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Comparative Proximate Composition of Some Maize (*Zea mays* L.) Varieties Grown in Northern Nigeria

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ABSTRACT

Maize, a versatile and widely cultivated cereal, encompasses numerous varieties grown worldwide. This study focused on 23 prominent varieties cultivated in Northern Nigeria, selected for their widespread availability, to investigate their proximate composition. The composition of the nutrients varied across the varieties; % crude moisture was significantly higher in BA-01 (11.25 %), NA-03 had a significantly higher % ash content of 3.64 %, % crude Fat ranged from 2.30% – 4.47 %, BA-03 had a significantly low % crude fibre of 10.06 %, KD-04 recorded the highest fibre content of (3.61 %) , while BA-03 had a significantly higher % carbohydrate content of 78.15%. Knowledge of the levels of nutrients present in the different varieties will help in choosing the variety that can suit any intended purpose.

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INTRODUCTION

Maize, a member of the Poaceae family, ranks as the third most significant cereal crop following wheat and rice (PARC, 2013), it is a staple food in many countries around the world (Shah *et al.,* 2016). This versatile crop serves as a fundamental ingredient in various food products, either in its natural or processed form. Maize grains boast a rich nutritional profile, comprising 72% starch, 17% ash, 10.4% protein, 2.5% fiber, and 4.8% oil, as well as essential vitamins and minerals (Farhad *et al.,* 2009). Notably, the oil and protein extracted from maize are highly valued for their commercial applications in food manufacturing (Paliwal, 2000; Hobbs, 2003).

The successful domestication and diversification of maize by indigenous farmers stands as a landmark accomplishment in plant breeding. Historical evidence reveals that maize was initially cultivated in Mexico and Central America (Singh & Kumar, 2016). Due to its exceptional genetic yield potential, maize is globally revered as the "queen of cereals." Its significance extends beyond being a staple food, as it also plays a crucial role in various industrial applications, including the production of high fructose corn syrup (Shah et al., 2016).

In Nigeria, maize ranks as the second most vital cereal crop, closely following sorghum. This versatile crop serves multiple purposes, including providing sustenance and energy for humans, serving as livestock feed, and offering raw materials for various industrial applications, (Dei,2017).

Maize grains are a nutrient-rich food source that can be transformed into a diverse array of products, including cornmeal, grits, starch, flour, tortillas, snack foods, and breakfast cereals, offering a wide range of culinary and industrial applications, Hossain *et al.,* (2016).

Maize offers multiple preparation options, such as boiling, roasting, frying, and popping,(Ape *et al.,* 2016) and its nutritional profile has been extensively studied, showcasing a wealth of beneficial nutrients, including carbohydrates, proteins, macro elements, minerals, vitamins, and phytochemicals, highlighting its value as a wholesome food.

Despite its importance, there is a lack of research comparing the nutritional content of various maize varieties in southwestern Nigeria. This study seeks to address this gap by analyzing the proximate composition of different maize varieties cultivated in this region. By identifying the variations in nutritional content, this research aims to inform the selection of the most suitable maize variety for both human and animal nutrition.

MATERIALS AND METHODS

Sample Collection

Twenty-three different maize varieties used for this study were purchased from Maize cultivated local governments areas from each state in collaboration with the Agric development project officers.

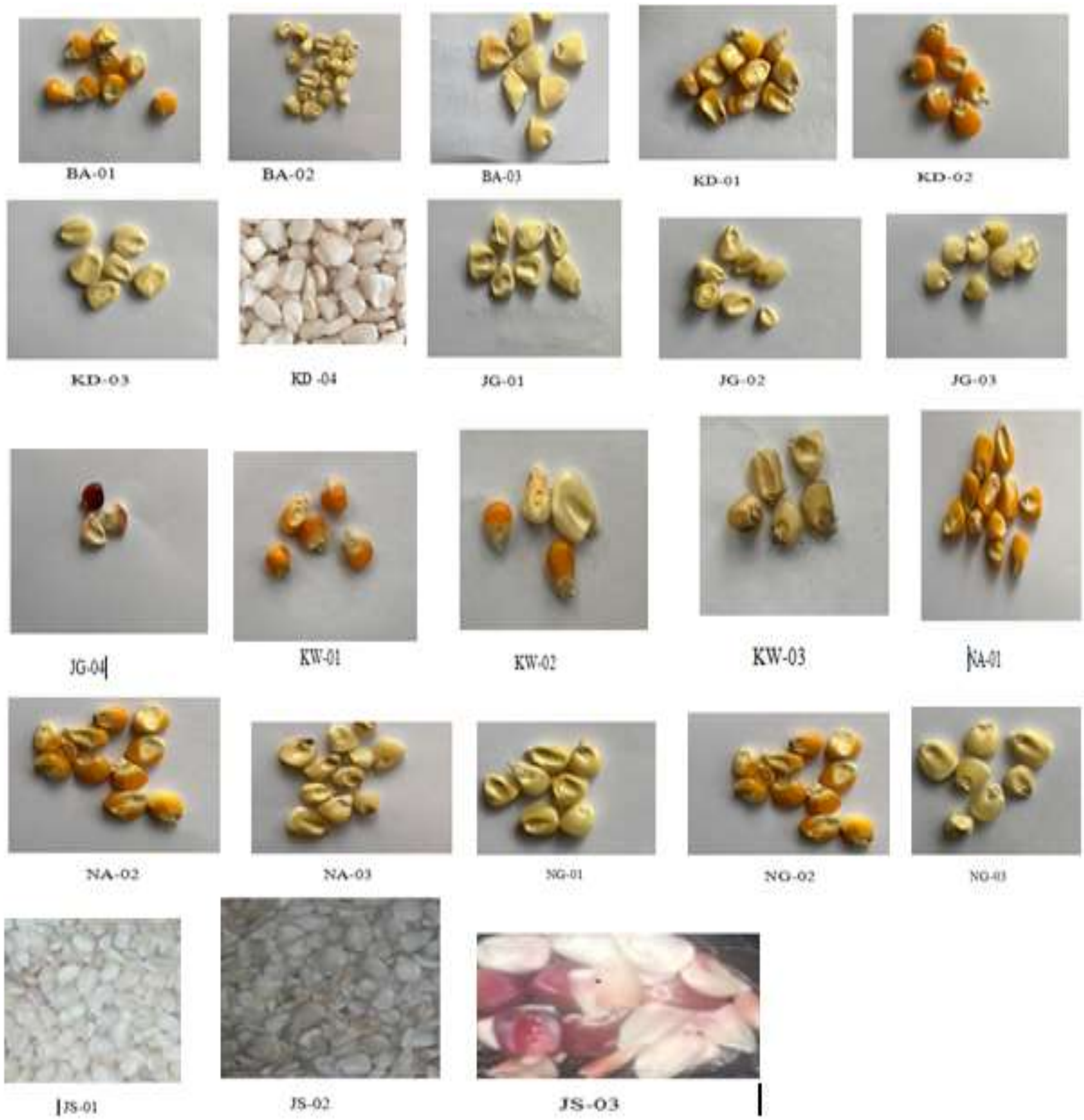

Plate I: Variations in seed color of the different Maize accessions

Determination of Moisture Content

Moisture content is a critical factor in food analysis, serving two primary purposes: determining the chemical composition of food on a dry basis and predicting the product's shelf life. To measure moisture content, a 10g sample was placed in a pre-dried and weighed petri dish. The dish was then weighed at regular intervals until the weight remained constant, indicating the removal of all moisture. The moisture percentage was subsequently calculated using the formula:

$$\text{Moisture \%} = \frac{\text{loss in weight after drying}}{\text{Initial samples weight}} \times 100$$

Determination of Ash Content

The ash content of food represents the inorganic residue remaining after the combustion of organic matter, serving as an indicator of the total mineral content. To estimate total ash, a 5g moisture-free sample was placed in a pre-heated, cooled, and weighed crucible. The sample was first charred on a hot plate, then incinerated in a muffle furnace at 600°C for 5 hours. After cooling in a desiccator, the crucible was weighed. This process was repeated until the resulting ash was light-colored (white or greyish) and had a constant weight. The ash content was then calculated using the following formula:

$$\text{Ash percentage} = \frac{\text{Weight of Ash}}{\text{1g (oven – dry weight)}} \times 100$$

Determination of Fat Content

The fat content of the maize samples was estimated as crude ether extract of moisture free samples using the Soxhlet's Extraction Method on SocsPlus System. A thimble was filled with a weighed amount of moisture-free sample (5 g) and placed in the thimble holder, which was placed in an already weighed beaker, and 80 ml petroleum ether (60-80 °C) was poured into the beaker. The system was loaded with beakers, and the temperature was set to 100 °C. After 120 minutes of operation, the temperature was raised to the recovery temperature, which was twice the initial boiling temperature.

Determination of Protein Content:

The protein content of the samples was determined by analyzing their nitrogen content using the Micro Kjeldahl Method. The protein content was calculated by multiplying the nitrogen content by a conversion factor of 6.25. The analysis involved digesting 300mg of moisture-free sample with a mixture of 3g K2SO4 and CuSO4 (5:1 ratio) and 10ml of concentrated H2SO4, until the solution clarified. The digested sample was then diluted with 50ml of distilled water and made alkaline with 40ml of 40% NaOH. The liberated ammonia was collected in a 250ml conical flask containing 25ml of 4% boric acid and two drops of indicator, and subsequently titrated with 0.1N HCl. The nitrogen content was calculated using the following formula:

% Nitrogen (wet) = (A-B) x 1.4007 x 100 / weight (g) of sample

Where:

- A = vol. (mL) std. HCl x normality of std. HCl
- B = vol. (mL) std. NaOH x normality of std. NaOH

Nitrogen content on dry basis was calculated (when moisture content is known) as follows:
% Nitrogen (dry) = % Nitrogen (wet) x 100 / (100 - % moisture)

Calculate the percentage protein (wet or dry basis) as follows:

% PROTEIN = % nitrogen x 6.25

Where 6.25 is the protein-nitrogen conversion factor.

Determination of Fibre Content:

The acid-alkali digestion method was employed to determine the fibre content, which consists of insoluble vegetable matter resistant to proteolytic and diastatic enzymes, but can be broken down through microbial fermentation. Fibre is primarily composed of cellulose, hemicelluloses, and lignin. To estimate crude fibre, a 3g moisture- and fat-free sample was boiled in a 500ml beaker with 200ml of 1.25% sulphuric acid for 30 minutes, maintaining a constant volume by adding hot distilled water. The mixture was then filtered through muslin cloth, and the residue was rinsed with hot distilled water until acid-free. The residue was subsequently boiled with 200ml of 1.25% sodium hydroxide solution for 30 minutes, filtered, and rinsed with hot distilled water until alkali-free, followed by washing with 50ml of alcohol and ether. The residue was then dried in an oven at 130°C for 2-3 hours, cooled, and weighed (W2). The dried residue was ignited in a muffle furnace at 600°C for 2-3 hours, cooled, and weighed again (W3). The crude fibre content was calculated using the following formula:

% Crude fiber = (W2 – W3) x 100 / W3

Determination of Carbohydrate:

The total carbohydrate content was determined by subtracting the combined percentage of crude protein, fat, ash, and crude fibre from 100%. This calculation is based on the principle that the sum of all nutritional components in a food sample should equal 100%. The formula used to calculate total carbohydrates is:
100 - (% Crude Protein + % Fat + % Ash + % Crude Fibre)

Determination of Mineral Content

The mineral composition was determined using the method described by Onwuka (2005).

Table 1: Sources and Description of Maize Germplasm collected for the Study.

S/N	Accessions	Local Name	State	Local Govt Area	Seed Colour
1	BA-01	Masara	BAUCHI	Tafawa-Balewa	Light Red
2	BA-02	Masara	BAUCHI	Jemaare	White
3	BA-03	Masara	BAUCHI	Ningi	White
4	KD-01	Masara	KADUNA	Lere	Witish-Red
5	KD-02	Masara	KADUNA	Jemaa	Red
6	KD-03	Masara	KADUNA	Igabi	White
7	KD-04	Masara	KADUNA	Zaria	White
8	JG-01	Masara	JIGAWA	Dutse	White
9	JG-02	Masara	JIGAWA	Kiyawa	White
10	JG-03	Masara	JIGAWA	Birnin-kudu	White
11	JG-04	Masara	JIGAWA	Hadejia	Purple
12	KW-01	kaba	KWARA	Kaiama	White
13	KW-02	Abgado	KWARA	Patigi	White
14	KW-03	Abgado	KWARA	Edu	Red
15	NA-01	Masara	NASSARAWA	Doma	Light Red
16	NA-02	Masara	NASSARAWA	Toto	Light Red
17	NA-03	Masara	NASSARAWA	Akwanga	White
18	NG-01	Kaba	NIGER	Kagara	White
19	NG-02	Masara	NIGER	Mariga	Red
20	NG-03	Masara	NIGER	Zungeru	White
21	JS-01	Masara	PLATEAU	Barikin-ladi	White
22	JS-02	Masara	PLATEAU	Bokkos	White
23	JS-03	Masara	PLATEAU	Mangu	Purple

Table 2: Proximate Composition of the studied maize landraces

Parameter	Moisture	Ash	Fat	Protein	Fibre	Carbohydrate
NA-01	8.63±0.01m	2.38±0.02h	3.87±0.01hi	13.28±0.01n	3.38±0.00o	68.57±0.03h
NG-02	10.17±0.03o	1.97±0.01d	3.15±0.01de	11.16±0.01d	2.73±0.02h	70.83±0.01l
JG-04	7.67±0.00i	3.17±0.01l	4.46±0.01j	15.63±0.01s	3.19±0.01lm	65.93±0.01c
JS-01	7.46±0.00h	2.06±0.01e	2.87±0.01bcd	10.43±0.01b	3.28±0.03n	73.88±0.01t
BA-02	7.93±0.01j	3.12±0.00k	3.77±0.01h	14.30±0.00q	3.23±0.01mn	67.73±0.02g
KW-03	10.28±0.03p	2.16±0.01f	3.06±0.03cde	11.37±0.01e	1.95±0.03b	71.16±0.01m
KD-01	6.80±0.01e	3.17±0.03l	4.46±0.00j	13.40±0.00p	2.97±0.01k	69.25±0.02i
NA-02	6.56±0.01d	3.26±0.01m	4.28±0.03j	13.19±0.01m	2.82±0.02i	69.94±0.03j
NG-03	7.19±0.01g	2.85±0.00j	3.67±0.01gh	11.86±0.00h	2.35±0.01e	72.15±0.01o
JG-01	8.17±0.03k	2.37±0.01g	3.79±0.00hi	14.62±0.02r	3.50±0.03p	67.64±0.01f
JS-02	6.83±0.03ef	1.77±0.01b	2.85±0.01bcd	11.93±0.01i	1.73±0.02a	75.87±0.01u
BA-03	5.55±0.01c	1.85±0.01c	2.67±0.01b	10.06±0.03a	1.95±0.01b	78.15±0.01x
KW-01	8.25±0.01l	2.22±0.00g	3.27±0.01ef	12.17±0.01j	2.28±0.03d	71.94±0.01n
KD-02	6.87±0.01f	1.99±0.00d	3.19±0.01de	11.61±0.03g	3.61±0.03q	72.83±0.03q
NA-03	10.24±0.01p	3.64±0.00n	4.47±0.01j	16.39±0.01v	3.20±0.01lm	62.15±0.02a
NG-01	5.46±0.01b	2.14±0.01f	3.88±0.01hi	13.06±0.03l	2.51±0.03g	73.16±0.04s
JG-02	7.68±0.01i	1.59±0.02a	2.30±0.06a	10.53±0.02c	1.74±0.01a	76.39±0.01v
JS-03	7.95±0.01j	1.99±0.01d	3.60±0.03fgh	12.27±0.01k	1.97±0.01b	72.28±0.01p
BA-01	11.25±0.02q	2.45±0.01i	4.39±0.01j	15.96±0.01t	3.27±0.03n	62.82±0.01b
KD-02	8.97±0.01n	2.20±0.01g	4.17±0.01ij	14.60±0.01r	2.90±0.01j	67.28±0.00e
KD-03	6.57±0.01d	3.24±0.01m	3.35±0.58efg	16.18±0.03u	3.17±0.01l	66.58±0.01d
JG-03	5.38±0.02a	1.80±0.01b	2.76±0.02bc	11.53±0.02f	2.17±0.03c	76.56±0.01w
KD-04	7.91±0.02j	2.36±0.02h	3.86±0.01hi	13.34±0.02o	2.46±0.00f	70.20±0.01k
Total	7.81±0.19	2.42±0.07	3.57±0.08	12.99±0.23	2.71±0.07	70.58±0.50

Values are Mean±Standard Error of Mean. Means with the same letter(s) within a set of treatment column are not significantly different at $p \leq 0.05$ using Duncan Tests

DISCUSSION

Determining the proximate composition of various maize varieties is crucial for identifying those rich in essential nutrients necessary for human and animal growth. The moisture content of food holds significant economic value for both processors and consumers, as it inversely affects the dry matter content. Moreover, moisture content impacts food stability and quality. Grains with high moisture content are prone to rapid deterioration due to mold growth, insect damage, and other factors, Suleiman *et al.,* (2013).

The moisture content of the maize varieties analyzed in this study ranged from 5.38±0.02 % to 11.25±0.02 %. Notably, this range exceeds the moisture content of 11.10 % reported by Adeniyi *et al.,* (2019) for maize samples purchased from south western Nigeria. The variation recorded might be as a result of differences in Environmental factors.

Crude fat is a vital constituent of maize grains, and enhancing its content contributes significantly to human well-being, Reboul,(2017), The Percentage crude fat of the twenty-three analyzed maize landraces which ranged from 2.3±0.06% –4.28±0.00% is slightly similar to 4.07±0.02 as reported by Okonkwo and Agharandu, (2017) in a study of proximate composition on some cereal crops in south eastern Nigeria.

Proteins serve as a vital source of amino acids, which are essential for building and maintaining bodily tissues, Olufunso *et al.,* (2019). Additionally, proteins can provide energy when necessary. They also play a crucial role in producing nitrogen-containing compounds, such as antibodies and enzymes, which are vital for maintaining normal bodily functions. The 10.06 % -13.34 % protein observed in this study is analogous to the protein content (10.79 %) as reported Okonkwo and Agharandu, (2017) in a study on Proximate and Vitamin Composition of Selected Cereals in South-Eastern Nigeria.

The result of crude fibre of the analyzed maize landraces ranged from 1.7 % -3.38 %, this is higher than the 0.8 %-1.7 % value reported Olufunsho *et al,* 2019 in their study on Comparative Proximate Composition of Maize (*Zea mays* L.) varieties grown in South-western Nigeria. Dietary fibre, primarily composed of cellulose and hemicellulose, exerts beneficial effects on human health by enhancing water retention capacity during gastrointestinal transit. (Roboul *et al.,* 2017). A diet rich in crude fibre is considered salubrious, as it facilitates the production of bulkier, softer stools.

Maize is an excellent source of carbohydrates, providing energy for the body while facilitating the metabolic utilization of fats. Additionally, maize aids in maintaining a healthy intestinal tract, supporting overall digestive function. Percentage carbohydrate content of analyzed maize varieties were observed to fall between 62.15 % and 78.15 %. This is in accordance with the results reported by Ape *et al.,* 2016 in study in comparative Proximate Analysis of Maize and Sorghum in Enugu State, Nigeria.

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