Comparative Proximate Analysis of Sorghum Bicolor Races in South East and South Nigeria

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Abstract- *Sorghum bicolor* Race Bicolor, Guinea, Caudatum, Durra and Kafir are typical Sorghum types produced and consumed in Nigeria. The quality of food is dependent on its nutritional content hence a quest to determine the nutrition content of Sorghum in Southern Nigeria. Ten plants per Race were analysed for its nutrition content (Ash, Fibre, Carbohydrate, Moisture Content and Lipid) using proximate analysis. Maximum ash content was recorded in Race Durra (10.20-13.30 %) while least was recorded in Race Guinea (4.00-4.70%); least moisture content ranged between 30.30-32.00% (Race Guinea); Carbohydrate content levels are as follows Guinea>Caudatum>Bicolor>Kafir>Durra; Lipid content was highest in Race Guinea and least in Race Kafir. The nutritive content of the Sorghum investigated compared well with proximate matter content of cultivated and improved Sorghum varieties. This implies that Sorghum cultivation in Southern Nigeria is possible and yields will be as nutritious as those grown in the North.

Index Terms- Sorghum, Fibre, Carbohydrate, Lipid, Moisture content and Ash

I. Introduction

Sorghum is a cereal crop that has over the years adapted to Nigeria ecosystem whilst expressing varying forms of characteristics both at morphological and molecular level. Sorghum has capacity to withstand adverse environment which confers it with a dynamic survival strategy that enables the plant thrive in the diverse ecosystems (especially the dry regions) of the world (Habindavyi, 2009) including Nigeria. Sorghum, grows in almost all the ecological zones of Nigeria, however, it is predominantly cultivated in the Northern part of Nigeria (House, 1985). Sorghum breeding and cultivation (subsistence and commercial) have resulted into diverse forms of improvement using natural and scientific means.

Sorghum though perennial by nature, the grain sorghum is mainly cultivated as an annual crop (Thomas *et al*., 2003). Sorghum has the characteristics of a typical Poacea and a striking resemblance with *Zea mays* and *Sacharrum sp*. (Sally *et al*., 2007) but the stem is thin relative to those of *Zea mays*. Sorghum production in Nigeria surpasses all other crops (FMEST, 1984) and it is consumed by majority of the population in different form. In terms of food contribution, sorghum is the major cereal consumed by the majority of the population (NAERLS, 1997). In the Northern states, about 73% of the total calories intake and 52.3% of the per capital protein intake are contributed by sorghum (Samm, 2009).

Camacho described landraces as dynamic population(s) of a cultivated plant that possess historical origin, distinct identity and devoid of formal crop improvement programme. Landraces are genetically diverse, locally adapted and synonymous with traditional farming systems (Camacho *et al.* 2005). Jones and co researchers described a landrace as a domesticated, regional ecotype (Jones *et al*, 2008 and FAO, 2013) which has adapted locally (Philip, 2000) and possesses traditional varietal characteristics (Camacho *et al*, 2005). Landraces are selectively domesticated species that have undergone inherent transformation through adaptation to a specific natural and cultural environment (Philip, 2000).

Sorghum grain is one of the major ingredients in swine, poultry and cattle feed in the western hemisphere, China and Australia. Sorghum is also grown for forage; in northern Nigeria it is very common and fed to animals fresh or as silage or hay. Sweet sorghum is used to a limited extent in producing sorghum syrup and 'jaggery' (raw sugar) in India and has recently gained importance in ethanol production.

Sorghum grain contains 11.3% protein, 3.3% fat and 56–73% starch. It is relatively rich in iron, zinc, phosphorus and B-complex vitamins. Tannins, found particularly in red-grained types, contain antioxidants that protect against cell damage, a major cause of diseases and aging (CGIAR, 2012).

The protein and starch in sorghum grain are more slowly digested than those from other cereals, and slower rates of digestibility are particularly beneficial for people with diabetes. Sorghum starch is gluten-free, making sorghum a good alternative to wheat flour for individuals suffering from celiac disease (CGIAR, 2012).

Globally, over half of sorghum cultivated are consumed by human beings (NSP, 2006). It is a major crop for many poor farmers in Africa, Central America, and South Asia. Grain sorghum is used for flours, porridges and side dishes, malted and distilled beverages, and specialty foods such as popped grain (CPR, 2000).

II. Materials and Methods

Fresh samples (panicles) were collected from the field, the grains were excised from the panicle and dried before pulverisation using a 100 µmesh screen. The pulverized samples were then examined for **moisture content**, protein, crude fat, crude fiber, carbohydrate and ash adapting methods used by Kirk

and Sawyer (AOAC, 1990; Kirk and Sawyer, 1980 and James, 1995).

Moisture content: Moisture content was determined using gravimetric method **(**AOAC, 1990). 5.0 g of the pulverized sample was weighed into a previously weighed moisture can. The sample in the can was dried in the oven at 105°C for 180 mins. At the end of the scheduled time, the sample can was removed and cooled in a desiccator and weighed. The drying and cooling phase was done repeatedly at 60 mins interval until a constant weight was obtained. The weight of moisture lost was calculated and expressed as a percentage of the weight of sample analyzed. The formula used for calculation of moisture content is as follows;

Moisture content (%) = $\frac{W2-W3}{W2-W1}$ x $\frac{100}{1}$

Where: W1= Weight of empty moisture can
W2= Weight of empty can + sample before drying
W3= Weight of can+ sample dried to constant weight

III. Protein Analysis in Sorghum

Kjeldahl method was adapted (Chang, 2003). Total nitrogen was determined and multiplied with factor 6.25 to obtain protein content. 0.5 g was taken and mixed with 10 mL of concentrated H_2SO_4 in a digestion flask. A tablet of selenium catalyst was added to it before it was heated under a fume cup board to get a clear digest. The digest was made up to 100 mL in a volumetric flask and used for the analysis. The 10 mL of the digest was mixed with equal volume of 45% NaOH solution in a Kjeldahl distillation kit. The mixture was distilled into 10 mL of 40% boric acid containing 3 drops of bromo cressol green and methyl red mixture. A total of 50 mL of distillate was collected and titrated against 0.02 N EDTA from green to a deep red end point. A reagent blank was also digested, distilled and titrated. The nitrogen content and hence the protein content was calculated as follows:

1 mL of 1 N H_2SO_4 = 14 mg

Protein (%) = N_2 (%) x6.25

N_2 (%) = $\frac{100}{W}$ x $\frac{Nx14}{1000}$ x $\frac{Vt}{Va}$ x T.B

W = Weight of sample (0.5 g)

N= Normality of titrant (0.02 N H_2SO_4)

V_t= Total digest volume (100 mL)

T= Sample titre value

B= Blank titre value

Total ash content: This was achieved using furnaces incineration gravimetric method described (James, 1995 and AOAC, 1984). 5.0 g of the processed sample was measured into a previously weighed porcelain crucible. The sample was burnt in a muffle furnace at a temperature of 550°C. When it has become completely ashed, it was cooled in desiccator and weighed.

The weight of ash obtained was determined by difference and calculated as a percentage of the weight of sample as follows:

Ash (%) = $\frac{W2-W1}{Weight\ of\ sample}$ x $\frac{100}{1}$

W_1 = Weight (g) of empty crucible

W_2 = Weight of crucible + Ash

Crude Fibre: Crude fibre content of Sorghum using method adapted by James (James, 1995). 5.0 g of processed sample was heated in 150 mL of 1.25% H_2SO_4 solution for 30 min under reflux. The boiled sample was washed in several portions of hot water using a two-fold cloth to trap the particles. It was returned to the flask and boiled again in 150 mL of 1.25% NaOH for another 30 min under same condition. After washing in several portion of hot water the sample was allowed to drain dry before being transferred quantitatively to a weighed crucible where it was dried in the oven at 105°C to a constant weight. It was thereafter taken to a muffle furnace where it was burnt, only ash was left of it. The weight of the fibre was determined by difference and calculated as a percentage of the weight of sample analyzed thus:

$$\text{Crude fiber (\%)} = \frac{W_2\text{-}W_3}{\text{Weight of sample}} \times \frac{100}{1}$$

Where:

W_2=Weight of crucible +sample after washing, boiling and drying

W_3=Weight of crucible +sample of ash

Determination of crude fat: This was determined by solvent extraction gravimetric method described by Kirk and Sawyer (1980). 5g of sample was wrapped in a porous paper (whatman filter paper) and put in a thimble. The thimble was put in a soxlet reflux flask and mounted into a weighted extraction flask containing 200 mL of petroleum ether. The upper of the reflux flask was connected to a water condenser.

The solvent (petroleum ether) was heated, boiled vaporized and condensed into the reflux flask filled. Soon the sample in the thimble was covered with the solvent until the reflux flask filled up and siphoned over, carrying its oil extract down to the boiling flask. This process was allowed to go on repeatedly for 4 h before the defatted sample was removed, the solvent recovered and the oil extract was left in the flask. The flask (containing the oil extract) was dried in the oven at 60°C for 30 min to remove any residual solvent. It was cooled in desiccator and weighed. The weight of oil (fat) extract was determined by difference and calculated as a percentage of the weight of sample analyzed thus:

Where:

$$\text{Fat (\%)} = \frac{W_2\text{-}W_1}{\text{Weight of sample}} \times \frac{100}{1}$$

W_1= Weight (g) of empty extraction flask

W_2= Weight (g) of flask+oil (fat) extract

Determination of carbohydrate: This was determined using the method of James (1995). 45 mL of each of the sample extracts was diluted to 450 mL with distilled water. 1 mL of each of the diluted filtrate was pipetted into different test tubes while 1 mL of water was pipetted into a test tube as a blank and 1 mL of glucose into a test tube as a standard. To each of the test tubes, 5 mL of freshly prepared 0.10% Anthrone reagent was added, stoppered and mixed thoroughly by gently shaking. Each tube was labelled and placed in a test tube rack both the test tubes and the rack were placed in water bath (30°C) for 12 min, removed and cooled to roots temperature. The absorbance of the samples and standard were read from a spectrophotometer at 630 nm against the blank. The green colour which shows the presence of glucose was stable for about 2 h. Total available carbohydrate as percentage glucose is calculated as shown below:

$$\text{Glucose (\%)} = \frac{25A1}{X \times A_2} \times 100$$

X= weight of sample (g)

A= Absorbance of diluted samples
A_2= Absorbance of diluted standard

IV. Results

Sorghum bicolor Race Guinea, bicolor, Caudatum, Kafir and Durra were collected growing wild in the different states (Rivers, Delta, Cross River, Ebonyi and Imo) in Nigeria. Analysis on the nutrient content indicates that Sorghum plants have higher concentration of moisture relative to ash, carbohydrate, lipid and fibre (Table 1 and Fig. 1). Carbohydrate content was highest in Guinea and Caudatum Races. However, the carbohydrate contents on the Sorghum Races are lower than levels reported by Consultative Group For International Agricultural Research- 56-73% (CGIAR, 2012). Maximum moisture content recorded among the *S. bicolor* races was 30.30-51.2% which is higher than values reported for Sorghum from the North by Jimoh and Abdulahi (2017). The higher moisture content may be associated with the higher levels of rainfall hence less transpiration. The concentrations of the different proximate matter component are presented in Figs 1-5.

Table 1: Proximate matter composition of S. bicolor Races
Table 4.xx: Proximate Analysis of Sorghum bicolor (cultivated Sorghum Races)

		Ash (%)	Moisture (%)	Carbohydrate (%)	Lipid (%)	Fibre (%)
S. bicolor Race bicolor (Delta)	Range	5.30-5.70	45.5-47.0	20.00-20.40	1.50-1.80	13.00-13.50
	Mean ± SD	5.49 ± 0.14	46.23 ± 0.51	20.28 ± 0.11	1.65 ± 0.11	13.33 ± 0.16
S. bicolor Race Guinea (Rivers)	Range	4.00-4.70	30.30-32.00	32.90-33.70	2.40-2.70	12.35-13.00
	Mean ± SD	4.23 ± 0.26	30.82 ± 0.52	33.25 ± 0.20	2.60 ± 0.11	12.73 ± 0.20
S. bicolor Race Caudatum (Abia)	Range	4.50-5.10	45.61-47.00	33.20-33.70	1.80-2.00	4.330-4.80
	Mean ± SD	4.77 ± 0.18	46.10 ± 0.37	33.46 ± 0.14	1.92 ± 0.07	4.56 ± 0.12
S. bicolor Race Kafir (Cross River)	Range	5.00-5.60	33.20-34.30	18.40-18.80	1.40-1.65	30.00-33.44
	Mean ± SD	5.27 ± 0.18	33.97 ± 0.32	18.59 ± 0.13	1.56 ± 0.08	31.46 ± 1.13
S. bicolor Race Durra (Ebonyi)	Range	10.20-13.30	48.60-51.20	15.00-15.60	1.50-1.70	9.00-9.70
	Mean ± SD	12.69 ± 1.00	49.57±0.75	15.25 ± 0.18	1.60 ± 0.06	9.34 ± 0.19

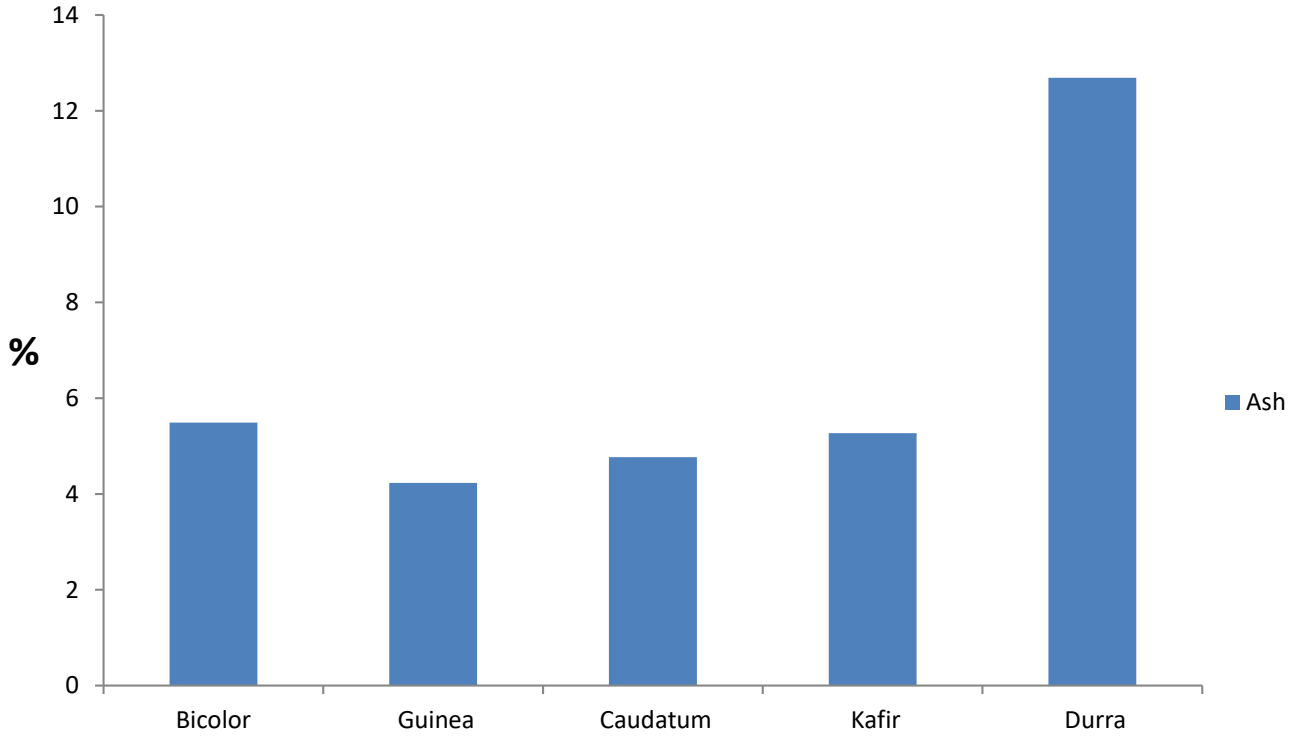

Fig. 1: % Ash content in races of *S. bicolor*

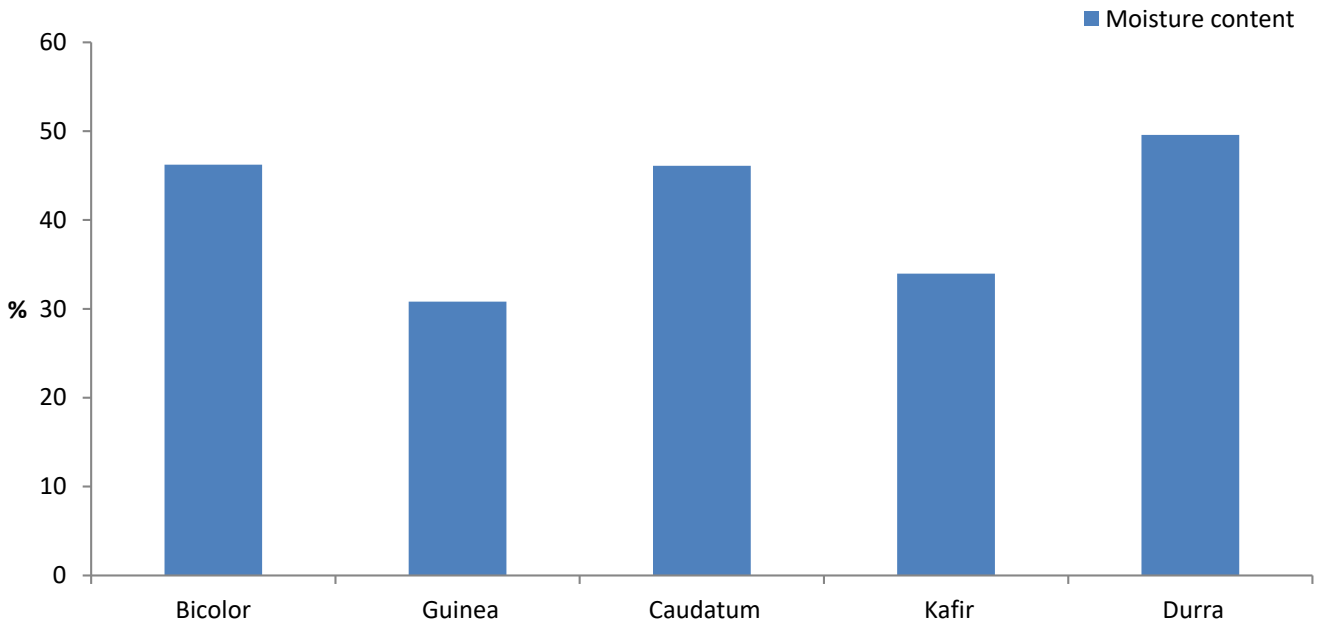

Fig. 2: % Moisture composition in *S. bicolor races*

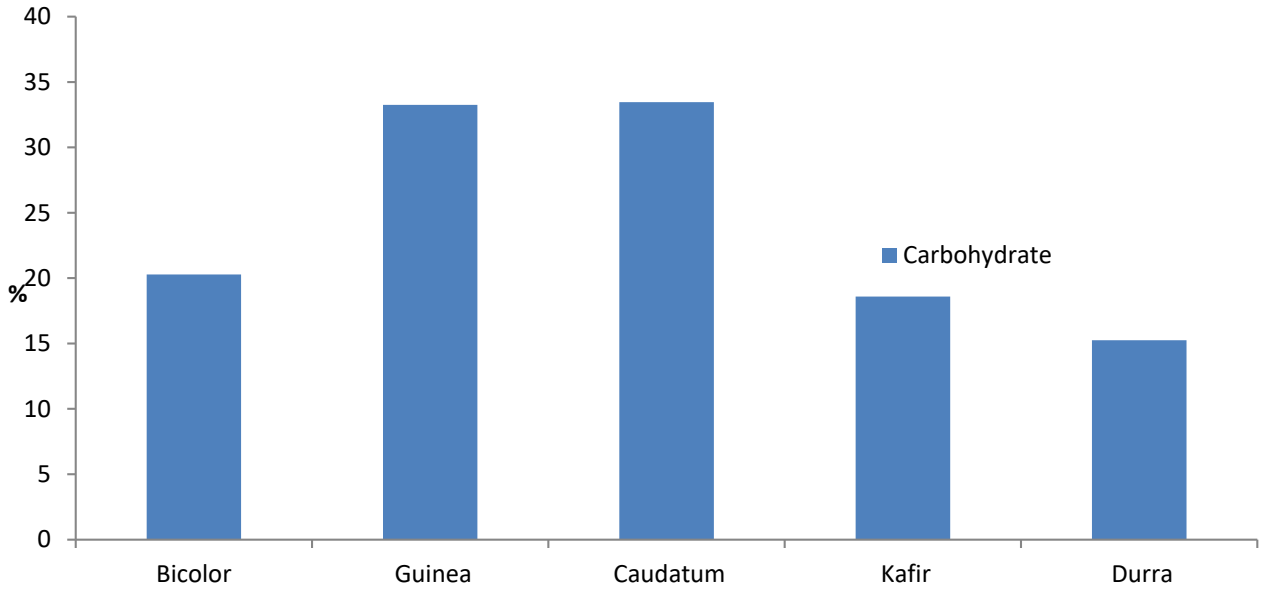

Fig. 3: % Carbohydrate composition in *S. bicolor* races

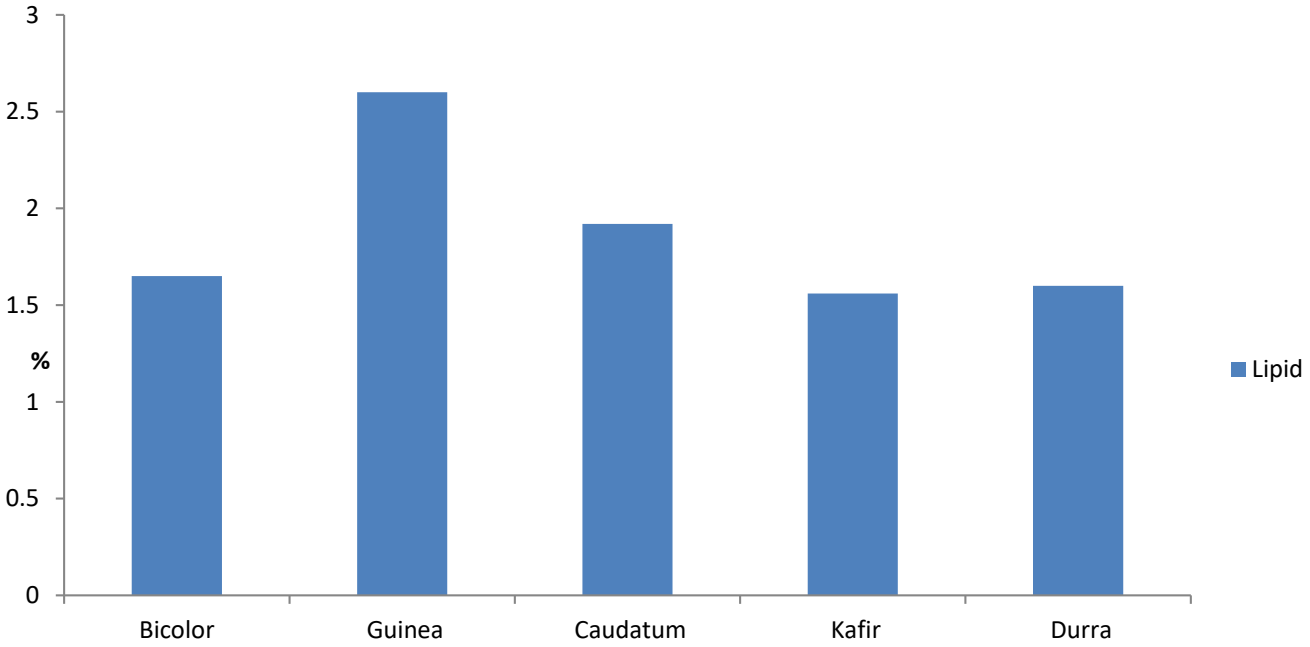

Fig. 4: % Lipid content iof *S. bicolor* races

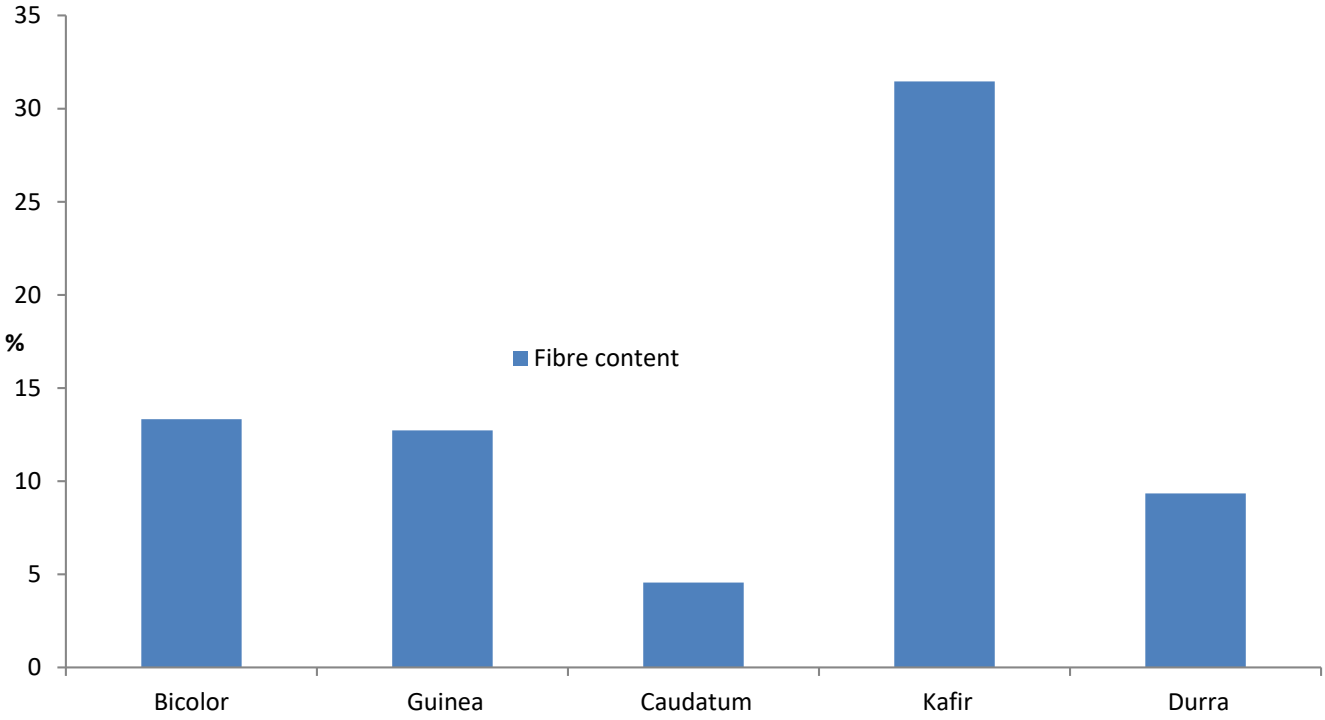

Fig. 5: % Fibre content in *S. bicolor* races

V. Discussion

Proximate analysis results from Sorghum in the Southern part of Nigeria suggests that the nutrition content of the plant is similar to those found in the Northern parts of Nigeria. The crop has capacity to thrive in Southern Nigeria with yields having nutritive contents competitive like those cultivated in the North. Also, lipid content suggests improved protein content in the Sorghum from the South relative to those of the North.

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