Low Carbohydrate Screening of Maize (*Zea mays*) and Rice (*Oryza sativa*) Available in Jos Metropolis and environs, Plateau State, Central Nigeria

Edah A. O., Ankwai, G. E. and Gye D. J.

Department of Pure and Industrial Chemistry, Faculty of Natural Sciences, University of Jos, Jos Nigeria.

Abstract: **Maize and rice grains are major components of food security in the diet of Nigerians. It serves as a major source of carbohydrate in both human and livestock sustenance. They are precursor for the release of energy essential in normal body metabolism. In this study, Maize from Mangu (MM), Maize from Doka (DM), Basmati Rice (BR) identified as low carbohydrate rice from India and Foreign Rice (FR) were proximately evaluated by AOAC, (2012) methods. The research showed that Maize from Mangu (MM) contains significant protein(7.05 ± 0.01)%, ash (1.40 ±0.01)%, carbohydrate (73.96 ±0.010)% and fat 4.40±0.01)%, while the Maize from Doka (DM) had protein (6.65±0.01)%, ash (1.30±0.01)%, carbohydrate (71,68±0.01)%, and fat (4.20±0.01)%. Implying that the Maize (MM) had more carbohydrate than of DM, which may be implicated for low carb, this may be attributed to the specie's capacity to retain relatively high moisture (7.30±0.01%) and fiber (8.43±0.01)%. The evaluation of rice revealed that BR had relatively high moisture (7.6±0:01)%, ash (0.73±0.010)% and fiber (5.00±0.01)% while the FR, had moisture (7.6±0.01)%, ash (0.73±0.10) and fiber (5.0±0.00)%. The low level of carbohydrate in Basmati Rice could be due to it high moisture and ash content. The mineral content in mg/1000g (of Ca, P, Fe, Zn) of the samples are all below the recommended dietary intake per day. The results show that the maize has lower carbohydrate content than rice. The nutritional proximate compositions of the maize samples were higher than that of the rice. The glycaemic index (G.I) of Basmati Rice (55 to70) makes it suitable for diabetic individuals.**

Keywords: **Maize, Rice, Low Carbohydrate, Diabetic, Proximate analysis, Glycemic index**

I. INTRODUCTION

Cereals are the most important stable foods for mankind worldwide and represent the main constituent of animal feed. The major cereals are wheat, corn, rice, barley, sorghum, millet, oats and rye. Wheat, corn, and rice take up the greatest parts (Peter and Herbert, 2013).Food are made of carbohydrate, fat, protein, vitamin, water, and minerals. In their natural form Maize and rice are rich in source of these food components(W. F. Abdulrahman and A. O. Omoniyi, 2016). Cereals are categorized next only to tuber produce as a source of food in Nigeria (Oke, 1965). The moisture content, crude protein, crude fiber, ash, ether extract can be determined according to AOAC Methods of Analysis of some Nigerian Cereals AOAC, (2012). Carbohydrates are made of units of sugars (glucose, fructose etc). Protein consists of amino acids (Edah, 1992). Warm-season cereals (corn, rice, sorghum, millet) are grown in tropical lowlands throughout the year and in temperate climates during the free season. Rice is mainly grown in flooded fields (Peter Koehler and Herbert Wieser, 2013). More than half of the world's population depends on rice as the major source of calories (FAO 2003). Nigeria is the largest rice producing country in the West African region (Onu*et la.*, 2015).

A characteristic of all cereal, however, is that they contain large amount of carbohydrate and small amount of water (Woman's Institute Library of Cookery, 1924).The amount of carbohydrate in a meal is the most important factor influencing blood glucose levels after a meal. Glycemic index ranks food depending on the rate at which the body breaks it down to form glucose. Foods containing carbohydrate include cereals, rice, grains such as barley and some vegetables such as potato, sweet potato and corn (Nutrition Australia April 2009). The GI is a way of ranking carbohydrate-containing foods (from 0-100) based on whether they raise blood sugar levels a lot, moderately or a little. Carbohydrate containing foods that are digested quickly will result in a high blood glucose level and have a high glycemic index (high GI foods). Foods with a GI 70 and above are classified as high GI foods.Carbohydrate foods that are digested more slowly raise blood glucose levels more slowly, and so have a lower glycemic index (low GI foods). Foods with a GI 55 and below are low GI foods (Better Health, 2013). Eating foods with a low GI can help people with diabetes control their blood glucose levels. Cereals (e.g maize and rice) are classified among foods with high carbohydrate content. For a diabetic, desiring the control of blood sugar, only a little corn and rice is allowed. As rice and maize are rich in starch, and usually a high GI food, portions should be strictly controlled. With years of research, Amar Singh Chawalwala introduce specially processed parboiled rice (Basmati Rice) with low G.I. Special techniques during cultivation and processing are being used to maintain the Low G. I levels. This is a remarkable research by the R & D department to help rice lovers having diabetes to maintain their low G. I. levels, when used in moderate quantities (Amar, 2015).Lal Qilla Basmati Rice of high carbohydrate content of 77.10% is known to have low G.I of 50%. This makes it suitable for diabetic patients when consumed moderately (Amar, 2015). (Uche Nzeka & Joshua Taylor 2016) estimated rice and maize consumption

2017/2018 in Nigeria is projected at 6.8 million tons and 4.5 million tons respectively. In Nigeria, About 5 million people are still living with diabetes (World Heath day, 2016). The Nigeria markets are supplied with maize and rice that are said to be of low carbohydrate content.

Statement of the Problem

Consumers are faced with the problem of unknown level of carbohydrate content of rice and maize being sold in Nigerian markets as low carbohydrate food items.

Aim

To determine whether the rice and maize samples have low carbohydrate content

Objective

To determine by proximate analysis and the mineral composition (Ca, P, Fe, Pb and Zn) of maize and rice being sold in Nigerian markets.

Significant of the research

The research might help to provide information on maize and rice samples that have low carbohydrate content with high nutritional value and minerals content. The dietary management of some diseases can also be carried out appropriately, for example food for diabetic patients that are nutritionally rich and contain minerals with assured levels of low carbohydrates contents.

II. MATERIALS AND METHODS

Sample Collection and Preparation.

For the purpose of this work two local maize were obtained from Mangu (MM) in Mangu LGA of Plateau State (MM) and from Doka village in Toro LGA of Bauchi State (DM). Lal Qilla Basmati Rice (BR) a Low carbohydrate Rice from India and common foreign rice (FR) were also obtained from the market. The samples were collected in polythene bags and transported to the laboratory for analysis. The selection of the two types of the cereals is because they are the most highly consuming cereals in Nigeria. Foreign particles were carefully sorted out then the samples were pounded into fine particles in a ceramic laboratory mortar. The samples were packed in polythene bags for the analysis.

Proximate Composition

Proximate analyses of the samples were done according to Standard Procedures of Association of Analytical Chemist (AOAC 2012). The system consists of the analytical determinations of water (moisture), ash, crude fat (ether extract), crude protein and crude fibre. Protein was determined by micro-Kjeldahl using the Digestion System. Fat was determined by ether extraction using the Soxhlet apparatus. Ash was determined by ashing in a furnace. Carbohydrate (Nitrogen-free extract (NFE)),representing sugars and starches in food, was calculated by difference. %carbohydrate=100-(%Moisture+%Fat+%Ash+%Crude fiber+%Crude protein). All the proximate values were reported in percentages (AOAC, 2012). The analysis was carried out at Laboratory 111 university of Jos Post Graduate Laboratory.

Mineral Composition

1 g of each of the powdered sample in a 50mlbeaker was wet digested using 30 ml of HNO acid solution (2:1 volume) on a hot digestion system, heated until the samples turn colorless solution. After digestion was complete, the solution of each sample was transferred into a 50 ml calibrated sample bottle and the solution was diluted to the mark with distilled water. Ca, Pb, Fe, and Zn in cereal samples were determined by flame Atomic Absorption Spectrophotometer (VARIAN model AA240FS,United States) using a working standard of 10 ppm for each of the species .Phosphorus in the sample was determined by the vanadium Molybdate (yellow) spectrometry as described by (James,1995).The results were obtained in ppm (equivalent of mg/1000g).

III. RESULTS AND DISCUSSION

Results

Table I: Proximate composition of Maize and Rice (g/100g)

Sample Code	%Moisture Content	%Crude Protein	%Ash Content	% Crude Fat	%Crude Fibre	%Carbohydrate Content
DM	7.30±0.12	6.65±0.00	1.30±0.00	4.20±0.12	8.43±0.00	71.68±0.01
MM	6.10±0.01	7.05±0.01	1.40±0.00	4.40±0.03	7.10±0.01	73.96±0.01
FR	6.8±0.07	7.71±0.01	0.70±0.00	0.8±0.01	4.38±0.01	79.00±0.22
BR	7.60±0.01	7.00±0.01	0.73±0.01	1.4±0.00	5.00±0.12	77.84±0.06

Mean ± standard deviation, *(SRM) = Standard reference for maize* *NA = Not Available,*

DM = Maize from Doka village Bauchi State *MM = Maize from Mangu Plateau State* *FR = Foreign Rice,*

BR= Basmati Rice

Table II: Mineral composition of Maize and Rice Samples in (mg/1000g)

Parameter	DM	MM	FR	BR
Calcium	34.97±0.01	43.00±0.01	57.02±0.01	68.25± 0.01
Phosphorus	1.56±0.01	1.38±0.01	1.77±0.01	2.08±0.01
Iron	17.78±0.01	19.89±0.0.00	23.91±0.01	27.40±0.01
Lead	0.01±0.00	0.02±0.00	0.01±0.01	0.01±0.01
Zinc	26.18±0.00	23.69±0.00	25.77±0.01	25.81±0.01

Discussion

Proximate Analysis and Mineral Composition.

A comparative proximate composition was studied among the samples, which are defined as MM (Maize from Mangu), DM (Maize from Doka), BR (Basmati Rice, low carbohydrate from India) and FR (Foreign Rice). A proximate chemical and nutrient composition of these selected Maize and Rice varieties obtained from this study shown in Table I and Table II for proximate and mineral composition respectively.

Proximate Composition of Maize

Moisture content: Moisture content was highest in maize DM (7.30 ± 0.01) % and lowest in Maize MM(6.10 ± 0.01)%. Research show that low moisture content in food items increases the length of storage periods of the foods products (Alozie *et al*,2009); while high moisture content in foods encourage microbial growth; hence, food spoilage (Temple *et al,* 1996). (Ullah *et al,* 2010) reported the value of moisture content in ten varieties of corn seed in the range of (10.908 – 9.20)% which are higher than the results of this studies. Aisha and El-Tinas, 2000 found that the moisture content of 12 samples of corn were in the range of (4.30 – 6.70) % , this is in agreement with the result of our present study. The values of the moisture content in the maize samples are notably below the standard reference of 10.4 %(USDA). Hence can be store for a longer period.

Crude Protein: Protein being the body building nutrient was found to be higher in MM (7.05 ± 01) than DM (6.65 ± 0.00). In a similar study by (Ijabadeny and Adebolu, 2005) it was found that the % protein content of three maize varieties grown in Nigeria, were in the range of (10.67 - 12.39) % which vary with the present study. The values of the present maize results were found to be below the standard reference value of 9.42% (USDA).

Crude Fibre: The maize from Doka showed higher fiber contents DM (8.43 ± 0.01) % than MM (7.10 ± 0.01) %. The high fiber content can have some biological beneficial effects such as laxative effect on the Gastrointestinal Tract (GIT), increase fecal bulk and reduction in plasma cholesterol level as reported by Okoye, (1992). The values of the present studies are higher than those reported for other varieties by (Ijabadeniyi and Adebolu, 2005) of (2.07-2.77) %, this is not consistent with the result of the present study. The value of DM and MM are consistent with the standard reference value of 7.3% (USDA, 2010).

Crude Fat: The crude fat content in maize from Mangu and maize from Doka were (4.40±.01)% and (4.20±0.01)% respectively. The variation of the fat content in the maize samples may be attributed to different factors such as agromeric, environmental factors and varieties. However, fat contributes to the energy value of these grains thereby providing essential fatty acids for optimum neurological, immunological and functional developments in children (Guthrie, 1989). The values are slightly closer to the standard reference of 4.7%.

Ash Content: The ash content, which is an index of mineral contents of food was found to be (1.30±0.01) % and (1.40±0.01) % for maize from Doka and maize from Mangu respectively. Similar results 0.70 – 2.50% in different maize hybrids were reported by (Saleem *et al.*, 2008) and (Keshun, 2009). This is in agreement with the present study. (Maziya-Dixon *et al.*, 2000) had results in the range of 1.4 – 3.3%, which are consistent with the values observed in the present study. The values for DM and MM are slightly higher than standard reference value of 1.2% (USDA, 2010).

Carbohydrate: Carbohydrates are the major component of the grains. The low value of carbohydrate in DM (71.68 ± 0.01) % might be due to its relatively high moisture in the DM (7.30 ± 0.00) %. The carbohydrate in MM (73.96 ±0.01) %. A slightly lower average value of (65.63-70.23) % for the carbohydrate content for the maize varieties grown in Nigeria were reported by (Ijabadeniyi and Adebolu, 2005). The values are not in agreement with the present results of maize samples. Ullah *et al*., (2010) that reported percent carbohydrate was found in the range of 69.66% - 74.55% which is in agreement with the present study.

Mineral Composition of the Maize

The result of the elemental analysis of the maize indicate that Maize from Mangu has high calcium MM(43.00±0.01) and Iron MM(19.89±0.01) than Doka Maize which has higher value of Phosphorus DM (1.56±0.01) and Zinc DM(26.18±0.02). All the values are below the recommended dietary allowance for minerals (RDA) of Ca (1000mg/day), P (800mg/day), Fe (8mg/day and Zinc (11mg/day). This is an indication of good source of minerals in a diet.

Proximate Composition of Rice

%Moisture Content: The moisture content of Basmati Rice BR (7.60± 0.00) % was significantly higher than FR (6.80±0.00). (Ebuihi and Oyewole, 2007) reported that the moisture of rice also affects it storage. The values of BR may affect it storage. The values of the rice sample of this study were found to be below the standard reference of 12.9% (USDA, 2010).

% Protein Content: Foreign Rice (FR) had significantly higher crude protein (7.71±0.01) %which is above the standard reference of 6.61%(USDA, 2010).This implies that the cereals are particularly useful in reducing the prevalence of kwashiorkor.

%Crude Fibre: Basmati rice BR (5.00±0.00) % has higher fiber content than Foreign Rice FR (4.38±0.01) %. However, the values obtained for these test diets FR (4.38±0.01) % and BR (5.00±0.00) % fell within the recommended ranges. Fibers are mainly indigestible complex carbohydrates in plant cell wall. They serve as roughages in the gastrointestinal track that enhance smooth stooling.

% Crude Fat: The result of this study for the Foreign Rice (0.8±0.00)% and Basmati rice BR(1.40±0.00) % . The result obtained showed the values are above the standard reference of 0.58% (USDA, 2010). Which show that they can be reach source of dietary fat good for energy.

%Ash Content: Basmati Rice (0.73±0.00) % has higher ash content than FR (0.70±0.00) %. The ash content is an index of mineral contents of food.

%Carbohydrate: FR had significantly ($p<0.05$) higher amount of carbohydrate compared to Basmati Rice .The value of ordinary foreign rice FR (79.46 ± 0.22)% was found to be the higher compare to Basmati Rice (77.45 ± 0.06)%. This result shows that BR (77.45 ± 0.06)%has low carbohydrate content than the ordinary foreign rice FR(79.46 ± 0.22)%. The carbohydrate value of Basmati Rice (BR) could be due to research by R& D department of Amar Singh Chawalwala that produced specially processed parboiled rice with low G.I., Specially techniques during cultivation and processing were employed in order to maintain low glycemic index (G.I) levels. This is to ensure and help rice lovers having diabetes to maintain their low G. I. levels, when used in moderate quantities (Amar Singh, 2018).

Mineral Composition of Rice Samples

Basmati Rice (BR) has significantly ($P<0.05$) higher amount of mineral contents determined compared to the other variety. The sample BR had significantly higher Ca (68.25± 0.01) followed by Fe(27.40± 0.01) and Zn (25.81± 0.01) and least was Pb (0.01± 0.01).In view of the recommended dietary allowance (RDA) for minerals: Ca(1000mg/day), P(800mg/day), Fe(8mg/day and Zinc(11mg/day)all are below the recommended values. This shows that cereals are slow in absorption of trace metals.

For Calcium RI(68.25± 0.01) highest followed by Iron RI(27.40± 0.01) all these minerals with the exception of lead are necessary for physiological development and general well-being of human being and animals. The deficiency of one or more of these mineral elements may constitute nutritional disorder in human.

The statistical analysis for both maize and rice shows that the overall calculated P Values ($P < 0.0001$) is accepted and is statistical significance was true which shows that the moisture contain, crude protein, ash, crude fat, crude fibber and carbohydrate has an accurate standard deviation (SD) and proffer the $P < 0.05$ between mean values of the maize and rice varieties.

IV. CONCLUSION

The results obtained in this research reveal that the maize and rice varieties vary greatly in term of their nutritional and mineral contents. The carbohydrate of Basmati Rice (BR) is lower than that of the Foreign Rice (RF). The Maize from Doka (DM) has low carbohydrate compared to the Maize from Mangu (MM). Therefore BR and DM would be choice food items for diabetic individuals as low carbs. It was observed that the nutritional compositions of the maize samples were higher than that of the rice. This shows that the maize can be a preferred alternative source of low carbohydrate. The rice and maize samples are all rich in minerals (Ca, P, Zn and Fe) with the Basmati rice having higher values. The result showed a very low concentration of lead with Maize from Mangu recording the highest among the samples. The low glycaemic index (G.I) of Basmati Rice, makes it suitable for diabetics. A special technique is used during the cultivation and processing in order to maintain low level of carbohydrate and (glycaemic index G.I). The maize under examination may provide an alternative source of cheap food that has lower in carbohydrate than the rice. The results were compared with certified Standard Reference Material of the United State Department of Agriculture (SRM, USDA) and it revealed that the composition of these cereals, make them preferable for diabetic individuals. Suitable limits of quantification may satisfy the recommended daily dietary allowances of mineral and good source of energy. The nutritional results of this study may be exploited by maize and rice consumers and investing farmers in Nigeria.

V. RECOMMENDATION

Perusing the information on the nutritional contents of the maize and rice varieties and their sources we may recommend that more research using special techniques during cultivation and the processing of their produce in order to maintain the carbohydrate levels of in rice and maize for easy classification of for items. This is important for agricultural investors, and individuals that may require low carbohydrate food and feed stock

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