Evaluation of Proximate and Heavy Metals Composition of Four Locally Available Rice Cultivars in Bauchi Town, North-Eastern Region of Nigeria

***Musa Ibrahim Abubakar[1], Nuru Muhammad Yakubu[2], Misbahu Sambo[3], Auwal Muhammad Ladan[1], Mu'azzam Mu'azu Wali[4] and Saminu Abdu[5]**

[1]Department of Biological Sciences, Abubakar Tafawa Balewa University Bauchi, Nigeria.

[2]Department of Applied Ecology, Abubakar Tafawa Balewa University Bauchi, Nigeria.

[3]Department of Biochemistry, Abubakar Tafawa Balewa University Bauchi, Nigeria.

[4]Department of Microbiology, Abubakar Tafawa Balewa University Bauchi, Nigeria.

[5]Department of Community Medicine, Abubakar Tafawa Balewa University Bauchi, Nigeria.

***Corresponding author**

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ABSTRACT

Food security is essential for survival, and it is ensured not only by how much crop is cultivated but also by how nutritionally qualitative the crop is. Therefore, the aim of this research was to evaluate four cultivars of rice (Faro, Fadama II, Jamila and Jipdan) locally available in Bauchi town, Northeastern Nigeria for their heavy metals and nutrients content. The evaluation was done using standard methods. The results revealed that all the four cultivars contain Ni, Cd, Hg and Pb within safety limits. They also contain Cu and Fe within beneficial range for human consumption. All the four cultivars have high carbohydrate content of not less than 70 %. Faro has the highest protein (7.125 %), Fadama II has the highest fiber (4.210 %), Jamila has the highest lipid (1.550 %) and Jipdan has the highest ash (10.650 %) content. These results suggest that in addition to the carbohydrate they all contain, Faro should be the preferred cultivar in respect to protein, and Jipdan should be the preferred cultivar in respect to minerals.

Keywords: Cultivars, Heavy metals, Minerals, Nutrients, Rice.

INTRODUCTION

Food is essential for survival. Since time immemorial, early man begin to identify what is edible in his environment. And through trial and error, he realizes that seeds can be propagated. He later, intentionally propagated seeds and developed techniques for their propagation. With the growing rate of human population and movement of people from one part of the environment to the other, crops that where grown elsewhere were introduced to and grown in new environments. This has provided man with variety of crops to use and has helped in sustaining food production for human consumption [1].

However, the increasing human population has posed challenges for food production sufficient enough to feed the population [1]. These challenges were equally faced by various Governments through funding of Agricultural programs and research activities which results to emergence of more productive varieties of crop species [2], [3]. Among the crops whose production was of interest to various Governments is Rice.

Rice is the seed of monocot plant of the genius Oryza and of the grass family Poaceae (formally Graminae) which includes twenty wild species and two cultivated ones; Oryza sativa (Asian rice) and Oryza glaberrima

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(African rice) [4]. The African rice originated from wild rice (O. barthii) some 3500 years ago and its offspring domesticated probably in the inland Delta area of Nigeria from where it spread through the upper Niger valley to the rest of West Africa. However, the Asian rice is gradually displacing the African rice due to its superior attributes [5]. Rice is now cultivated in more than 100 countries in the world with China being the country with highest production [6]. Nigeria is the country with the highest production in West Africa (4.0 million metric tonnes in 2018) [7], and paradoxically, the highest importer of rice in Africa (3.0 million metric tonnes annually). This cannot be unconnected with the fact that Nigeria is the most populous country in Africa [8]. Two varieties of rice are grown in Nigeria. They are: the local variety (which include Jamila, Mai lemo, Yar china, Mai Zabo, Mahanga, Madara, Mai kwalli, Mass, Yar tudu etc) and improved variety (which include Nerica, Sippi, Faro 16, Faro 44, Faro 57 etc) [4]. Each variety has its unique requirements and specifications for its cultivation for higher yield to be assured [4].

Although, the quantity of crops produced by nations is basic to ensuring food security, but the nutritional quality matter the most, because quantity sufficiency without quality sufficiency may result to malnutrition. Therefore, evaluating the most available and most used varieties of rice in Bauchi town, Northeastern Nigeria for their nutritional quality will help greatly in identifying the variety with the highest quality, thus helping authorities in making informed decisions that will help in cultivating the identified variety in order to ensure food security not only by increasing yield but also by improving the nutritional status of the populace that consume it. Thus, in this project, four cultivars of rice (Jipdan, Fadama II, Jamila and Faro) that are mostly consumed in Bauchi town, Northeastern Nigeria, were evaluated for their proximate and heavy metals composition.

METHODOLOGY

A. Sample Collection

The four cultivars of rice were collected from Muda Lawal market, Buachi, Bauchi State, Nigeria.

B. Crude Protein Analysis

Crude protein was determined by Kjeldahl method [9]. Total Nitrogen, N, in the sample was first determined, and the % N in the rice was multiplied with the factor 6.25 to obtain % total protein. In brief: 0.5 g of each milled rice sample was transferred into a digestion tube. 2 ml of concentrated H_2SO_4 was added for digestion. Digest was distilled with Markham distiller in a fume cupboard to liberate NH_3 trapped into a 5 ml of 2 % H_3BO_3. The resulting ammonium borate was titrated against 0.01M H_2SO_4.

% N was calculated using the formula:

$\% N = 10^2 [(Va – Vb) \times 0.01 \times 0.01401] / \text{wt. of sample}$

Where Va = titer volume of acid, Vb = titer volume of blank

C. Moisture Content Analysis

This was determined as reported by [9]. It was done by measuring 10.0 g of each sample in a dessicator, and heating it to constant weight in a hot air-circulating thermostatic oven at 110 ºC. The % Moisture content was calculated using the formula:

$\%$ Moisture content $= 10^2$ [9wt. of crucible + sample before drying) – (dry wt. of crucible + sample)] / wt. of sample.

D. Determination of Ash

This was done as reported by [9]. A milled sample of 2 g was weighed into a porcelain crucible, Wa. The sample was transferred into a muffle furnace set at 550 ºC and ashed for 4 hours. The crucible and its content were weighed after ashing, Wb. The percentage ash was calculated using the formula:

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% Ash = (Wb ÷ Wa) x 100

Where Wa = weight of empty crucible, Wb = weight of crucible + sample after ashing

E. Determination of Carbohydrates

The total carbohydrate content was determined by difference method using the formula:

% Carbohydrate + 100 – (% Ash + % Moisture + % Crude fat + % Crude protein + % Crude fiber) [9].

F. Fat Content Analysis

2.0 g of each sample was exhaustively extracted for 6 hours in a Soxhlet extractor using petroleum ether. The % Fat was calculated using the formula:

% Fat = 10^2 Wt. of fat / Wt. of sample [9].

G. Heavy Metals Analysis

One gram (1 g) of the sample was weighed and placed in a 100 mL conical flask. Thereafter, 5 mL of concentrated HNO_3 was added into the flask, and left for 8 hours. After pre-digestion, 10 mL of di-acid mixture (6.1 mL of H_2SO_4 and 3.1 mL of $HClO_4$) were added to the flask. The content of the flask was heated at 190 – 200 ^oC on a hot plate until dense white fumes evolved, and transparent white contents were formed. The solution was cooled and 25mL of double distilled water was added to the flask. The solution was filtered into a 100 mL volumetric flask and made to volume using distilled water [10], [11]. The resulting solution was analyzed for minerals as well as toxic metals using Atomic Absorption Spectrophotometry.

H. Statistical Analysis

Descriptive statistics was used to analyze the data. The values are expressed as Mean ± Standard deviation in a tabular form.

RESULTS

The results of heavy metals analysis is presented in Table I. The results shows that all the four cultivars contain Copper (Cu), Cadmium (Cd), Nickel (Ni), Iron (Fe), Mercury (Hg) and Lead (Pb) within the World Health Organization (WHO) regulatory limit. This shows that all the four cultivar are safe for consumption with regards to the aforementioned heavy metals.

Table I: Minerals Content And Their Concentration In The Four Cultivars Of Rice

Sample			Metals (mg/L)			
	Cu	Cd	Ni	Fe	Hg	Pb
Jipdan	0.178 ± 0.021	0.029 ± 0.002	0.09 ± 0.004	0.981 ± 0.012	0.008 ± 0.002	0.110 ± 0.011
Fadama II	0.124 ± 0.002	0.002 ± 0.001	0.038 ± 0.005	0.606 ± 0.000	0.010 ± 0.004	0.250 ± 0.021
Jamila	0.138 ±	0.003 ±	0.06 ±	0.890 ±	0.003 ±	0.085 ±

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	0.005	0.002	0.006	0.009	0.006	0.005
Faro	0.066 ± 0.001	0.007 ± 0.056	0.056 ± 0.007	0.415 ± 0.039	0.008 ± 0.003	0.220 ± 0.007
WHO Regulatory Limit	20.00	0.40	0.10	48.000	0.030	0.300

Values are expressed as Mean + Standard deviation

The results of proximate analysis of the four cultivars is presented by Table II. The results showed that Faro has the highest moisture (8.950 %), protein (7.125 %) and carbohydrates (72.735 %). While Jipdan has the highest ash content (10.650 %). On the other hand, Jamila has the highest lipid content (1.550 %), and finally, Fadama II has the highest fiber content (4.250 %).

Table II: Proximate Analysis Of The Four Cultivars Of Rice

Sample			Parameters (%)			
	Moisture	Ash	Lipid	Fiber	Protein	Carbohydrate
Jipdan	6.650	10.650	0.950	3.800	5.512	72.438
Fadama II	8.350	9.450	1.150	4.250	6.256	70.544
Jamila	8.100	8.950	1.550	2.600	6.910	71.890
Faro	8.950	6.490	1.350	3.350	7.125	72.735

DISCUSSION

Rice is a food crop of worldwide importance and form a foundation of diet for over 3 billion people, constituting half of the world population. It is widely cultivated throughout the world (as it is grown in more than 100 countries) except Antarctica [12], [8]. In Nigeria, Rice is a major contributor to Local as well as international trade. Two specie of rice are mainly grown in Nigeria; *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice) [4]. However, the Asian rice is gradually displacing the African rice due to its superior attributes. Rice production represents 38 89 % of total cereal production in Nigeria [4]. More than 90% of Nigerian rice is produced by resource-poor small-scale farmers, while commercial farmers produce the remaining 10%. Bauchi is among the States with larger irrigation schemes for rice production [13].

Although, some rices were found to be rich source of carbohydrate, riboflavin, niacin, thiamin, and contain moderate amount of protein and fat [1], it was still reported that about 870 million people are estimated to suffer from chronic undernourishment globally, the vast majority of whom live in developing countries where rice is closely associated with food security and political stability [12]. This clearly indicates that there is the need for us identify those varieties of rice (among the ones we consume) with higher nutritional status so as to recommend them for consumption by the populace so as to avert the consequence of malnutrition. Therefore, four cultivars of rice locally available in Bauchi town, Bauchi State, Nigeria, were analyzed for their heavy metals and nutritional content.

The heavy metals analysed were Cd, Hg, Pb, Ni, Cu and Fe. Pb is associated with carcinogenesis and mutagenesis in experimental animals. It is also linked with disorders of the central nervous system [14]. Cd and Hg both have negative effect on the urinary and respiratory systems [15]. The concentration of all these heavy metal (Pb, Cd and Hg) are within the WHO regulatory limit, hence, since their concentration in the rice cultivars analyzed is negligible to be concerned about, their presence in the rice cultivars do not pose any threat to their consumption. Fe is a heavy metal, however, within safety limit, it is beneficial to the living system. Within safety limit, it

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serves as component of hemoglobin and is involved in metabolism of lipids, carbohydrates and protein. It also serve as a cofactor. Its deficiency leads to anemia [14]. Within safety limits, Cu is required for absorption and incorporation of iron into hemoglobin. It serves as a cofactor of many enzymes. It defects among other things, may lead to demyelination and degradation of the nervous system [16]. These beneficial heavy metals (Cu and Fe) in the cultivars are within the WHO regulatory limit (beneficial range) and therefore serve as source of these metals for health improvement.

Another way of assessing nutritional quality is to carryout proximate analysis of the food material of interest. This entails assessing the moisture, ash, lipid, fiber, protein and carbohydrates percentages in the food material. The results of moisture content analysis of the four cultivars revealed that Faro has the highest moisture content (8.950 %). This value is comparable to what [6] reported (8.36 % for Faro 60). Having the highest moisture content to be 8.950 % is an indication that all the four cultivars were well dried and their parbolinig period was not prolonged, thus, could be stored for a long period of time without been spoiled [6]. Results of ash content determination shows that Jipdin has the highest ash content (10.650 %). Percentage ash represent the minerals content of a sample. The results of the metals analysis presented in table 1 has further supported the high ash content of the Jipdin cultivar we got. The ash content in Jipdin is even higher than that in the Igbemo and Benue rice cultivars (1.19% and 1.20% respectively) as reported by [6]. Lipids percentage in the four cultivars was also determined. Lipids are heterogenous group of macromolecules. They play role essential for survival. Among other things, they serve as shock absorbers and components of cell membrane. Although, high milling of rice removes the outer layer of the grain where most of the fats are concentrated, it is of no surprise when we found out that their lipids content is all below 2%, this is because rice is not meant to serve as source of lipids. Our result is similar to that of [6] who reported Faro 60 to have fat content of 1.48%.

Fibers are the undigestable part of the food. It aids in digestion and prevents constipation. Reference [17] reported that the rice they analyzed contained fiber in the range of 1.5 – 2.0%. Our results contradict this report as even the cultivar with the lowest fiber content has a value greater than 2.0%. However, our results is in conformity with what [18] reported (fiber content of 1.93 – 4.3%). Protein are body building components of food. Although, rice is meant to serve as carbohydrate source, a lot of researchers are ongoing to come up with energy giving food that have a reasonable amount of protein. Thus, having rice with reasonably high amount of protein will help in closing the gap of eating crops with just a single class of food. In this research, Faro was found to have the highest protein content (7.125%). This was higher than that reported by [17] (1.55 – 6.22%), although, lower than that reported by [6] from Igbemo cultivar (8.34%). Rice is eaten mainly for its carbohydrate. Carbohydrates are energy giving food. Although, Faro has the highest carbohydrate content (72.735%), the other remaining cultivars also have carbohydrate content > 70%. Thus, they are all good source of carbohydrate. Many researchers have also reported the carbohydrate content of the rice they analyzed to be > 70% [17], [18].

CONCLUSION

The present research revealed that the four cultivars of rice (Jipdan, Fadama II, Jamila and Faro) are the most available cultivars and presumably the most consumed in Bauchi town. Nutritional evaluation of these cultivars showed that they are all good sources of carbohydrate. However, Faro should be preferred with respect to protein, while Jipdan should be preferred with respect to minerals. Fadama II is to be preferred with respect to fiber, and with regards to lipid, although very negligible, Jamila should be sought for.

Authors Contribution

All authors have contributed equally during the research.

Conflict Of Interest

There is no conflict of interest among the authors.

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