Microbial Diversity and Proximate Composition of Some Commonly Consumed Local and Foreign Rice (*Oryza Sativa)*

Omorodion Nnenna J.P & Ndioho, Edise O
University of Port Harcourt,
Department of Microbiology
PMB5323 River State Nigeria.

Abstract
Rice (Oryza Sativa) is produced locally or internationally, small scale or large scale and otherwise. It is commonly used at home where it is eaten as cooked, fried or ground rice with stew or soup. 20 samples of locally produced rice and 20 samples of Foreign Rice was analyzed using standard microbiological methods .The total heterotrophic bacteria counts for local rice ranged from 3.6 x 10^5 to 3.32 x 10^6CFU/g. The counts for total heterotrophic bacteria for foreign rice ranged from 3.3 x 10^5 to 2.31 x 10^6CFU/g. The counts for total coliform for local rice ranged from 1.5 x 10^3 to 3.05 x 10^4CFU/g while the counts for total coliform \\bacteria for foreign rice range from 2.1 x 10^3 to 3.14 x 10^3CFU/g. The counts for total Staphylococcus sp. for local rice range from 2.0 x 10^5 to 3.04 x 10^6CFU/g while the counts for Staphylococcus sp. for foreign rice ranges from 5.1 x 105 to 2.29 x 106CFU/g. The total fungal counts for local rice range from 7.0 x 104 to 8.1 x 10^5CFU/g. The counts for total fungi for foreign rice range from 2.0 x 104 to 3.5 x 10^5CFU/g. The isolated bacteria from local rice were Escherichia coli, Salmonella sp., Enterobacter sp., Staphylococcus aureus, Klebsiella sp., as well as Bacillus sp., were observed. The isolated bacteria from foreign rice were Escherichia coli, Enterobacter sp., Staphylococcus aureus, Shigella sp., Klebsiella sp., including Bacillus sp.,the fungi isolated samples from both include Candida sp, Penicillum sp, Aspergillus sp, Geotrichum sp were seen. Local Rice had greater contamination compared to Foreign Rice. Some Physico-chemical characteristics of the rice varieties were Average length of 7.92mm, Average cooking time of 11minutes. All the grains were long or medium grain. Carbohydrate, Protein, Lipid, Ash, Moisture and Fibre content of the Local Rice were 69.46%, 8.42%, 1.50%, 0.67%, 11.02% and 8.94% respectively. Carbohydrate, Protein, Lipid, Ash, Moisture and Fibre content of the Local Rice were 61.80%, 7.79%, 8.75%, 0.72%, 11.20% and 9.72% respectively. Foreign Rice had more stored food energy of 357.11kcal/g compared to 325kcal/g of Local samples. Manufacturing companies and farmers should observe accurate aseptic techniques to produce rice free from contaminations, eminent education and awareness of citizens against pollution of farm lands to improve fertility and consumers are requested to vigorously wash the dishes, cutleries and food products to eradicate contamination.

Keywords: *Foreign, Local, Pathogen, Rice*

INTRODUCTION

Rice can be regarded as grains and seeds in the family of Graminae. The major specie is called Oryza sativa in the world of science (Anindita et al, 2019). Rice can be grown commercially or for consumption purposes, locally or internationally, small or large and otherwise. Rice is known to be grown in virtually every part of the world. It is used at home where it is eaten as cooked, fried or ground rice with stew or soup (Arifa, et. al. 2012). Local rice is useful to improve the economy of the country, hence, there is the need to assess the quality of imported rice products. Rice is majorly grown in wet season.

Categorically, two groups are tremendously researched on; White rice and brown rice. White rice is commonly eaten, but brown rice have greater nutritional benefits. As a good supply of several mineral nutrients and antioxidants, brown rice may additionally help prevent coronary heart ailment. Rice can also be classified based on the location which include; Japanese rice, Indian rice and many others. Physiologically, rice has a very high nutritional value. Its constituents and Quantity respectively include; Water: 68.44 g, Dietary fiber: 0.4 g, Energy: 130 kcal (540 kJ). Statistically, rice per-capital consumption has stepped up from 21.21kg in 1992 to 24.50kg between 1995-1999, which covers 9% of the total calorie consumption in Nigeria. Minerals like calcium, magnesium, phosphorus are found together with some traces of iron, copper, zinc and manganese (Yousaf, 2009). Rice is cultivated in the biological and agricultural sectors of Nigeria, with various species having different characteristics in biology and morphology (Sanni et al., 2005). The two regularly grown species of rice in Nigeria are Oryza sativa and Oryza glabberima. Numerous species of rice are grown in Abakaliki and its surroundings. These species display differences in cooking quality and type. As indicated by Sanjiva (1999), the differences in the nature of rice is from the contrast in their gelatinous feature. These laborers announced that the degree of growing of any specie of rice could be utilized as a record of its quality. Raw riceOryza sativa is categorically a cereal crop eaten as food. Nutrition is the most essential priority for the production of Oryza sativa. The daily market reports that the consumption of Oryza sativa is trivially mind blowing. Consequently, rice is produced using different manufacturing procedures to yield several products depending on the culture of the people of a particular geopolitical zone.

In Nigeria, Rice is cultivated in apparently all regions consisting of several species and processing features (Sammi et al., 2005). Currently, Abakaliki in Ebonyi State is a main producer of Oryza sativa in Nigeria (Ofomata et al, 1975). Occasionally, Rice is an economic crop used in homes , ceremonies, generation of income and provision of employment opportunities(Alaska et al., 2011).Nutritionally, the composition of rice entails 95% cereal and more than 80% calories and about 50% protein in the food of the people (Yusuf, 1997). Sanint (2004) stipulated that in developing countries it gives 27% of the nutritional energy supply and 20% of protein intake. Rice is a good source of complex carbohydrates, protein, vitamins and minerals. The aim of the research is to evaluate the microbial diversity of rice and the proximate composition of some commonly consumed local and foreign rice.

MATERIALS AND METHODS

Area of study

The Rice (foreign and local brands) were purchased from markets within Nigeria from mainly Rivers **State and Akwa Ibom State.**

Location of Markets

The markets were Choba market located about 1km from University of Port Harcourt, Alakahia retail shops and supermarkets, Omuokiri Market located in Aluu, Obo Market at Akwa Ibom state and many others.

Collection of Samples

Samples were collected from raw local and foreign brands. Two samples were collected from each rice bag, one for bacterial analysis and the other for fungal analysis. Samples collected were sent to a Microbiology Laboratory for further analysis. 20 samples of locally produced rice and 20 samples of internationally produced rice

Preparation of the rice samples:
Each sample (25 g) was diluted with 225 mL of peptone water0.1% (wt/v). This mixture was shaken and decimally diluted

Microbiological analysis:
Microbiological analysis which include enumeration of total bacteria, total fungi count, total coliform count, and total staphylococcus counts. Spread plated method was employed for the isolation of microorganisms. 0.1 ml of serially diluted sample was spread plated on Plate count agar, Mannitol salt agar, MacConkey agar and Potato dextrose agar .The plates for Total viable count (TVC), total Staphylococcus count and coliform were incubated at 37oC for 24 hrs while plates for fungus were incubated for 48 hrs. Single colonies of bacteria were picked from the different bacteriological media previously incubated based on their morphological characteristics. These isolates were sub-cultural on freshly prepared nutrient agar media and incubated for 24 hours at 37oC so as to get discrete colonies. After sub-culturing of the isolates on nutrient agar and potato dextrose agar media, agar slants were prepared in bijou bottles by dispensing 10ml of nutrient agar and potatoes dextrose agar solution into bijou bottles. The medium was sterilized by autoclaving at 121oC for 15mins at 15 psi. The bottles were slanted and allowed to solidify.as recommended by APHA (2005).
Bacterial Isolates were confirmed based on colonial morphology, and cultural characteristics on growth media which include: colony size, colour, opacity, consistency, colony pigmentation elevation, odour, swarming, identification materials, reagents and protocols were according to (Cheesbrough, 2005). Examination of Fungi was done based on the colonial morphology (colour, size, texture) and the cell morphology (mycelium, hyphae) of the fungi using lactophenol blue. A piece of mycelium from the Petri-dishes was mounted on a clean grease-free slide using a sterile wire loop and was covered with a cover slip. A drop of lactophenol cotton blue was added and allowed for few minutes before examining under the microscope.

Physico-chemical properties
Parboiling of rice is broadly used which is the aqueous treatment of crude rice before processing. The nature of processed parboiled rice is being evaluated depending on actual boundaries like level of processing, grain size, colour, and shape at 1000g weight. The following are the physico-chemical properties used in the research of rice;

Water Uptake Proportion
This was controlled by cooking 2.0 g of entire rice in 20 ml refined water for a base cooking time in a bubbling water shower and emptying the shallow water out of the cooked rice. The cooked Samples were then weighed precisely and the water take-up proportion was determined as the proportion of last cooked load to uncooked weight. Water take-up proportion = (weight of cooked rice)/(weight of uncooked rice as described by Alaka et al., (2011).

Cooking time
This was controlled by cooking 2.0 g of rice from every sample and put in 20 ml distilled water, eliminating some vapour at various time during cooking and crushing them between two surfaces until no white center was left. Ideal cooking time was taken as the set up cooking time after two (2) extra minutes as described by Alaka et al., (2011).

Grain Lengthening during Cooking

This was observed by first measuring the underlying grain length (L0) prior to cooking. The last length (L0) in the wake of cooking was then estimated. The grain lengthening during cooking was then determined as: L1 – L0, where L0 = beginning grain length prior to cooking, L1 = last length subsequent to cooking as described by Alaka et al., (2011).

Determination of food energy.

Calorific value is a vital characteristic showing the useful energy composition of foods. The gross food energy was estimated using the equation: Food energy (kCal/g) = (CP × 4) + (F × 9) + (CHO × 4), where CP means crude protein (%); F means fat (%); and CHO means carbohydrate content (%) as described by Alaka et al., (2011)..

Proximate analysis

Proximate composition of local and foreign analysis was determined as described by Aminu et al.2021

Statistical analysis

All measurements were done in duplicates for each of the samples, and data were reported for duplicate analyses of the same extract. All statistical analyses were carried out using analysis of variance (ANOVA). Significance of the differences was ascribed at the 0.05 level for ANOVA.

RESULT

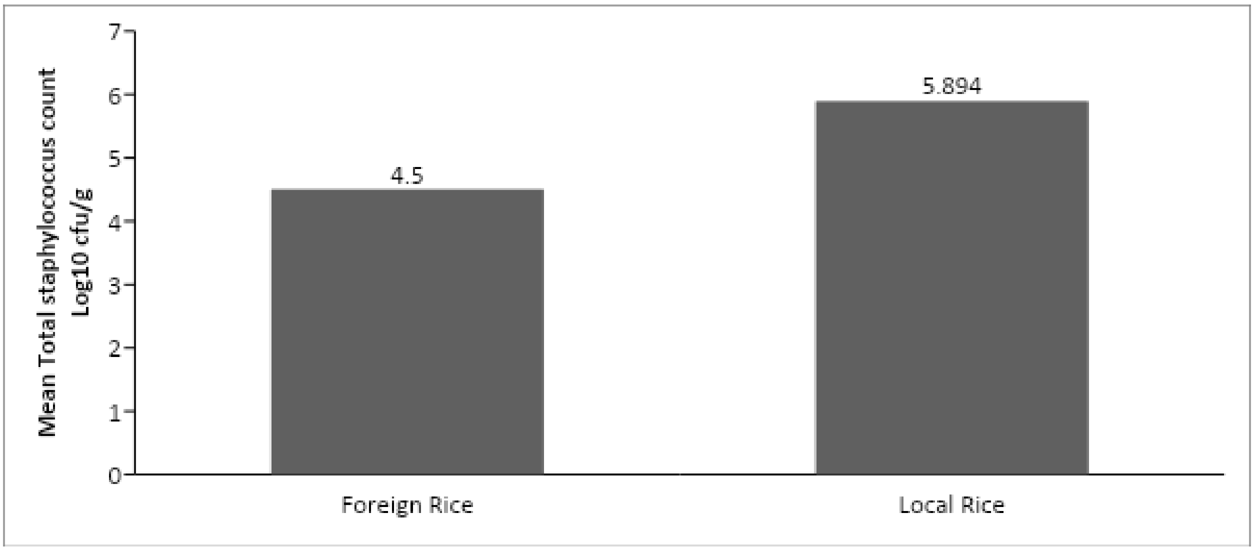

Fig1 Total Mean Staphylococcal Count Isolated from Local and Foreign Rice Samples

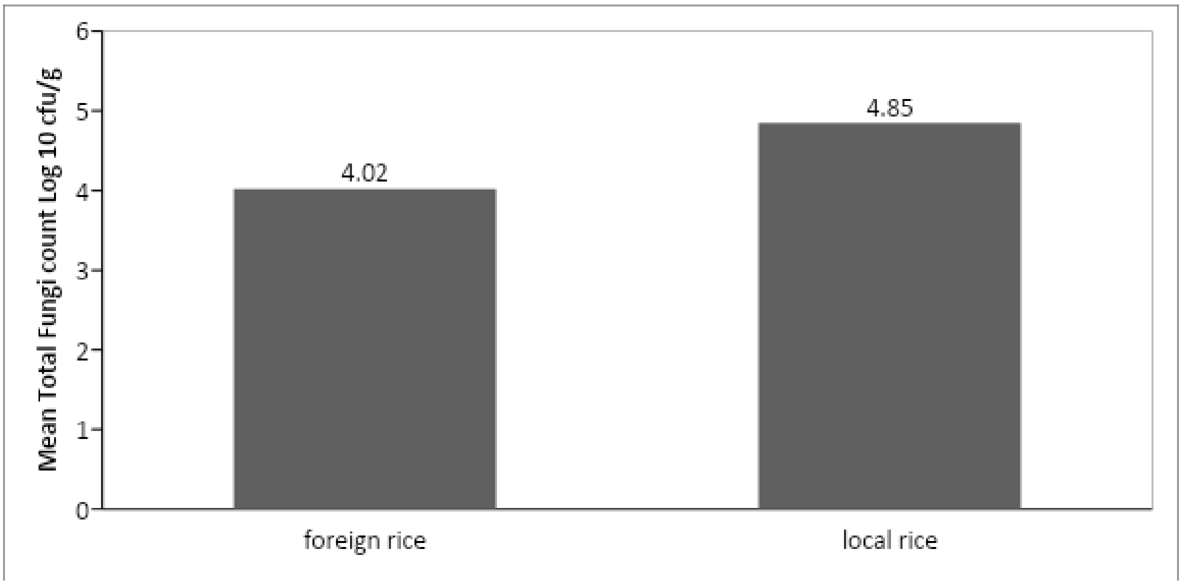

Fig 2 Total Mean Fungal Count Isolated from Local and Foreign Rice

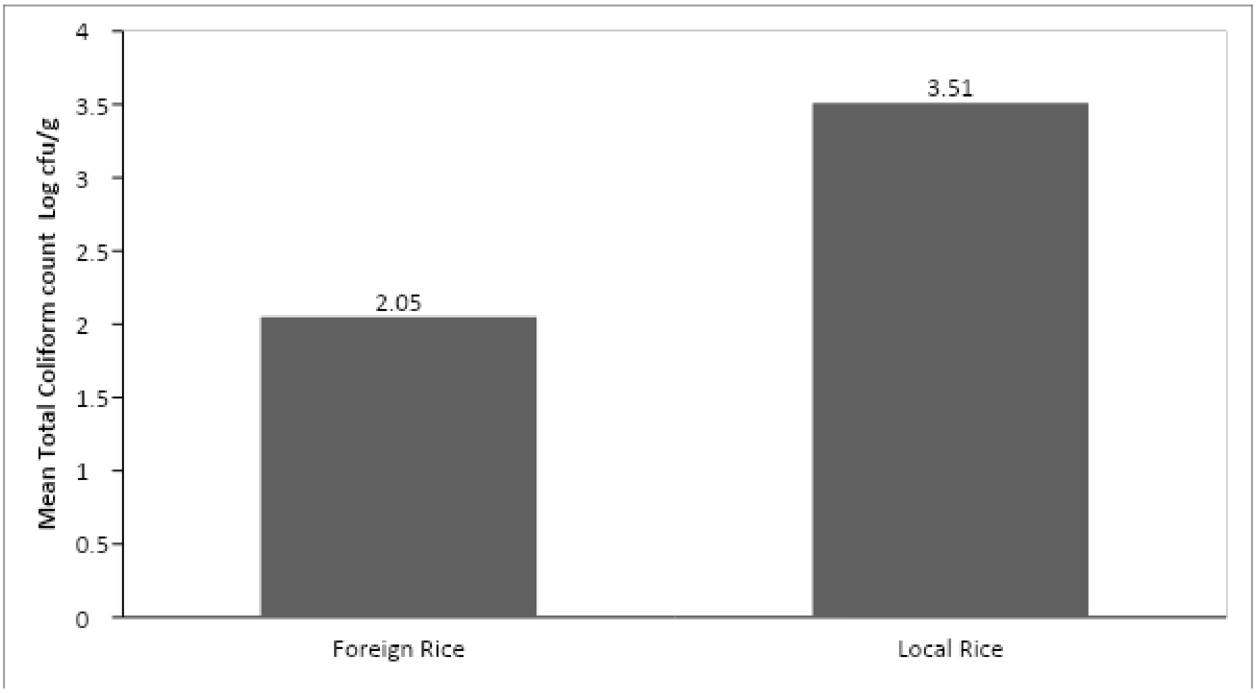

Fig 3Total Mean Coliform Count Isolated from Local and Foreign Rice Samples

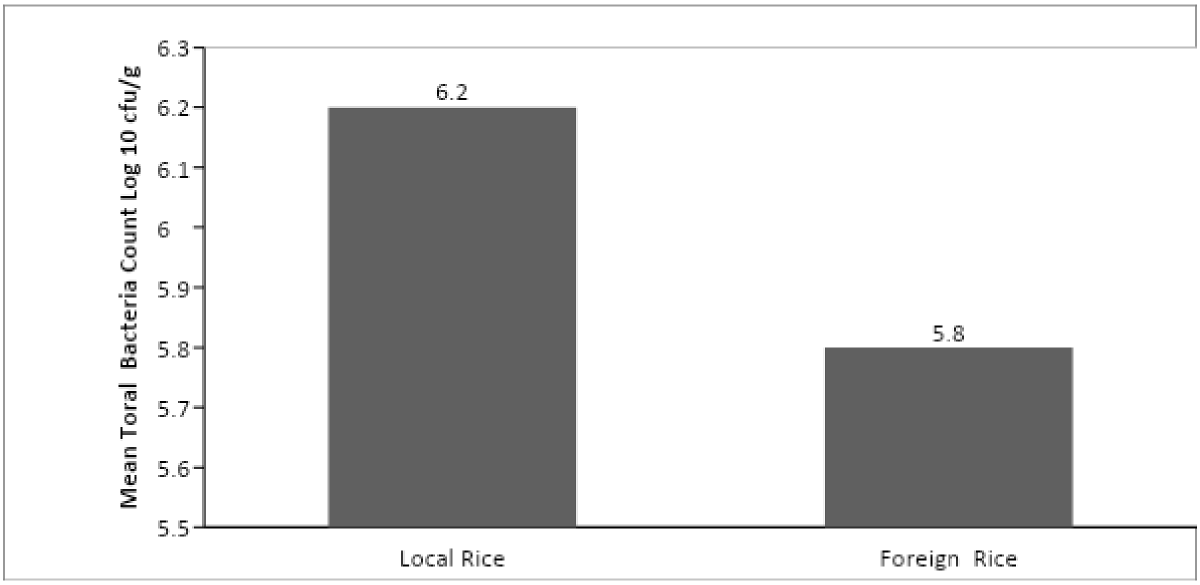

Fig 4. Total Mean Bacteria Count Isolated from Local and Foreign Rice Samples

TABLE 1 Proximate composition of local rice sample

S/N	Properties	Local Rice		Average
		Test 1 (%)	Test 2 (%)	
1	Carbohydrate content	70.19	68.73	69.46
2	Protein content	8.41	8.42	8.42
3	Lipid content	1.50	1.50	1.50
4	Ash content	0.67	Nil	0.67
5	Moisture content	11.29	10.95	11.12
6	Fibre content	8.94	8.93	8.94

TABLE 2 Proximate composition of foreign rice sample

S/N	Properties	Foreign Rice		Average
		Test 1 (%)	Test 2 (%)	
1	Carbohydrate content	61.80	61.80	61.80
2	Protein content	7.79	7.79	7.79
3	Lipid content	8.70	8.80	8.75
4	Ash content	0.72	0.72	0.72
5	Moisture content	10.50	11.40	10.95
6	Fibre content	10.49	8.94	9.72

TABLE 3 Physico-chemical properties of Foreign Rice Samples

S/N	Code	Length	Water-Uptake Ratio	Cooking Time	Grain Lengthening During Cooking
1	FR1	8.9mm	1.005	8mins 58secs	4.1mm
2	FR2	6.7mm	1.591	9mins 9secs	3.5mm
3	FR3	7.5mm	1.601	9mins 50secs	3.9mm
4	FR4	7.9mm	1.890	10mins 6secs	4.2mm
5	FR5	8.6mm	2.001	9mins 56secs	3.7mm
6	FR6	6.9mm	1.695	11mins 5secs	4.4mm
7	FR7	7.8mm	1.342	9mins 38secs	4.0mm

8	FR8	9.4mm	1.700	9mins 52secs	2.5mm
9	FR9	7.6mm	1.905	10min14secs	2.8mm
10	FR10	7.9mm	1.245	10mins 49secs	3.1mm
11	FR11	7.7mm	1.592	9mins 48secs	2.9mm
12	FR12	7.9mm	1.650	9mins 59secs	3.9mm
13	FR13	8.9mm	2.003	10mins 51secs	2.0mm
14	FR14	7.9mm	1.785	12mins 0secs	3.5mm
15	FR15	6.9mm	1.852	11mins 7secs	2.8mm
16	FR16	7.9mm	1.457	9mins 58secs	3.5mm
17	FR17	6.9mm	2.010	10mins 45secs	3.8mm
18	FR18	7.9mm	1.900	10mins 57secs	4.0mm
19	FR19	6.9mm	1.252	9mins 51secs	3.8mm
20	FR20	7.6mm	1.859	11mins 7secs	4.9mm

TABLE 4 Physico-chemical properties of Foreign Rice

S/N	Code	Length	Water-Uptake Ratio	Cooking Time	Grain Lengthening During Cooking
1	LR1	6.5mm	2.010	11mins15secs	2.7mm
2	LR 2	7.8mm	2.005	9mins 30secs	2.5mm
3	LR3	6.7mm	1.592	9mins 55secs	3.6mm
4	LR4	8.6mm	1.665	9mins 40secs	4.7mm
5	LR5	6.9mm	1.726	9mins 59secs	2.8mm
6	LR6	8.9mm	1.540	10mins 30secs	2.6mm
7	LR7	7.9mm	1.921	9mins 39secs	3.9mm
8	LR8	7.5mm	1.845	9mins 40secs	3.7mm
9	LR9	8.1mm	2.026	11mins 10secs	3.8mm
10	LR10	6.8mm	1.457	10mins 8secs	3.9mm
11	LR11	7.5mm	1.875	9mins 0secs	1.9mm
12	LR12	6.9mm	1.432	11mins 2secs	2.2mm
13	LR13	8.9mm	1.567	11mins 15secs	2.7mm
14	LR14	7.9mm	1.389	9mins 57secs	1.6mm
15	LR15	8.5mm	1.410	9mins 49secs	4.8mm
16	LR16	8.8mm	1.088	9mins 59secs	2.7mm
17	LR17	7.9mm	1.705	10mins 15secs	2.8mm
18	LR18	6.8mm	1.764	9mins 49secs	3.6mm
19	LR19	8.5mm	1.644	9mins 30secs	1.8mm
20	LR20	8.9mm	1.797	9mins 55secs	3.5mm

DISCUSSION

The results obtained from the microbial analysis of rice show that counts for total heterotrophic bacteria counts for local rice ranged from 3.6 x 10^5 to 3.32 x 10^6CFU/g. The counts for total heterotrophic bacteria for foreign rice ranged from 3.3 x 10^5 to 2.31 x 10^6CFU/g. Most of these values are higher than the standard count of 5.0 × 105 colonies per gram of sample approved by World Health Organization .The Total Viable Count (TVC) of the local rice samples was significantly higher than foreign rice samples($p<0.05$) and this might be as a result of an increase in moisture content of the local rice samples. An increased moisture content allows for the proliferation of microorganisms at a higher rate, this is in accordance to the findings of Arifa et al. (2012) An increased Total Viable Count (TVC) also indicates the inappropriate handling and storage of the product (Ramaday & Elnaby, 1962). Low level of contaminants in foreign rice samples could be because the Foreign rice samples are treated properly.

The counts for total coliform for local rice ranged from 1.5 x 103 to 3.05 x 104CFU/g.,while foreign rice ranged from1.13 x 10^2. to 228 x 10^3 cfu/g Some of coliform counts from the rice samples were higher than the standard count of 5.0 × 10^3 colonies per gram of sample approved by World Health Organization. Coliforms affect food safety and preservation because these organisms are reflection of fecal contamination and can carry water related pathogens (Lee et al., 2007). E coli is harbored in the intestinal tracts of animals and humans and is an indicator organism of fecal contamination, although cooking kills coliform bacilli, they can be found different sources or on several surfaces and are therefore a continuous source of food hygiene problems. Kazuko et al., 2018.

The counts for total Staphylococcus sp. for local rice ranged from 2.0 x 10^5 to 3.04 x 10^6CFU/g while the counts for foreign rice ranged from 5.1 x 10^5 to 2.29 x 10^6CFU/g. The Total Staphylococcus counts were higher than the standard count of <105 approved by Food and Drug Agency (FDA). Staphylococcus spp are commonly found in the surrounding soil, water and air and are found on human nose and skin.

The total fungal counts for local rice ranged from 7.0 x 104 to 8.1 x 10^5CFU/g. The counts for total fungi for foreign rice ranged from 2.0 x 104 to 3.5 x 10^5CFU/g. The total fungi count was significantly higher in the local rice sample compared to the foreign rice sample ($p<0.05$) obtained in this study. This can be attributed to the water activity of rice samples and the physiology of the contaminating fungal genera. The growth of fungi relies on temperature and water activity (Christian, 1963). As the water activity reduces, the growth of microbes is reduced (Troller, 1973 Occurrence of fungi could be a source of high pathogenicity (Pitt et al., 1994). These organisms cause several infections on their own and produces mycotoxins that are of public health importance to humans. Aflatoxin B1 (AFB1), the most potent aflatoxin produced mainly by *Aspergillus flavus*, is extremely toxic, mutagenic, carcinogenic and teratogenic to both humans and livestock and chronic exposure to low levels of AFB1 causes a serious health and economic hazard (Karlovsky,1999; Mishra and Das, 2003). These metabolites can affect agricultural produce as a results of mold invasion before and during harvest, or during storage. The formation of aflatoxins is closely linked to fungal growth (Tsai & Yu, 1999). The isolated bacteria from local rice were *Escherichia coli* , *Salmonella sp.* , *Enterobacter sp., Staphylococcus aureus/, Klebsiella sp*., as well as *Bacillus sp*. were observed. The isolated bacteria from foreign rice were *Escherichia coli, Enterobacter sp.* , *Staphylococcus aureus* ,, *Shigella sp..* , *Klebsiella sp*. (including Bacillus sp. were seen. Local Rice had greater contamination compared to Foreign Rice. Former studies carried out with regards to microbial safety in rice in other areas showed similar results where *Escherichia coli*, *Salmonella sp*, *Enterobacter sp.*, *Staphylococcus aureus*, *Shigella sp.*, *Klebsiella sp*. and *Bacillus sp*.the fungi isolated in the rice samples include *Candida sp, Penicillum sp, Aspergillus sp, Geotrichum sp* Arifa et al.,2012, Kazuko et al 2018..

Some Physico-chemical characteristics of the rice varieties were Average length of 7.92mm, Average cooking time between 9 to 11minutes. Size and shape were dictated by first ordering the rice samples, based of length; long (> 6mm long), medium (5-6mm long) and short (<5mm long) as reported by Alaka (2011). Oko, et al. (2011) reported that linear elongation of rice on cooking is one of the major characteristics of good rice.

The moisture levels of all rice samples varied between 11.02%–11.20% (, which is lower than the safe moisture content (14%) for a good storage of processed rice, although acceptable value around 12% is recommended for long term storage and to prevent insect infestation and microbial proliferation (Adair et al., 1973).. Moisture content invariably affects the quality and palatability of rice grains (Oko and Onyekwere, 2010). All samples were found to have the moisture content between 10.29% to 11.90% which is almost within the acceptable limit (12%) for long term storage of rice (Adair et al., 1973) when compared with the other sample. The moisture content in this study was lower than values were reported by Ebuehi and Oyewole (2008), Oko and Onyekwere (2010), Diako et al. (2011), , Oko et al. (2012), Mbatchou and Dawda (2013) and Thomas et al. (2013) High moisture content aids in stabilizing the protoplasmic contents of the cells and as such maintains the homeostasis of the cells, although high moisture content is associated to spoilage due to growth of microorganisms.

Foreign rice had an increased lipid content of 8.75%, followed by Local rice which exhibited the low lipid content of 1.50%. There was significant difference with foreign rice having high lipid content ($p<0.05$) the lipid content is vital towards human health as a result of its unique health benefits of rice fat besides dietary consumption of rice (Jenning and Akoh, 2009). They are very vital food components due to their role in growth, development and physiological functions of body (FAO/WHO, 1993). Lipid content is similar and within the range with those reported by Resurrection and Juliano (1975) and Taira and Itani (1988).

The protein content of local and foreign rice samples was high more than 7% and were found to meet the range, 7%–9% (Juliano, 1985) Protein in rice are very important as proteins are basic building blocks for cells and tissue repairs in the body (Mbatchou and Dawda, 2013). Protein content affects the nutritional quality of rice (Sompong et al., 2011). Rice protein content composed of up to 8% of the grain (Juliano, 1985), which is small but of increased nutritional value (FAO, 1970, Chaudhary and Tran, 2001). The protein quality of rice rely solely on the composition of amino acids (FAO, 1970). Resurrection et al. (1979) classified protein content greater than 10% as high content. Protein content in this study is comparable to that found by Heinemann et al. (2005), Thomas et al. (2013), Chen et al. (2004), Ebuehi and Oyewole (2008), Oko and Onyekwere (2010), Oko et al. (2012), and Rohman et al, (2014

The values of ash content were found significantly different among all the local and foreign rice samples. Foreign rice sample had the highest amount of ash (0.72%),($p<0.05$) whereas Local rice sample had the lowest ash content (0.67%)But low contents of ash in local rise was observed and may be as a result of the difference in genetic architecture of rice varieties (Butt et al., 1997). Ash content plays a crucial role to show the mineral elements of a food sample (Mbatchou and Dawda, 2013) and gives an idea to check the levels of essential minerals found in the food (Edeogu et al., 2007). According to Juliano and Bechtel (1985), the ash content of rice subjected to conventional milling differ from 0.3% to 0.8% and around 0.5% were the most common (USDA, 2004). Therefore, the mean values for ash content in rice recorded in this research meet those reported by Shayo et al. (2006), Oko and Onyekwere (2010), Anjum et al. (2007), Oko and Ugwu (2011) and Mbatchou and Dawda (2013). The high percentage of ash content may alter the sensory attributes of the rice especially colour and taste (Julliano, 1985). The differences of ash content in all local and foreign rice smaples may linked to the variations in mineral content of the soils and the water used for irrigation (Shayo et al., 2006).

Crude fibre are non-hydrolysable polysaccharides which can be in soluble or insoluble state and increase faecal bulk. They form complexes with protein, sugars and cholesterol. When taken in excess, they help to reduce the risk of colon cancer and scrub out the intestines leaving a much healthier digestive system (Okezie et. al., 2017). The fibre percentages of all the rice samples were below 10.0%. Foreign rice sample had the highest amount of fibre (9.72%), whereas Local rice sample had the lowest fibre content (8.94%) this different from the study conducted by Aminu et al.2021 the crude fibre content of the locally produced rice is significantly higher than the foreign rice. Dietary fibre functions help in maintaining bowel movement and can prevent diverticulosis by aiding the absorption of trace elements in the guts (Okezie et. al., 2017). Fibre has the ability to reduce the blood cholesterol and sugar after meals in diabetics. Fibre can reduce the risk of bowel disorders and fights against constipation (FAO/WHO, 1998). The wide range of diseases in man may have a relationship with the absence or low fibre in diet (Eastword, 1974). The presence of fibre in diet increases the bulk of faeces, which has a laxative effect in the gut (Mbatchou and Dawda, 2013). .The Fibre content for all the samples is similar and in the range of Ebuehi and Oyewole (2008), Oko and Onyekwere (2010), Oko et al (2012), and Rohman et al (2014). The crude fibre content affects the rice digestibility whereby high content of crude fibre in rice lowers its digestibility (WHO, 1985).

Carbohydrate is a vital components of rice grain and it is cruical in obtaining significant amount of dietary energy. The carbohydrate content of all the samples ranged from 61.8%–69.46%. . Hence, the carbohydrate content of all the rice samples was less than 75.00%, and near about the desired range (80%) (Juliano, 1985)..Rice carbohydrates are mainly starch which is made of amylose and amylopectin. A similar range of the carbohydrate content of different rice samples has also been reported by Chen et al. (2004), Yadav et al. (2007), Ebuehi and Oyewole (2008), Oko and Onyekwere (2010) and Oko and Ugwu (2011). Mbatchou and Dawda (2013) reported that an increased level of starch makes the single grains sticked to each other while a reduced starch content prevents sticking of the grains together after cooking. The differences in values of carbohydrate among the accessions were statistically significant (P < 0.05) with real differences occurring among the accessions in their carbohydrate content. These values correspond closely to that Reported by Abbey et al., 2001, Laureys, 1999 and Ebuehi and Oyewole, 2007, the observed high carbohydrate contents of both local and imported rice varieties confirms that rice is a source of carbohydrate.

Table 3/ shows that the average length of the tested varieties ranged from 6.31 to 7.63mm (P< 0.05). Dipti el al., (2002) grouped grains whose lengths are greater than 6mm as long, 5mm-6mm medium and less than 5mm as short. By this grouping, all the rice samples tested were long grains. Long grain rice are expensive in the market. Size and shape of rice affect many other properties like sieving, dehusking, polishing, storage as well as cooking. Anonymous (1997), reported that in Bangladesh, high income people prefer long grains whereas the low-income group prefer the short bold grains because of its high-volume expansion. All the tested varieties were long size. The grain size and shape of most modern rice varieties is long with translucent appearance

Foreign Rice had more food energy of 357.11kcal/g compared to 325kcal/g of Local samples, Food energy values differ among all the Local and Foreign rice samples. Foreign rice provided the increased energy among all the samples analyzed (357.11 kCal per 100 g), whereas the lowest value were recorded in Local (325.00 kCal per 100 g).Food energy is a value that measures the available amount of energy obtained from food via cellular respiration (Thomas et al., 2013). Food energy values of rice samples obtained in the research were found similar and within the values of Sompong et al. (2011) and Oko et al. (2012). Results show that the average length of the tested varieties ranged from 6.31 to 7.63mm while average width ranged from 2.04 to 3.01mm and they differed significantly. Dipti el al., (2002. Local Rice was found to contain more microbial contaminants than Foreign Rice. Rice is a major source of carbohydrate in this contemporary cosmos. It has been found to contain other nutrients including protein, fibre, moisture, vitamin, fat and lipid for adequate or balance diet. Rice exhibits little or no variation in their sizes, shapes, water-uptake ratio, cooking time, length-width ratio and other physico-chemical properties.

Conclusion

The local rice was found unsatisfactory in terms of microbial content. Local rice samples have high moisture content may be due to then inferior quality of packaging material or poor storage conditions of rice, local rice harbors more microbial contaminants as compared to foreign rice samples, showing that these are protected from contamination while subsequent handling, packaging, storage and transporting. The physical characteristics of the local and foreign tested are quite good. Their grain size is long, and their appearance which is an important index of quality is good and proximate compositions were all within acceptable levels. Therefore, the varieties are of good quality.

REFERENCES

Anindita, D. P. and Prapti, R.(2019). Evaluation of Microbiological Safety of Organic and Conventionally Grown Rice. International Journal of Health Sciences & Research. 158. Vol.9; Issue: 1; ISSN: 2249-9571.

Arifa, T., Isbah, H., Madiha, A. and Bushra M. (2012).Microbial assessment of uncooked and cooked rice samples available in local markets of Lahore. Pakistan Journal Botany. 44: 267-270

Alaka, I. C. and Okaka, J.C (2011). Physicochemical and milling characteristics of some selected locally processed rice in south eastern. *Nigeria Journal of Science and Technology*. Vol.17(1) 20-32.

Alaka, I. C. and Okaka, J.C (2011). Physicochemical and milling characteristics of some selected locally processed rice in south eastern. Nigeria Journal of Science and Technology. Vol.17(1) 20-32.

Arifa, T., Isbah, H., Madiha, A. and Bushra M. (2012).Microbial assessment of uncooked and cooked rice samples available in local markets of Lahore. Pakistan Journal Botany. 44: 267-270.

Adair, C. R., Bollich, C. N., Bowman, D. H., Joson, N. E., Johnston, T. H., Webb, B. D., Atkins, J. G. (1973). Rice breeding and testing method in the United States. In: Rice in the United States: Varieties and Production. Department of Agriculture of the United States: 22–27.

Abbey, T. K., Alhassan, A., Ameyibor, K., Essiah, J. W., E. Fometu, and Wiredu, M. B. (2001). Integrated science for senior secondary schools vol. 75, 76, 451. Accra North, Ghana: Unimax Maxmillan Ltd

Anjum F M, Pasha I, Bugti M A, Batt M S. 2007. Mineral composition of different rice varieties and their milling fractions. Pak J Agric Sci, 44(2): 51–58.

Aminu Ibrahim1, Musa Bashir and Zinatu Muhammad Garba M. Bashir, A. Ibrahim, Z. M. Garba, (2021)Proximate and Anti-Nutritional Estimation of some Local and Imported Rice (Oryza Sativa):A Comparative Approach. Dutse Journal of Pure and Applied Sciences (DUJOPAS), Vol. 7 No. 2b

Butt, M.S., Anjum, F.M., Rehman, A. and Ali, V. 1997. Physicochemical characteristics of spring wheats. Journal of Agricultural Research. 35 (6): 413-422. 74

Christian, J.H.B. 1963. Water activity and growth of microorganisms. Recent Advances in Food Science. In: Eds.): J.M. Leitch, and D.D. Phodes. London:Butterworths and Co. pp. 248-255.

Chaudhary R C, Tran D V. 2001. Specialty rices of the world: Aprologue. In: Chaudhary R C, Tran D V. Specialty Rice of theWorld: Breeding, Production, and Marketing. Rome, Italy: FAO,and New Delhi, India: Oxford & IBH Publishing Co. Pvt. Ltd: 3–14.

Chen J, Lii C Y, Lu S. 2004. Relationships between grain physicochemical characteristics and flour particle size distribution for Taiwan rice cultivars. J Food Drug Anal, 12 (1): 52–58.

Chen J, Lii C Y, Lu S. 2004. Relationships between grain physicochemical characteristics and flour particle size distribution for Taiwan rice cultivars. J Food Drug Anal, 12 (1): 52–58.

Dipti, S.S, Hossain, S.T, Bari, M.N and Kabir, K.A. (2002). Physicochemical and Cooking Properties of some fine rice varieties. Pakistan Journal of Nutrition 1(1(4) Pg188-190.

Diako C, Sakyi-Dawson E, Bediako-Amoa B, Saalia F K, Manful JT. 2011. Cooking characteristics and variations in nutrient content of some new scented rice varieties in Ghana. Ann FoodSci Technol, 12(1): 39–44.

Ebuehi O A T, Oyewole A C. 2008. Effect of cooking and soakingon physical characteristics, nutrient composition and sensoryevaluation of indigenous rice and foreign rice varieties inNigeria. Afr J Biote chu, 6(8): 1016–1020.

Ebuehi O A T, Oyewole A C. 2008. Effect of cooking and soaking on physical characteristics, nutrient composition and sensory evaluation of indigenous rice and foreign rice varieties in Nigeria. Afr J Biote chu, 6(8): 1016–1020.

Ebuehi OA, Oyewole AC (2007). Effects of cooking and soaking on physical characteristics, nutrient composition and sensory evaluation of indigenous and foreign rice varieties in Nigeria. Nigerian Afri J Biotech.; 6 (8): 1016-1020.74

Edeogu C O, Ezeonu F C, Okaka A N C, Ekuma C E, Elom S O. 2007. Proximate composition of staple food crops in Ebonyi State (South Eastern Nigeria). *Int J Biotechnol Biochem*, **3**(1): 1–8.

Eastword M A. 1974. Dietary fibre in human nutrition. J Sci Food Agric, 25: 1523–1527.

Ebuehi O A T, Oyewole A C. 2008. Effect of cooking and soaking on physical characteristics, nutrient composition and sensory evaluation of indigenous rice and foreign rice varieties in Nigeria. Afr J Biote chu, 6(8): 1016–1020.

FAO/WHO. 1998. Obesity: Preventing and managing global epidemic. WHO technical report, Geneva, Switzerland.

FAO. 1970. Amino Acid Content of Foods and Biological Data on Proteins. Rome Nutrition Division: FAO, 122.

FAO/WHO. 1993. Fats and oils in human nutrition. Report of ajoint expert consultation organized by the Food and Agriculture Organization of the United Nations and the World Health Organization. Rome Mbatchou V C, Dawda S. 2013. The nutritional composition of four rice varieties grown and used in different food preparations in Kassena-Nankana district, Ghana. Int J Res Chem Environ, 3(1): 308–315.

Heinemann R J B, Fagundes P L, Pinto E A, Penteado M V C, Lanfer-Marquez U M. 2005. Comparative study of nutrient composition of commercial brown, parboiled and milled rice from Brazil. J Food Comp Anal, 18(4): 287–296.

Jenning B H, Akoh C A. 2009. Effectiveness of natural versussynthetic antioxidants in a rice bran oil-based structured lipid.Food Chem, 114(4): 1456–1461.

Juliano B O. 1985. Factors affecting nutritional properties of rice protein. Trans Nat Acad Sci Technol, 7: 205–216

Juliano B O. 1985. Factors affecting nutritional properties of rice protein. *Trans Nat Acad Sci Technol*, **7**: 205–216.

Juliano B O. 1993. Nutritional value of rice and rice diets. In: Rice in Human Nutrition. IRRI and FAO, Rome, Italy: 61–84.

Karlovsky, P. 1999. Biological detoxification of fungal toxinsand its use in plant breeding, feed and food production. Natural Toxins, 7: 1-23.

Lee, M.J., S.Y. Park and S.D. Ha. 2007. Reduction of *coliforms* in rice treated with sanitizers and disinfectants. *Journal of Food Control*, 18: 1093-1097.

Laureys,C. (1999). "A natural choice for texture in: Rice derivatives, Sunrice research organization, P. Williams, Y. Pan and V. Poulson

Mishra, H.N. and C. Das. 2003. A review on biological control and metabolism of aflatoxins. Critical Review of Food Sciences, 43: 245-264.

Mbatchou V C, Dawda S. 2013. The nutritional composition of four rice varieties grown and used in different food preparations in Kassena-Nankana district, Ghana. Int J Res Chem Environ, 3(1): 308–315.

Mbatchou V C, Dawda S. 2013. The nutritional composition of four rice varieties grown and used in different food preparations in Kassena-Nankana district, Ghana. Int J Res Chem Environ, 3(1): 308–315.

Oko A O, Ubi B E, Efisue A A, Dambaba N. 2012. Comparative analysis of the chemical nutrient composition of selected local and newly introduced rice varieties grown in Ebonyi State of Nigeria. Int J Agric Forest, 2(2): 16–23.

Oko, A. O. & Ugwu, S. I. (2011). The proximate and mineral compositions of five major rice varieties in Abakaliki, South-Eastern Nigeria. International Journal of Plant Physiology and Biochemistry, 3(2), 25-27.

Oko A O, Onyekwere S C. 2010. Studies on the proximate chemical composition and mineral element contents of five new lowland rice varieties in Ebonyi State. Int J Biotechnol Biochem,6(6): 949–955.

Oko A O, Ubi B E, Efisue A A, Dambaba N. 2012. Comparative analysis of the chemical nutrient composition of selected local and newly introduced rice varieties grown in Ebonyi State of Nigeria. Int J Agric Forest, 2(2): 16–23.

Oformata, G. E. K. (1975): Nigeria in maps: Eastern States. Ethiopia publishing Hons. Benin City, Nigeria. Pg.146.

Oko A O, Onyekwere S C. 2010. Studies on the proximate chemical composition and mineral element contents of five new lowland rice varieties in Ebonyi State. Int J Biotechnol Biochem, 6(6): 949–955.

Oko A O, Ugwu S I. 2011. The proximate and mineral compositions of five major rice varieties in Abakaliki, South-Eastern Nigeria. Afr J Biotechnol, 6(8): 1016–1020.

Oko, A. O. & Ugwu, S. I. (2011). The proximate and mineral compositions of five major rice varieties in Abakaliki, South-Eastern Nigeria. International Journal of Plant Physiology and Biochemistry, 3(2), 25-27.

Okezie E., Ugbogu A. E., Odungide A A. and Atani, C. S. (2017). Proximate, Antinutritional and Mineral Estimation of some selected consumed Green vegetables in Afaha Eket, Akwa-Ibom state, Nigeria. American Journal of Food Science and Technology, Vol. 5:5, 182-191.

Pitt, J.I., A.D. Hocking, B. Kanjana, B.F. Miseamble, K.A.Wheeler and P. Tanboon. 1994. The normal mycoflora of commodities form Thailand Rice, Beans and other commodities. International Journal of Environmental Health Research, 4: 102-108.

Ramady, A. and A. Elnaby. 1962. Microbial examination of foodand food products. *Journal of Food Sciences*, 45: 125-132

Rohman A, Helmiyati S, Hapsari M, Larasati Setyaningrum D. 2014. Rice in health and nutrition. *Int Food Res J*, **21**(1): 13–24.

Sanjiva, R. B. (1999). The Amylose and the Amylopectin Contents of Rice and Their Influence on the Cooking Quality of the Cereal. *Indian Institute of Science, Bangalore*, pp. 55-58.

Sanni, S. A., Okeleye, K. A., Soyode, A. F., Taiwo, O. C. (2005). Physiochemical Properties of Early and Medium Maturing Nigerian rice varieties. *Nigerian.Food Journal.*, 23:

148-152.

Sanni S.A, Okeleye,K.A Soyode, A.F,Taiwo, O.C(2005) Physicochemical properties of early and medium maturing and Nigerian rice vatieties.Nig.Food J.23:148-152

Sompong R, Siebenhandl-Ehn S, Linsberger-Martin G, Berghofer E. 2011. Physicochemical and antioxidant properties of red and black rice varieties from Thailand, China and Sri Lanka. Food Chem, 124(1): 132–140.

Shayo N B, Mamiro P, Nyaruhucha C N M, Mamboleo T. 2006. Physico-chemical and grain cooking characteristics of selected rice cultivars grown in Morogoro. Tanz J Sci, 32(1): 29–36.

Taira H, Itani T. 1988. Lipid content and fatty acid composition of brown rice of cultivars of the United States. J Agric Food Chem, 36(3): 460–462.

Thomas R, Wan-Nadiah W A, Bhat R. 2013. Physiochemical properties, proximate composition, and cooking qualities of locally grown and imported rice varieties marketed in Penang, Malaysia. Int Food Res J, 20(3): 1345–1351.

Troller, J.A. 1973. The water relations of food borne bacterialpathogens. *Journal of Milk Food Technology*, 36: 276-282.

Tsai, G.J. and S.C. Yu. 1999. Detecting Aspergillus parasiticusin cereals by an enzyme linked immunosorbent assay. International Journal of Food Microbiology, 25: 181-189.

USDA (United State Department of Agriculture). 2004. Agricultural Research Service.

USDA Nutrient Database for Standard ReferencRetrieved January 25, 2015.https://ndb.nal.usda.gov/ndb

WHO. 1985. Energy and Protein Requirements. World Health Organization, Geneva.

Yadav R B, Khatkar B S, Yadav B S. 2007. Morphological, physicochemical and cooking properties of some Indian rice (Oryza sativa L.) cultivars. J Agric Technol, 3(2): 203–21

Yousaf, M. (1992). Study on Some Physicochemical Characteristics Affecting Cooking and Eating Qualities Of Some Pakistani Rice Varieties. M.Sc. Thesis. Department of Food Technology, University of Agriculture Faisalabad, Pakistan. International Journal Agriculture Biology, 10: 556-560

Yusuf, H. K. M. (1997). Report of the Sustainable Food Security Mission in Bangladesh. FAO, Rome. http://www.thaiagj.org