information on the effect of various cooking methods on the loss or retention of some nutrients in some rice varieties consumed in Niger State, and considering the fact that there is high consumption of rice in Niger State, it is therefore important to know the impact of cooking on nutrient status of rice. The objective of this study was to investigate the effect of cooking processing on nutrient content of some rice varieties consumed in Niger State. This study will provide information on the best cooking practices that will ensure adequate nutrient intake from rice.

This research arises from the fact that, people uses different methods in cooking rice such as ordinary cooking and parboiling before cooking without the knowledge of to what extend these methods tends to reduce the overall nutritive value of the rice. Nutrients such as protein, fibre, carbohydrate are been reduce to different levels by these methods. So there is a need for a scientific assessment on the effect of these processing methods on the nutritional composition of the different rice varieties consumed in Niger state.The present study is to investigate the effect of processing on the nutritional composition of some different varieties of rice consumed in Niger State

3.2 METHODS

3.2.1 Sample Collection

A total of nine different rice samples were gotten from Kure market in Minna, Niger state: three foreign rice, three local rice and three Nigerian bagged rice and were packaged in separate labeled polythene bags. All of these types of rice are consumed in Niger state.

3.2.2 Sample preparation (processing method)

Ordinary cooking

50g of rice was weighed and poured into a bowl of distilled water, where it was rinsed and strained to remove impurities and water respectively. The rice were placed in the stainless steel bowl, 300ml of distilled water was added (rice water ratio 1:3 w/v) and the rice was boiled to soft edible cooked rice (Otemuyiwa *et al.*, 2018) and oven dried at a temperature of 60^0C till constant weight was obtained. The dried rice samples were prepared into powdered form using a blender and labeled for proximate analyses.

Parboiling

50g of rice was weighed and poured into a bowl of distilled water, where it was rinsed and strained to remove impurities and water respectively. The rice were placed in the stainless steel bowl, 300 ml of distilled water was added (rice water ratio 1:3 w/v) and cooked until the rice began to gelatinize. The cooking water was drained off, and another 150 ml of distilled water was added to the precooked rice and boiled to soft edible cooked rice (Otemuyiwa *et al.*, 2018) and oven dried at a temperature of 60^0C till constant weight was obtained. The dried rice samples were prepared into powdered form using a blender and labeled for proximate analyses.

The samples were stored in plastic air tight containers and stored until used.

3.3 ANALYSIS OF PROXIMATE COMPOSITION

The moisture, ash, fibre and protein content of the samples in triplicate were determined by the methods of analysis of Association of Official Analytical Chemists AOAC (2005) procedure. The fat content was determined by Soxhlet extraction method while carbohydrate was determined by difference.

3.3.1 Determination of moisture content

A clean crucible was dried to a constant weight in an air oven at 105 ºC and the crucible was cooled in a desiccator and weigh (W_1). 2.0g of the sample was weighed into the crucible and weighed (W_2) and dried in the oven at 105 ºC to a constant weight (W_3).

Moisture (%) = <u>Loss in weight on drying (g)</u> x 100

Initial weight of sample (g)

$$= \frac{W_2 - W_3}{W_3 - W_1} \times \frac{100}{1}$$

Where,

W_1= Weight of empty crucible

W_2= Weight of crucible + sample before oven drying

W_3 = Weight of crucible +sample after oven drying

3.3.2 Determination of Ash Content

Two clean crucible was ignited in a Muffle Furnace at 550 ºC for 1 h, cooled in a desiccator and was weighed (W_1). 2.0g of the sample into the crucible, was weighed (W_2) and transferred into the Muffle Furnace (550 ºC) for 8h. The Furnace was allowed to cool to 200 ºC; the crucible was transferred into a desiccator and cooled to a constant weight (W_3).

$$\text{Ash (\%)} = \frac{\text{Weight of ash (g) x 100}}{\text{Weight of sample (g)}}$$

$$= \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where,

W_1= Weight of empty crucible

W_2= Weight of sample in the crucible before incineration/ashing

W_3 = Weight of sample in the crucible after incineration/ashing

3.3.3 Determination of fat

A 250cm^3 round bottom flask was washed and dried at room temperature and 200cm^3 of petroleum ether (40 – 60 ºC) was poured into it. This was fitted in a Soxhlet Extractor unit. A fat-free extraction thimble was weighed (W_1), 20g of sample was added and reweighed (W_2). The thimble was fixed into the Soxhlet Extraction chamber with forceps and cold water was put on circulation through the condensers of the apparatus. The heating mantle of the apparatus was switched on and the heating rate was adjusted to 40 – 60 ºC until the solvent refluxes at a steady rate for 8 h. The thimble was removed, allowed to cool, dry (50 ºC) and reweighed (W_3)

$$\text{Lipid (\%)} = \frac{\text{Weight of lipid extracted (g) x 100}}{\text{Weight of sample (g)}}$$

$$= \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,

W_1= Weight of thimble

W_2= Weight of thimble + sample before extraction

W_3 = Weight of thimble + sample after extraction

3.3.4 Determination of Crude Protein

Digestion: involves the oxidation of organic matter with conc. H_2SO_4 and reduction of nitrogen to ammonium sulphate:

$$2H_2SO_4 \longrightarrow 2SO_2 + 2H_2O + O_2$$

$$R\;CH(COOH)(NH_2) + O_2 \longrightarrow xCO_2 + yH_2O + zNH_3$$

$$2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$

Distillation: involves the liberation of ammonia by NaOH. The ammonia is trapped in an excess boric acid solution in a receiving flask.

$$(NH_4)_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O + 2NH_3$$

$$NH_3 + H_2O \longrightarrow NH_4OH$$

$$H_3BO_3 + 3NH_4OH \longrightarrow (NH_4)_3BO_3 + 3H_2O$$

Titration: The ammonium borate is titrated with the standard HCl.

$$(NH_4)_3BO_3 + 3HCl \longrightarrow 3NH_4CI + H_3BO_3$$

(Kjeldahl method)

2.0g of the sample was weighed into a $100cm^3$ Kjeldahl digestion flask and 1.0g of the catalyst mixture (K_2SO_4 + anhydrous $CuSO_4$) was added. $25cm^3$ of concentrated H_2SO_4 was added and heated to 500 ºC until a clear solution was obtained. The solution was allowed to cool, then it was transferred into a $100cm^3$ volumetric flask and diluted to mark with distilled water.$10cm^3$ aliquot of the diluted digest was pipetted into a Markham semi-micro nitrogen distiller,$10cm^3$ of 40% NaOH solution was added and distilled. The liberated ammonia was trapped in a $100cm^3$ conical flask containing $10cm^3$ of 4% boric acid and 2 drops of methyl red indicator. The distillation was continued until the pink colour of the indicator turned greenish, it was then titrated with 0.1M HCl until the end point was indicated by a change of colour from greenish to pink.Volume of the acid used for the distillate as well as a blank were noted and triplicate determination per sample was carried out.

Nitrogen (%) = $(V_1\text{-}V_O)\ M \times 14 \times 100 \times 100$

$$2 \times 1000 \times 10$$

Where V_O = Volume of HCl required for the blank

V_1 = Volume of HCl required for 10ml sample

M = Concentration of HCl (0.1M)

14 = Atomic weight of nitrogen

100 = Total volume of digest

100 = % conversion

10 = Volume of distillate used

1000 = Conversion to dm^3

2 = Atomic weight of sample taken in gram

Crude protein (%) = 6.25 × Nitrogen (%)

Where,

6.25 = conversion factor. Proteins contain 16% nitrogen, therefore 100/16 = 6.25.

3.3.2 Determination of total carbohydrate content

Total carbohydrate = nitrogen free extract (NFE) is calculated by difference:

Total Carbohydrate (%) = 100 – (% Crude Protein + % Crude Lipid + % Ash + % Moisture+ % Fibre)

Statistical Analysis

The design was completely replicated three times (n = 3). Results presented are mean values of each determination ± standard deviation (SD). Differences between the mean values of the treatments were determined by the least significant difference (LSD) test and the significance was defined at $p<0.05$.

RESULTS

Table 4.1: Moisture content of The Rice Samples Before and after Processing

SAMPLES	RAW	PARBOILED	ORDINARY COOKED

F1	13.333±0.333^{a}	13.867±0.167^{a}	13.833±0.441^{a}
F2	12.067±0.167^{a}	13.500±0.288^{b}	13.167±0.167^{b}
F3	12.167±0.167^{a}	13.500±0.288^{b}	13.333±0.441^{b}
N1	13.000±0.882^{a}	13.500±0.577^{b}	13.000±0.289^{a}
N2	12.667±0.333^{a}	13.333±0.333^{b}	12.833±0.167^{a}
N3	11.500±0.289^{a}	12.833±0.167^{b}	11.500±0.289^{a}
L1	11.000±0.577^{a}	11.867±0.333^{b}	11.833±0.167^{b}
L2	11.167±0.167^{a}	11.500±0.000^{b}	11.300±0.289^{ab}
L3	11.167±0.726^{a}	11.500±0.333^{b}	11.333±0.289^{ab}

Mean ± Standard deviation of triplicate analysis

Values in row with the different superscript were significantly different at $p \leq 0.05$

KEY: F = Foreign rice N = Nigerian bagged rice L = Local rice

Table 4.2: Ash content of the rice samples before and after processing

SAMPLES	RAW	PARBOILED	ORDINARY COOKED
F1	0.833±0.167^{b}	0.167±0.333^{a}	0.833±0.167^{b}
F2	0.920±0.031^{b}	0.300±0.289^{a}	0.500±0.000^{a}
F3	0.833±0.167^{c}	0.490±0.006^{a}	0.567±0.167^{b}
N1	1.000±0.289^{c}	0.667±0.167^{a}	0.833±0.167^{b}
N2	0.833±0.153^{a}	0.800±0.167^{a}	0.800±0.167^{a}
N3	4.333±3.586^{c}	0.667±0.167^{a}	1.333±0.167^{b}
L1	1.333±0.167^{b}	0.500±0.000^{a}	1.000±0.289^{b}
L2	1.490±0.006^{b}	0.667±0.167^{a}	1.157±0.328^{b}
L3	1.000±0.289^{a}	1.000±0.289^{a}	1.000±0.289^{a}

Mean ± Standard deviation of triplicate analysis

Values in row with the different superscript were significantly different at $p \leq 0.05$

KEY: F = Foreign rice N = Nigerian bagged rice L = Local rice

Table 4.3: Fat content of the rice samples before and after processing

SAMPLES	RAW	PARBOILED	ORDINARY COOKED
F1	1.167±0.441[b]	1.000±0.289[a]	1.033±0.033[a]
F2	1.167±0.167[c]	0.333±0.167[a]	0.833±0.601[b]
F3	1.100±0.289[c]	1.000±0.000[a]	1.000±0.577[b]
N1	1.367±0.167[c]	1.167±0.167[a]	1.267±0.333[b]
N2	1.833±0.167[c]	1.000±0.000[a]	1.067±0.000[b]
N3	1.500±0.000[b]	1.300±0.000[a]	1.310±0.000[a]
L1	1.833±0.167[b]	1.500±0.000	1.500±0.289[a]
L2	1.567±0.167[c]	0.833±0.167[a]	1.000±0.289[b]
L3	1.833±0.333[c]	0.500±0.000[a]	0.500±0.289[b]

Mean ± Standard deviation of triplicate analysis

Values in row with the different superscript were significantly different at $p \leq 0.05$

KEY: F = Foreign rice N = Nigerian bagged rice L = Local rice

Table 4.4: Fibre content of the rice samples before and after processing

SAMPLES	RAW	PARBOILED	ORDINARY COOKED
F1	1.833±0.167[b]	1.333±0.167[a]	1.833±0.167[b]
F2	1.900±0.577[a]	1.450±0.289[a]	1.687±0.116[a]
F3	2.000±0.000[b]	1.333±0.167[a]	1.633±0.133[b]
N1	2.167±0.167[b]	1.167±0.167[a]	2.000±0.289[b]
N2	1.400±0.033[b]	0.967±0.100[a]	1.360±0.121[b]
N3	1.667±0.167[a]	1.167±0.167[a]	1.167±0.167[a]
L1	1.500±0.000[c]	1.167±0.167[a]	1.333±0.167[b]
L2	1.490±0.006[b]	1.287±0.144[a]	1.393±0.067[b]
L3	1.697±0.003[b]	1.417±0.137[a]	1.333±0.167[a]

Mean ± Standard deviation of triplicate analysis

Values in row with the different superscript were significantly different at $p \leq 0.05$

KEY: F = Foreign rice N = Nigerian bagged rice L = Local rice

Table 4.5: Protein content of the rice samples before and after processing

SAMPLES	RAW	PARBOILED	ORDINARY COOKED
F1	5.633±0.410^{b}	4.007±0.167^{a}	4.600±0.058^{a}
F2	4.167±0.600^{c}	2.960±0.040^{a}	3.167±0.089^{b}
F3	5.300±0.625^{c}	3.250±0.180^{a}	4.420±0.160^{b}
N1	7.283±0.148^{c}	4.393±0.056^{a}	5.563±0.503^{b}
N2	8.160±0.021^{c}	4.993±0.007^{a}	6.083±0.682^{b}
N3	7.987±0.194^{c}	4.667±0.484^{a}	5.933±0.118^{b}
L1	8.683±0.093^{c}	5.003±0.290^{a}	5.883±0.044^{b}
L2	7.600±0.058^{c}	5.100±0.050^{a}	5.433±1.189^{b}
L3	8.567±1.184^{c}	6.067±0.333^{a}	6.533±0.033^{b}

Mean ± Standard deviation of triplicate analysis

Values in row with the different superscript were significantly different at $p \leq 0.05$

KEY: F = Foreign rice N = Nigerian bagged rice L = Local rice

Table 4.6: Carbohydrate content of the rice samples before and after processing

SAMPLES	RAW	PARBOILED	ORDINARY COOKED
F1	77.867±0.318^{a}	79.533±0.059^{b}	81.667±0.726^{c}
F2	78.313±0.602^{a}	80.563±0.512^{b}	83.553±0.667^{c}
F3	77.613±0.470^{a}	81.340±1.320^{b}	83.750±0.645^{c}
N1	76.407±0.473^{a}	79.217±0.167^{b}	82.440±0.419^{c}
N2	76.773±0.328^{a}	81.740±0.447^{b}	83.740±0.447^{c}
N3	76.347±0.307^{a}	80.033±0.775^{b}	83.333±0.775^{c}
L1	73.983±0.130^{a}	75.617±0.792^{b}	77.617±0.792^{c}
L2	75.613±0.393^{a}	77.587±0.288^{b}	79.587±0.288^{c}
L3	75.517±0.148^{a}	76.070±0.616^{b}	78.070±0.616^{c}

Mean ± Standard deviation of triplicate analysis

Values in row with the different superscript were significantly different at $p \leq 0.05$

KEY: F = Foreign rice N = Nigerian bagged rice L = Local rice

Discussion

The result of moisture content in the raw and samples subjected to cooking are presented in Table1. For all rice the parboiled samples recorded the highest moisture content except for F1 which recorded no significant difference ($p \leq 0.05$) between the raw, parboiled and ordinary cooked samples this value reduction agreed with the work reported by Ebuehi and Oyewole 2007 for white rice after cooking. Also, the rice N1, N2, N3, L2 and L3 recorded no significant difference ($p \leq 0.05$) between the raw and ordinary cooked samples but this does not agreed with the report by Ebuehi and Oyewole 2007 this might be due to extent of drying after cooking. Samples F2, L2 and L3 recorded no significant difference ($p \leq 0.05$) between the parboiled and ordinary cooked samples. The factor of moisture content is paramount in maintenance of quality in rice during storage, because its level controls the rate of deterioration and infestation of the grains. Ebuehi and Oyewole 2007. Moisture content of any sample depends on the age, freshness and agronomic practice during cultivation, increased moisture content in rice may likely affect the milling characteristics and palatability of cooked rice (Oko *et al*., 2012).

The result of ash content in the raw and samples subjected to cooking are presented in Table 2. There was a significant reduction ($p<0.05$) in all the ash content of the parboiled samples compare with their raw form. This is believed to be due to increasing level of moisture content. Cooking generally leads to reduction in mineral content of food samples due to leaching of the minerals into the cooking water Adepoju *et. al* 2012. Ordinary cooked samples retained more of its minerals after cooking. The L3 rice recorded no significant difference for all samples. F2 and N2 recorded no significance difference for both the parboiled and ordinary cooked samples.

The result of fat content in the raw and samples subjected to cooking are presented in Table 3. The value of crude fat obtained in this study is similar to that reported by Ebuehi and Oyewole 2007. The fat contents of both raw and cooked samples were very low for all the nine rice samples, hence, rice is not a good source of fat. The ordinary cooked samples retained more fat than the parboiled samples except for the F1, N3 and L1which recorded no significance difference ($p \leq 0.05$). This might be due straining of water during parboiling process. Otemuyiwa *et. al* 2018.

The result of fibre content in the raw and samples subjected to cooking are presented in Table 4. For all samples the parboiled rice recorded the lowest value for fibre but there was no significant difference between the raw and the ordinary cooked rice this does not agree with the report made by Ebuehi and Oyewole 2007 this might be associated with milling of rice which removes the outer layer of the grain where most of the fibre are concentrated (Frei and Becker, 2003). For samples F2 and N3 recorded no significant difference for raw, parboiled and ordinary cooked rice. Also, sample L3 recorded no significance difference ($p \leq 0.05$) for both the parboiled and the ordinary cooked rice.

The result of protein content in the raw and samples subjected to cooking are presented in Table 5. There were significant differences ($p \leq 0.05$) in their crude protein content, the parboiled samples having the lowest value and raw samples recorded the highest. The values obtained for the crude protein of the rice samples were in close agreement with the ones reported in the literature (Adepoju *et. al* 2016). The raw samples were low in crude protein. Cooking of raw rice samples resulted in significant reduction in value of crude protein. This was in line with the findings of Adepoju *et. al* 2016. The ordinary cooked samples retained more protein after cooking than the parboiled samples, this might be due straining of water during parboiling process. Otemuyiwa *et. al* 2018.

The result of moisture content in the raw and samples subjected to cooking are presented in Table 6. The total carbohydrate content of raw rice samples in this study were same with the range (75.37-78.37%), Osman M.A 2007 and Otemuyiwa *et. al* 2018 but lower than the value recorded by Adepoju *et. al* 2016. The high carbohydrate content of the rice samples explain why rice is consumed as a staple source of energy. There was a significant increase in the carbohydrate content of cooked rice samples compared with the raw one this is similar to that reported by Ebuehi and Oyewole 2007. Also, the ordinary cooked samples recorded higher carbohydrate value compared to the parboiled samples; this is due to the straining of water during parboiling process. Otemuyiwa *et. al* 2018.

Conclusion

This study revealed that there was nutrient depletion occurs in both indigenous and foreign rice varieties during cooking, except for carbohydrate value which was increased. Also there was a significant loss of nutrients between the two cooking methods, where the ordinary cooking methods which recorded a higher retention of nutrient than the parboiling methods. It is therefore important to encourage the best cooking practices that will ensure retention of nutrients

Recommendation

Due to present Federal Government ban on the importation of foreign rice into the country, the Nigerian bagged rice is a good substitute.