

Physico-Chemical Characterization of Some Nigerians' Sorghum Grain Varieties

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Abstract

The physico-chemical characteristics of nine (9) sorghum grain varieties (*Borno kamouanza*, *Chakalari red*, *Chakalari white*, *Jigari*, *Masakwa adjama*, *Masakwa bulwalana*, *Masakwa burku* and *Masakwa tumbuna*) from Nigeria, Borno State, Maiduguri, were investigated. The impurities of the grain were determined using the method described by [1], whereas the grains dimensions, weight, volume and density were carried out following the procedure of [2]. The hardness determination followed the procedure described by [3] and the tannin content that of [4]. Results showed that *Chakalari white* had the lowest impurity, the highest density and the whitest grains. It also had the hardest grains and low tannin content; therefore, was the sorghum grain variety highly recommended for food processing.

Keywords: Sorghum; Grain; Variety; Characterization; Nigeria

Introduction

Increasing concern about rising food cost combined with world food shortages, demand that closer attention be given to the usefulness of indigenous food sources as well as re-evaluation of the ways in which such foods are used [5]. Sorghum (*Sorghum bicolor* L. Moench) because of its abundance is recommended to be considered in that process. Therefore, the objectives of the current study were:

1. To investigate the Physico-chemical characteristics of nine (9) Nigerians' sorghum grain varieties *Borno kamouanza*, *Chakalari red*, *Chakalari white*, *Jigari*, *Masakwa adjama*, *Masakwa bulwalana*, *Masakwa burku* and *Masakwa tumbuna* and
2. To recommend to the community the best varieties appropriate for processing traditional foods.

Materials and Methods

Materials

The nine sorghum grain varieties investigated in the current study were obtained from Maiduguri Monday Market. They included *Borno kamouanza*, *Chakalari red*, *Chakalari white*, *Jigari*, *Masakwa adjama*, *Masakwa bulwalana*, *Masakwa burku* and *Masakwa tumbuna*. Other materials used were, a metal tray, a locally made sieve and a woven thresh for grains cleaning. A screw gauge micrometer was used for grain dimensions' determination. An analytical balance (B1154 Metler Teledo College Switzerland) and a 50 ml graduated cylinder were utilized for determining the 1000 grain weight and volume, respectively. The grain hardness was determined using a razor blade and a piece of rubber gum. For the tannin determination, Sodium Hydroxide, a bleach (3.50 % Sodium Hypochlorite), were utilized.

Methods

Impurity Determination

Hundred (100.00) g of each of the 9 sorghum grain varieties aforementioned were weighed. The grains were cleaned manually using a metal tray, a locally made sieve of 2.00 mm diameter and a woven thresh to remove the stones, broken and immature grains and sand. The impurities were weighed and the percentage of impurities calculated using the formula below. [1]

$$\% \text{ impurities} = (\text{weight of impurities} / \text{weight of grains before cleaning}) \times 100.00$$

Dimensions Determination

Ten clean kernels from each of the 9 sorghum varieties previously mentioned were counted, the length and width measured using a micrometer screw gauge. The results were recorded in duplicate and the mean values reported [2].

Grain Weight

One hundred kernel of each of the nine sorghum varieties were counted manually and weighed on an analytical balance (B1154 Metler Teledo College Switzerland). The values obtained were multiplied by ten. This was carried out in duplicate and the average taken and reported as the results [2].

1000 Grain Volume

The sampled 100.00 kernel weighed was transferred into a measuring cylinder containing a known volume of water. There was displacement in volume due to space occupied by the grains. The difference between the final and the initial volumes was taken and multiplied by ten. This was carried out in duplicate and the average was reported as the volume of 1000 kernel grains. This method is based on Archimedes principle [2].

1000 Grain Density

The densities of the different sorghum grain varieties were determined following the method described by [2]. The volume and mass obtained from each of the 1000 kernel were used to calculate the density of each of the variety.

$$\text{Density (g/ml)} = \text{Mass} / \text{Volume}$$

Hardness Determination

Twenty wholesome sorghum grains were cut, one half of each examined and the grain classified as hard, medium or soft as followed [3]. A small piece of 'rubber gum' was pressed onto the cutting surface and a clean sorghum grain, germ side, was pushed into the piece of rubber gum to hold it in place. The germ side is characterized by a circular indentation at the end of the grain which was held with a forceps and cut into two length-wise to obtain two even halves. Each half of the grain contained an equal portion of the germ. A sorghum grain, the endosperm of which was totally corneous (translucent or most translucent), was classified as hard. A medium grain had a continuous corneous endosperm but its inner flour endosperm, which is chalky in appearance, is less than 50.00%. A soft sorghum grain had an endosperm totally floury or the outer corneous endosperm very narrow and incomplete.

Color Determination

The color of the sorghum grain was determined following the procedure described by [4], in which 100.00 intact grains without glumes were counted and spread evenly over the surface of sheets of paper so that none of the grains were touching each. The grains were examined and counted as white or colored surface irrespective of whether the grain was "weathered" i.e. showed signs of mold on its surface. A colored grain was colored yellow, pink, red, brown or purple or a combination of these colors all over its surface. The test was carried out in duplicate and average result was obtained and expressed as white or colored grain.

Tannin Determination

The tannin content of sorghum varieties was determined using the procedure described by [4]. One hundred (100.00) clean grains were counted manually and soaked for 20.00 min in a reagent composed of 5.00 g of Sodium Hydroxide diluted in 100.00 ml of a bleach (3.50 Sodium Hypochlorite), at room temperature, 38.00o C. The grains were drained into a cooking strainer and rinsed with distilled water. They were spread on a paper towel in such a way that they do not touch each other. The grains were thereafter blotted dry using a second tissue paper towel. The tannin grains were considered as those colored black all over their surface except the germ side. The non-tannin grains were either white or brown in some parts of their surface. The percentage of tannin, non-tannin and mixed tannin and

non-tannin sorghum was determined by counting the number of the aforementioned grains out of the original 100.00 grains. A variety was considered as tannin or non-tannin whenever the number of black grains or white, partially brown grains, exceeded or equaled to 95.00%, respectively. Whenever, a treated variety contained both tannin and non-tannin grains, it was termed mixed and the level of tannin was stated; for example, 24.00% tannin.

Statistical Analysis

The statistical analysis was carried out using the Statistics Package for Social Sciences (SPSS) version 16. All the values expressed in percentage were obtained using the frequencies under the descriptive statistics. The means, their standard deviations, and differences significance, were computed through the independent samples T-test for the physical characterization of the 9 sorghum varieties and the paired samples T-test for danwake characterization. The significance of the assessment was set at 5.00%.

Results and Discussions

Physical Characterization of Sorghum Grains

The level of impurities, the length, width, color, 1000 grains weight, volume and density of the sorghum grain varieties investigated are presented in (Table 1).

Grain Variety	Kernel Impurity (%)	Kernel Dimensions (mm)		Kernel Color		1000 Grains Weight (g)	1000 Grains Volume (ml)	1000 Grains Density (g/ml)
		Length	Width	White (%)	Colored (%)			
<i>Borno kamouanza</i>	4.64 ^f	4.47 ^c	3.25 ^c	93.00 ^c	7.00 ^d	55.50 ^a	87.50 ^a	6.35 ^c
<i>Chakalari red</i>	6.76 ^d	4.20 ^c	3.19 ^c	0.00 ^f	100.00 ^a	33.50 ^f	48.50 ^f	6.90 ^b
<i>Chakalari white</i>	3.80 ^g	4.31 ^c	3.21 ^c	100.00 ^a	0.00 ^f	37.00 ^d	50.00 ^d	7.40 ^a
<i>Jigari</i>	17.36 ^a	4.30 ^c	3.24 ^c	0.00 ^f	100.00 ^a	21.00 ⁱ	37.00 ^g	5.65 ^e
<i>Kaura</i>	9.61 ^b	4.21 ^c	3.20 ^c	0.00 ^f	100.00 ^a	26.50 ^h	48.50 ^f	5.45 ^f
<i>Masakwa adjama</i>	5.03 ^e	5.19 ^b	4.34 ^a	0.00 ^f	100.00 ^a	49.00 ^c	85.00 ^b	5.75 ^e
<i>Masakwa bulwalana</i>	4.40 ^f	5.17 ^b	4.25 ^a	97.00 ^b	3.00 ^e	35.50 ^e	49.50 ^e	7.15 ^a
<i>Masakwa burku</i>	5.22 ^e	5.23 ^b	4.16 ^a	10.50 ^e	89.50 ^b	49.00 ^c	84.00 ^c	5.50 ^e
<i>Masakwa tumbuna</i>	8.25 ^c	4.99 ^b	3.76 ^b	48.00 ^d	52.00 ^c	50.50 ^b	85.00 ^b	5.95 ^d

Table 1: Some Physical Properties of Sorghum Grains.

Values are means of two determinations and those not followed by the same superscripts are significantly ($p < 0.05$) different.

Chakalari red, and *Kaura* were found hard grains at 65.00, 60.00 and 49.00%, respectively. *Jigari* was reported as soft variety at 74.50% whereas, *Masakwa tumbuna*, *Masakwa burku*, *Masakwa bulwalana* and *Masakwa adjama*, were considered as medium hard grains at 65.00, 55.00, 53.00 and 51.00 %, respectively.

Sorghum Grain Variety	Corneous/ Hard Grain (%)	Medium Hard Grain (%)	Soft Grain (%)
<i>Borno kamouanza</i>	35.00 ± 2.45	50.00 ± 2.00	15.00 ± 1.10
<i>Chakalari red</i>	55.00 ± 2.55	30.00 ± 1.88	15.00 ± 1.10
<i>Chakalari white</i>	60.00 ± 2.51	35.00 ± 1.96	5.00 ± 0.67
<i>Jigari</i>	0.00 ± 0.00	30.00 ± 1.88	70.00 ± 1.41
<i>Kaura</i>	50.00 ± 2.56	35.00 ± 1.96	15.00 ± 1.10
<i>Masakwa adjama</i>	30.00 ± 2.35	50.00 ± 2.05	20.00 ± 1.23
<i>Masakwa bulwalana</i>	35.00 ± 2.45	55.00 ± 2.04	10.00 ± 0.92
<i>Masakwa burku</i>	20.00 ± 2.05	55.00 ± 2.04	25.00 ± 1.33
<i>Masakwa tumbuna</i>	25.00 ± 2.22	60.00 ± 2.01	15.00 ± 1.10

Table 2: Hardness of Sorghum Grain Varieties.

Values are means of two determinations.

Chemical Characterization of Sorghum Grains

Tannin Content of Sorghum Grains

The results of the tannin content of sorghum varieties are given in (Table 3). As the results indicate, *Masakwa burku* and *Chakalari red* had the highest and the lowest tannin content, respectively. Significant ($p < 0.05$) variations existed among the tannin content of the various sorghum grain varieties. Six (*Borno kamouanza*, *Chakalari red*, *Chakalari white*, *Kaura*, *Masakwa adjama* and *Masakwa bulwalana*) among the 9 sorghum varieties investigated were found to be containing low tannin. The highest ($97.00 \pm 1.41a$ %) and the lowest ($0.75 \pm 0.96f$ %) tannin contents were found in *Masakwa burku* and *Chakalari red*, respectively. The tannin content (1.50 %) of *Chakalari white* was low (Table 3). There was no significant ($p > 0.05$) difference between the tannin content of *Chakalari red* and that (99.00 %) of *Masakwa adjama*. [6] reported *Borno kamouanza*, *Chakalari red* and *Kaura* as non-tannin varieties at 100.00 % whereas, *Jigari*, *Masakwa burku* and *Masakwa tumbuna*, were considered as varieties with tannin at 100.00, 96.00 and 95.00%, respectively. Tannins are anti-nutritional factors, which bind proteins, vitamins and minerals and make them unavailable for absorption.

Sorghum Grain Variety	Tannin Level (%)	Tannins (%)	Non Tannins (%)
<i>Borno kamouanza</i>	Low	1.50 ± 1.91 ^e	98.50 ± 1.91 ^b
<i>Chakalari red</i>	Low	0.75 ± 0.96 ^f	99.25 ± 0.96 ^a
<i>Chakalari white</i>	Low	1.50 ± 1.00 ^e	98.50 ± 1.00 ^b
<i>Jigari</i>	High	72.00 ± 2.71 ^c	28.00 ± 2.71 ^d
<i>Kaura</i>	Low	1.25 ± 0.96 ^e	98.75 ± 0.96 ^b
<i>Masakwa adjama</i>	Low	1.00 ± 0.82 ^f	99.00 ± 0.82 ^a
<i>Masakwa bulwalana</i>	Low	15.50 ± 4.51 ^d	84.50 ± 4.51 ^c
<i>Masakwa burku</i>	High	97.00 ± 1.41 ^a	3.00 ± 1.41 ^f
<i>Masakwa tumbuna</i>	High	90.25 ± 2.99 ^b	9.75 ± 2.99 ^e

Table 3: Tannin Content of Sorghum Grain Varieties.

Values are means of two determinations and those within the same column, not followed by the same superscripts are significantly ($p < 0.05$) different.

Conclusions

Among the sorghum grain varieties investigated, *Chakalari white* had the lowest impurity, the highest density and the whitest grains. It also had the hardest grains and low tannin content. Therefore, *Chakalari white* is highly recommended for food processing.

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