



## Proximate analysis and mineral compositions of different cereal grain varieties available in Kano state, Nigeria

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### Abstract

Cereals are undoubtedly full of nutrition, but unfortunately the refining process degrades their quality. In this study, the food composition of wheat varieties, sorghum varieties and maize varieties were chemically analyzed using the methods by Association of Analytical Chemist (AOAC). Calcium, Potassium, Magnesium and Zinc in the cereal samples were determined by Microplasma Atomic Emission Spectroscopy, Agilent Technologies 4210 MP-AES, FDGS Innovative Gas Company. The results obtained showed that the available carbohydrate was found in the range of 66.30 -71.38% for wheat varieties with Reyna wheat variety having the highest, whereas in sorghum varieties the carbohydrate ranged between 77.61 -77.98% with Samsorg -45 variety having the highest percentage, similarly the carbohydrate content of maize varieties was found to be in the ranged of 79.16 -82.63% with Evdt -2009 variety having the highest percentage. Attila wheat variety presented the highest protein content (15.59%) and the least was found to be Reyna variety (12.28%) while the highest protein content in sorghum varieties was observed to be with samsorg - 41 (6.92%) while the protein content of maize varieties was found to be in the ranged of (8.25 -9.98%) with smz -39 having the highest. The ash content of wheat varieties ranged from (1.21 -1.60%) with Reyna wheat variety having the maximum while that of sorghum varieties ranged between (1.03 -1.61%) with samsorg -41 having the utmost, for maize varieties the ash content ranged from (1.53 -2.09%) among which smz- 15 having the maximum. Fat and fibre were found to range between (1.71 -1.94%) and (1.4 -1.7%) for wheat varieties with Reyna having the utmost fat content while Attila and Norman B. Varieties were found to have higher fibre contents, similarly the fat and fibre content of sorghum varieties were in the ranged of (2.44 -2.62%) and (1.0 -1.65%) where samsorg -45 and 46 were significantly higher in terms of fat percentage whereas samsorg -46 was observed to have higher fibre content, while for maize varieties the fat and fibre content were in the ranged of (1.06 -2.96%) and (1.45 - 2.92%) with Evdt -2009 having the maximum fat percentage and smz having the highest fibre content. The result of the mineral composition showed that Reyna wheat variety was observed to have the maximum content of potassium, calcium and zinc ( $243.50 \pm 0.0$ ,  $90.25 \pm 0.00$  and  $0.67 \pm 0.00$ ) respectively, as compared to the other counter parts, whereas Attila wheat variety was the best in terms of Magnesium level ( $20.04 \pm 0.00$ ). On the other hand Samsorg -41 sorghum variety was found to have the highest level of potassium, calcium, magnesium and zinc ( $274.48 \pm 0.00$ ,  $194.26 \pm 0.00$ ,  $17.23 \pm 0.00$  and  $0.62 \pm 0.00$ ) respectively. Similarly Evdt -2009 maize variety was obtained to have the highest level of potassium, calcium, magnesium and zinc ( $455.44 \pm 0.00$ ,  $264.49 \pm 0.00$ ,  $21.19 \pm 0.00$  and  $1.44 \pm 0.00$ ) respectively. The results were compared with certified standard reference material (SRM) and revealed that consumption of the cereal varieties at suitable limit of quantification may assure the recommended daily dietary allowances of minerals and a good source of energy.

**Keywords:** food; cereals; varieties; proximate composition; mineral composition

### 1. Introduction

Foods are made up of carbohydrate, protein, fat, vitamins, water and minerals. In their natural form, cereals are rich source of these food components. When cereals are however refined by the removal of the outer covering- bran and germ, the remaining endosperm is mostly carbohydrate and lacks the majority of the other nutrients. The most common grains consumed as cereals include rice, maize, wheat, barley, sorghum, millets and oats.

In Nigeria, the most important cereals are sorghum, millet, rice, maize and wheat and of all these, maize remains the most popularly grown and consumed in all ecological zones of the country (Wudiri B.B, 1991) [25].

Grains in the form of rice, wheat, sorghum, millet, or maize constitute a majority of daily sustenance. The proximate composition of all cereals is similar, yet each one has its special feature. While all the five food substances – water, mineral matter (ash), protein, fat, and carbohydrate – are to

be found in cereals, they occur in different quantities. Some contain large quantities of protein and others practically none. While certain ones have considerable fat, others possess comparatively small quantities. A characteristic of all cereals, however, is that they contain a large amount of carbohydrate and a small amount of water (Woman's Institute, 2007) [24].

Kano State is one of the oldest, wide and fast growing towns in Nigeria that have been affected by so many agricultural products types which are being developed. This study therefore aimed at determining the food composition of the different grains varieties available in this study area. It will therefore provide information on nutritional content of the grains varieties consumed by the people in this area.

### 2. Materials and Methods

#### 2.1 Sample Collection

Three different types of cereals varieties commonly

consumed by the people in the study area: wheat ( Reyna, Atilla and Norman B.), sorghum ( Samsorg -41, samsorg -45 and samsorg -46) and maize ( Smz -15, smz -39 and Evdt -2009) varieties were obtained from Kano state Agricultural and Rural Development Authority ( KNARDA), collected in plastic buckets and transported to the preparation area.

**2.2 Sample Preparation**

Grains varieties were milled into powder with Christy and Norris laboratory mill (Type: 8” lab mill) to pass through a 20 mm sieve.

**2.3 Proximate Composition**

Standard methods by Association of Analytical Chemist (AOAC 2000) were adopted in the analysis. 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 Tecator Digestion System and Kjeltex Auto 1030 Analyzer (Tecator AB, Sweden).

Fat was determined by ether extraction using the Soxtec

System HT method (Tecator Soxtec System HT 1043 Extraction Unit, Tecator AB, Sweden).

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 fibre + %Crude protein).

**2.4 Mineral Composition**

2.0g of the sample was burnt to ashes in a muffle (as in ash determination) the resulting ash was dissolved in 100ml of dilute hydrochloric acid (1ml HCL) in a volumetric flask using distilled water. The digest so obtained was used for the various analyses. The procedure was repeated for all the samples.

Ca, Mg, K, and Zn in cereal samples were determined by Microplasma Atomic Emission Spectroscopy, Agilent Technologies 4210 MP-AES, FDGS Innovative Gas Company, at the Center for Dryland Agriculture Central Laboratory of Bayero University Kano.

**3. Results and Discussion**

**Table 1:** Proximate composition (%) of samples of some cereals varieties available in Kano

Cereals/Varieties	Moisture	Protein	Fat	Ash	CF	CHO
Wheat Varieties						
Reyna	11.40±0.01 <sup>b</sup>	12.28±0.01 <sup>c</sup>	1.94±0.00 <sup>a</sup>	1.60±0.01 <sup>a</sup>	1.4±0.02 <sup>b</sup>	71.38±0.01 <sup>a</sup>
Atilla	13.5 ±0.01 <sup>a</sup>	15.59±0.01 <sup>a</sup>	1.71±0.02 <sup>b</sup>	1.20±0.01 <sup>b</sup>	1.7 ± 0.01 <sup>a</sup>	66.30±0.02 <sup>c</sup>
Norman B.	13.8 ± 0.01 <sup>a</sup>	14.78±0.01 <sup>b</sup>	1.79±0.01 <sup>b</sup>	1.20±0.01 <sup>b</sup>	1.7 ± 0.01 <sup>a</sup>	66.73 ±0.01 <sup>b</sup>
Sorghum Varieties						
Samsorg -41	10.42±0.01 <sup>b</sup>	6.92 ±0.01 <sup>a</sup>	2.44±0.01 <sup>b</sup>	1.61±0.01 <sup>a</sup>	1.00± 0.02 <sup>c</sup>	77.61 ± 0.01 <sup>a</sup>
Samsorg-45	11.30±0.01 <sup>a</sup>	5.56 ±0.01 <sup>b</sup>	2.62±0.02 <sup>a</sup>	1.12±0.01 <sup>b</sup>	1.42 ±0.01 <sup>b</sup>	77.98 ± 0.02 <sup>a</sup>
Samsorg -46	11.45±0.01 <sup>a</sup>	5.58 ±0.01 <sup>b</sup>	2.50±0.00 <sup>a</sup>	1.15±0.01 <sup>b</sup>	1.65 ±0.01 <sup>a</sup>	77.77 ± 0.01 <sup>a</sup>
Maize Varieties						
Smz -15	10.16±0.01 <sup>a</sup>	8.48 ± 0.01 <sup>a</sup>	1.06±0.01 <sup>c</sup>	1.59±0.01 <sup>a</sup>	0.92 ±0.01 <sup>c</sup>	79.26 ± 0.02 <sup>b</sup>
Smz -39	8.29 ± 0.01 <sup>b</sup>	7.25 ± 0.01 <sup>b</sup>	2.35±0.01 <sup>b</sup>	1.03±0.07 <sup>b</sup>	2.42± 0.02 <sup>a</sup>	79.16± 0.02 <sup>b</sup>
Evdt -2009	7.16±0.01 <sup>c</sup>	6.75 ± 0.01 <sup>c</sup>	2.96±0.00 <sup>a</sup>	1.02±0.02 <sup>b</sup>	1.48 ±0.02 <sup>b</sup>	82.63 ± 0.01 <sup>a</sup>
*RV	<5.00	7-15.00	1.00-7.00	<5.00	<3.00	≥64.00

Values reported were average of duplicate analysis \*RV (\*Recommended values) (Wakil S.M and Onilude A.A, 2009). \*\*Proximate parameters: CF = Crude fibre, CHO = Carbohydrate

**Table 2:** Mineral composition (ppm) of samples of some cereals varieties available in Kano

Cereals/Varieties	Ca	K	Mg	Zn
Wheat Varieties				
Reyna	90.25±0.00 <sup>a</sup>	243.50±0.0 <sup>a</sup>	19.27±0.00 <sup>b</sup>	0.67±0.00 <sup>a</sup>
Atilla	63.53 ± 0.00 <sup>a</sup>	155.94±0.00 <sup>c</sup>	20.04±0.00 <sup>a</sup>	0.54±0.00 <sup>b</sup>
Norman B.	88.29±0.00 <sup>b</sup>	207.06±0.00 <sup>b</sup>	17.29±0.00 <sup>b</sup>	0.59±0.00 <sup>b</sup>
Sorghum Varieties				
Samsorg -41	194.26 ± 0.00 <sup>a</sup>	274.48 ± 0.00 <sup>a</sup>	17.23±0.00 <sup>a</sup>	0.62±0.00 <sup>a</sup>
Samsorg-45	180.81 ±0.07 <sup>b</sup>	207.09 ± 0.00 <sup>c</sup>	16.27±0.00 <sup>b</sup>	0.60±0.00 <sup>b</sup>
Samsorg -46	153.72 ± 0.00 <sup>c</sup>	221.33 ±0.00 <sup>b</sup>	14.15±0.00 <sup>c</sup>	0.49±0.00 <sup>c</sup>
Maize Varieties				
Smz -15	95.07 ± 0.00 <sup>c</sup>	217.88 ±0.00 <sup>b</sup>	19.05±0.00 <sup>b</sup>	0.86±0.00 <sup>b</sup>
Smz -39	118.03 ±0.07 <sup>b</sup>	123.40 ± 0.00 <sup>c</sup>	14.15±0.00 <sup>c</sup>	0.64±0.00 <sup>c</sup>
Evdt -2009	264.49 ±0.00 <sup>a</sup>	455.44 ± 0.00 <sup>a</sup>	21.19±0.00 <sup>a</sup>	1.44±0.00 <sup>a</sup>
*RV	60.00	516.00	76.00	≥3.20

Mean ± standard deviation \*(RV) Recommended values \*\*Mineral elements: Ca =Calcium, K= Potassium, Mg = Magnesium, Zn =Zinc

The results of the present investigations on proximate and mineral composition of the cereals varieties were presented in Tables 1 and 2 respectively.

Moisture content of Norman B. and Atilla varieties were recorded to have the highest content (13.8 ± 0.01<sup>a</sup> and 13.5± 0.01<sup>a</sup>) followed by Reyna variety (11.40±0.01<sup>b</sup>) These

values are within the range reported by other investigators (Ghavidel R.A and Prakash J.2007; Rasha M.K,*et al.*, 2011; Amagloh F.K *et al.*, 2013) <sup>[10, 19, 4]</sup> However, investigations have shown that low moisture content of food samples is a desirable phenomenon, since the microbial activity is reduced. (Oyenuga V.A 2013) <sup>[17]</sup>. Low moisture content in

food samples increased the storage period of the food products. (Alozie Y, *et al.*, 2009) <sup>[3]</sup>; while high moisture content in foods encourage microbial growth; hence, food spoilage occur (Temple VJ *et al.*, 1996) <sup>[21]</sup>.

Protein being the body building nutrient was found to be the highest in Attila (15.59±0.01<sup>a</sup>) followed by Norman B. and the least was found to be Reyna variety, (14.78±0.01<sup>b</sup> and 12.28±0.01<sup>c</sup>), respectively.

The highest ash content as observed in the current study was Reyna variety (1.60± 0.01) and this result is supported by (Pandhare R.B *et al.*, 2011) <sup>[18]</sup> who indicated that ash content of raw wheat is 1.43 ± 0.02.

Similarly the fat content ranged between (1.51 - 1.94) with Reyna variety having the highest percentage whereas crude fibre were between the ranged ( 1.35 -1.7) were Attila and Norman found to contain the highest percentage which are all in accordance with what is reported by (Kavitha and Parimalavalli, 2014) <sup>[14]</sup>.

Carbohydrates are the major food component of the grains. It was found in the range of (66.30 ± 0.00 -71.38± 0.00) with Reyna wheat variety having the highest percentage.

The proximate composition of sorghum varieties were also presented in table 1. Ash content is an indication of the mineral content of a sample. Ash content of a sample cultured in 3 different varieties was found in the ranged between (1.03 ± 0.00 – 1.61± 0.00) with samsorg -41 having the highest peresntage, Mustapha and Magdi (2003) <sup>[15]</sup> reported the ash content of 1.90% - 1.97% which is within the range obtained in this study but Abu *et al.*, (2001) <sup>[2]</sup> reported ash content of 1.0 - 1.5 which also agrees with the result obtained in this work.

The highest moisture content value was recorded with Samsorg -46 (11.45 ± 0.01), followed by Samsorg -45 (11.30 ± 0.01) and the least was observed to be Samsorg -41 (10.42 ± 0.01) varieties which is slightly higher than what is in the literature value reported by Mustapha and Magdi (2003) <sup>[15]</sup> 8.33 - 8.58.

The fat content ranging from (2.44 - 2.62) with samsorg -45 and 46 having the highest fat content and the present study is similar to what is in literature reported by Abu *et al.*, (2001) <sup>[2]</sup> 2.22 - 3.65.

On the other hand the protein content was in the ranged of (5.56 - 6.92) which is relatively lower than that obtained with the works of (Elfadil and Babiker, 2009) <sup>[9]</sup> protein contents 9.50. The variations in protein content of the various varieties are primarily due to the nature and deficiency of essential elements required for plant life (Arnon, 1995) <sup>[5]</sup>.

Similarly the carbohydrates content was recorded in the ranged of (77.61 – 77.98) which is similar to what is reported by (Abdulrahman W.F and Omoniyi A.O, 2016) <sup>[1]</sup> and thus there was a slight significant difference in terms of carbohydrates (starch) content between all the varieties.

The proximate composition of maize varieties were also shown in table 1. Where the moisture content of maize varieties ranged from (7.16 - 10.16) but smz -15 was observed to have higher moisture content as compared to other varieties and this findings is closer to that reported by (Ndukwe, 2015) <sup>[16]</sup> 9.85-11.35.

The highest ash content was recorded with smz -15 (2.09) while the least was smz -39 (1.53) this is in agreement with the findings of (Ndukwe, 2015) <sup>[16]</sup> 1.96-2.18, while the protein content was found to be higher in smz -39 variety (9.98) and the least was observed to be Evdt -2009 (8.25)

This result is also in agreement with the findings of (Saleem *et al* 2008; Idikut *et al.*, 2009; Berardo *et al.*, 2009). Ijabadeniyi and Adebolu, (2005) <sup>[20, 11, 7, 12]</sup> found the % protein content of three maize varieties grown in Nigeria in the range of 7.71 – 14.60 for the maize grains. In the literature some authors reported protein contents in maize hybrids from 7.77 to 13.84 (Jiang *et al.*, 2007) <sup>[13]</sup>.

Similarly the highest crude fibre content was recorded smz -39 (2.92) and the least was smz -15 (1.45) the present findings was similar to that reported by Ijabadeniyi and Adebolu (2005) <sup>[12]</sup> 2.07-2.77. The variation of the crude fibre content has been well demonstrated by numerous studies. The highest fat content was Evdt -2009 (2.96) and this is lower than the findings of, Ijabadeniyi and Adebolu (2005) <sup>[12]</sup> that found higher fat content in the range 4.17 – 5.0.

On the other hand the highest carbohydrate was found to be significantly higher in Evdt -2009 (82.63) whereas Ullah *et al.* (2010) <sup>[22]</sup> reported percent carbohydrate was found in the range of 69.659%-74.549% which is in close agreement with the present study.

Table 2 present the mineral composition of cereal grain cultivars/varieties. The macro elements were observed to be in order of K > Ca > Mg. The highest Ca and K was recorded to be with Reyna wheat variety (90.25 mg/1000g, 243.50 mg/1000g) followed by Norman B. wheat variety (88.29 mg/1000g and 207.06 mg/1000g) respectively. Similarly Attila variety was found to have higher in Mg content (20.0 mg/1000g) followed by Reyna variety (19.27 mg/1000g). On the other hand Reyna wheat variety was observed to have the highest micro element Zn (0.67 mg/1000g) followed by Norman B. (0.59 mg/1000g). These vital/ macro elements were abundantly higher in Reyna and Norman B. wheat varieties as compared to Attila wheat variety which was observed to have a relatively higher Mg content. However, the result of this study revealed that the varieties were significantly lower in terms of this macro elements than that reported by (Abdulrahman W.F and Omoniyi A.O, 2016) <sup>[1]</sup> and the RV(recommended value) except Ca which was significantly higher in the present study.

Another nutritional highlight is the mineral composition of the sorghum cultivars/varieties that is also shown in table 2 The analysis shows the highest level of Ca, K, Mg and Zn were with samsorg 41 Variety having (194.26 mg/1000g, 274.48 mg/1000g, 17.22 mg/1000g and 0.62 mg/100 g) respectively, the result obtained in this study were relatively lower than the findings of (Abdulrahman W.F and Omoniyi A.O, 2016) <sup>[1]</sup> as well as the recommended value as reported in their work. Potassium helps maintain fluid balance, and high intake improves blood pressure, according to the American Heart Association (Corleone J. 2011) <sup>[8]</sup>. Thus, the variation/differences in the mineral composition could be due to genetic factors or environmental factors like irrigation frequency, soil composition and fertilizer used. (Abdulrahman W.F and Omoniyi A.O, 2016) <sup>[1]</sup>.

The mineral composition of maize cultivars/varieties were also been investigated and is shown in table 2. Among the varieties used in this study Evdt -2009 variety was found to be higher in all the macro elements Ca, K and Mg (264.49 mg/1000g, 455 mg/1000g and 21.19 mg/1000g) and therefore these elements are abundantly attached to this particular variety as compared to others which were significantly lower, the present findings indicated that the

levels of Ca and K were apparently higher than the literature reported by (Abdulrahman W.F and Omoniyi A.O, 2016; Ndukwe, 2015) <sup>[1, 16]</sup>, while Mg and Zn (1.44 mg/1000g) is closer to the findings of (Abdulrahman W.F and Omoniyi A.O, 2016) <sup>[1]</sup>.

#### 4. Conclusion

This study investigated the proximate composition and mineral attributes of different varieties of cereal grains available in Kano State. From the results obtained, Attila wheat variety was ranked best in terms of protein and crude fiber whereas Reyna wheat variety was the best in terms of fat, carbohydrate and Ash as such Reyna wheat variety was observed to have the highest mineral contents. Similarly samsorg -41 sorghum variety was ranked most excellent in terms of protein, carbohydrates and ash as such contain a highest mineral content, samsorg -45 and samsorg -46 were found to have the highest fat content but the former was also good in carbohydrates were the later was ranked best in terms of crude fibre. The result for mineral varieties shows that smz -15 maize variety was the best in term of protein and ash content which was also an indication of high mineral content, smz -39 maize variety was only found to be good in crude fibre whereas Evdt -2009 maize variety was ranked best in terms of fat and carbohydrates contents. Among all the cereals used in this study wheat was ranked best in terms of protein content being the body building nutrient followed by maize while sorghum was the lowest. One remarkable finding from this study was the result found for Calcium and Potassium in the samples. It indicates that all cereals analyzed had higher Potassium and calcium concentration which are among the essential macro minerals needed for normal functioning of the body.

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