# INVESTIGATION OF THE PHYTOCHEMICAL AND NUTRITIONAL POTENTIALS OF LOCALLY PREPARED AQUEOUS EXTRACT OF *SORGHUM VULGARE'S* STALK

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**Abstract**
*Sorghum vulgare is a beneficial plant whose stalks are still under-explored. The need to examine its nutritional and medicinal values becomes critical as its stalk decoctions are becoming widespread local drink preparations. Samples of sorghum (guinea corn) were obtained from six selected farm lands in Minna, North central zone of Nigeria. They were dried, finely grounded and kept as both whole and extract samples. Extraction by decoction method was used. Proximate composition and elemental determinations were carried out on both sample types. Phytochemical screening were also carried out on only aqueous extract which is the only form in which the local drinks are prepared and consumed. The proximate shows prominent contents of ash, crude fibre, crude fat and carbohydrate values of whole and extract samples value which are (3.00%, 15%), (36.47%, Nil), (16.00%, 11.50%), (32.41%, 73.05%) respectively. Similarly the mean load of major essential elements: (Ca, Na, K and Mg) in mg/100g of the two forms showed (24.50, 40.30), (23.30, 15.70), (212.20, 142.90) and (14.00, 13.30). The mean load of trace essential elements: Fe, Zn, Mn and Cu gives (52.00, 25.00), (5.10, 5.60), (2.80, 2.70), and (0.70, 0.30) respectively. The aqeous extract showed prominent presence of alkaloid, cardiac glycoside, tannins and saponins while flavonoid was moderately present. The overall studies show that sorghum stalk possibly is not only capable of supplying nutrients but also could be a potential part of medicinal therapeutic formations*.

**Keywords:** *Sorghum vulgare, nutritional, medicinal, decoction, phytochemical*

## Introduction

*Sorghum vulgare* is commonly known as guinea corn plant. It is an economic crop because of the utility of all parts of the plant. Its grain is ranked the fifth position as the most cultivated cereal all over the world apart from wheat, rice maize and barley (Ghasemi *et al*., 2012). The record by FAO (2015) shows the production of sorghum is on rapid increase within the decade in Africa as at 2015. Sorghum is widely cultivated in West African sub-region.

The stalk of *sorghum vulgare*, locally called *'poporo'* in south west part of Nigeria, when soaked in hot water yields an extract that has been used as food as well as colorant (Ayub *et al*, 2010). It is also taken as refreshing and medicinal drink. Previous study of sorghum plant carried out by Sonon and Bolsen (1996) revealed the presence of nutrients in sorghum plant as food additive or drink in extracted form. Similarly, the medicinal potential of any part of sorghum can be deduced from the result of extensive phytochemical studies of the entire plant as observed by Lewington (1990), Sofowora (1993), Muhammad and Amusa (2005) and Nydia *et al*. (2013). Their overall findings, buttressed the presence of some phytochemicals such as alkaloids, saponins and tannins in different parts of the sorghum plant.

The fact that sorghum stalk is largely available and widely used in food and as indigenous medicament and herbal remedies makes the evaluation of the nutrient and chemical content worth studying. The two local modes by which sorghum stalk is analyzed are the solid particles (ground whole stalk of the plant) and liquid (hot water extract from soaked plant stalk). This study evaluated comparatively, the water extract of the sorghum stalk which is the mode in which the plant is actually consumed and the whole sorghum stalk powder for their nutritional and phytochemical contents.

## Materials and Methods

### Collection and Preparation of Sample

The sorghum stalks were collected from six different farms situated around Chanchaga and Dutsen Kura in Minna, Niger state, North Central zone of Nigeria. The samples were obtained within June and July of the year. The Chemistry laboratory of the Federal University of Technology, Minna, Niger State of Nigeria was used for the laboratory practical. The collected samples were chopped into smaller bits by stainless steel knife and weighed. The chopped samples were put in crucibles and covered by perforated aluminum foil and transferred to oven for drying at $110^0$C for 72 hours. The samples were weighed at different intervals until constant weight are obtained. The final weights were taken. The dried stalks were blended in an electric blender until dry fine particles were obtained. The powdered samples were then put in a transparent nylon, labeled and kept for further use. Decoction method was used for extraction. The liquid extract of each of the sample was prepared by boiling 20g of the fine samples in 200 $cm^3$ of distilled water for 30 minutes and allowed to steep for 24 hours. The aqueous extracts were then filtered to obtain extracts which were labeled and used for further analyses.

### Proximate Analysis of Sample

The proximate composition analysis was done to estimate the ash, protein, crude fat, fibre, and carbohydrate of the samples. The moisture content was not done on the aqueous extracts due to their infinitum water content. The crude fat content was obtained using soxhlet apparatus and extracting with petroleum ether (boiling point 60-90 $^0$C) based on the recommendation in (Method 945.16) of Association of Official Analytical Chemists' methods (AOAC, 2005). Determination of the nitrogen content was done by micro Kjeldahl method as described by Pearson (1976). The protein contents were obtained by the conversion from nitrogen content (Pearson, 1976) which was multiplied by a factor of 6.25. Carbohydrate was determined by difference of the sum of other compositions from whole percentage. The moisture, ash and fibre content determinations were carried out (method 985.29) of the Association of Official Analytical Chemists' methods (AOAC, 2005).

### Digestion of Sample for Mineral Analysis

Wet acid digestion procedure was followed in digesting the samples. 2.00g of each of the dried samples and 10.00g of aqueous extract were separately weighed into beakers. 5$cm^3$ of perchloric acid was added followed by 20$cm^3$ of nitric acid. A few glass beads was added as anti-bumping agents. The mixture was heated on a hot plate at a temperature range of $120^0$C to $200^0$C. The mixture was swirled with occasional addition of 5$cm^3$ of nitric acid until a clear digest solution was obtained. The mixture was allowed to cool and was filtered through acid wash filter paper into a 100$cm^3$ volumetric flask and made up to the mark. The filtrate was transferred into a polyethylene container temporarily before subsequent determination of the mineral contents.

**Instrumental Determination of Minerals**
Atomic absorption Spectrophotometer (BUCK scientific ACCUSYS 211 model no210 VGP) was used to determine Calcium, Zinc, Magnesium, Manganese, Copper and Iron. Flame photometer (model JENWAY PFP7) was used to determine the concentration of Potassium and Sodium in the samples.

**Qualitative Phytochemical Examination**
The aqueous extracts of the sorghum stalk was subjected to the following standard tests as described in Amadi *et al*. (2004):

***Alkaloids***
**Mayer's / Hager's test**: 2 $cm^3$ of each water extract of sorghum stalk was hydrolysed with hydrochloric acid, filtered and divided into two portions. The first portion was treated with 1$cm^3$ of a Potassium Mercuric Iodide (Mayer's reagent) in water-bath, while the second portion was reacted with saturated picric acid solution (Hager's reagent). The developments of yellow precipitates in both tests indicate positive result for alkaloids.

***Flavonoids***
**NaOH, Lead acetate:** Few drops of sodium hydroxide was added to 5 $cm^3$ of each of the sorghum extracts. Hydrochloric acid was then added to acidify and hence, yellow precipitate disappeared to give clear the coloration that indicated positive result for flavonoids.

**Shinoda test:** Lead Acetate Test was performed by treating the water extracts of the sodium stalk with few drops of lead acetate solution. Yellow precipitate was formed. Magnesium ribbon was dropped in another 5 $cm^3$ portion of the water extract of sorghum stalk followed by drop-wise addition of hydrochloric acid. The yellow precipitate turned to red colour to indicate a positive result for flavonoid.

***Carbohydrates***
**Molisch's test** : 5 $cm^3$ of distilled water was added to the water extract of sorghum stalk and then filtered. Two drops of alcoholic α- naphthol solution was then added. Violet ring was formed at the junction to indicate positive result for carbohydrate.

**Benedict's test**: 5 $cm^3$ of distilled water was added to the water extract of sorghum stalk and then filtered. Few drops of Benedict's reagent were then added. Orange red precipitate appeared to indicate positive result for sugar.

**Fehling test**: 5 $cm^3$ of distilled water was added to the water extract of sorghum stalk and then filtered. Few drops of Fehling's reagent were then added to indicate positive result for reducing sugar.

***Cardiac glycosides***
**Ferric Chloride test**: 3 $cm^3$ of dissolved $FeCl_3$ in glacial acetic acid was added to 2 $cm^3$ of the water extract of the sorghum stalk was dissolved and left to stand for a minute. Conc. $H_2SO_4$ was later added along the sides of the test tube containing the mixture. Blue colour appeared in acid layer to indicate positive result for cardiac glycosides.

***Tannins***

**Gelatin test:** 3 $cm^3$ of the water extract was diluted with 5$cm^3$ of distilled water. Few drops of 1% of gelatinous sodium chloride solution were then added. A gelatinous precipitate was formed to indicate the result for tannins.

**Ferric Chloride test**: 3$cm^3$ of the water extract was mixed with 5$cm^3$ of distilled water. Then two drops of 10% ferric chloride were added to the mixture. Intense green colour was formed that indicated the result for tannins.

***Saponins***

**Froth test**: 5 $cm^3$ portion of the water extract was treated with 25 $cm^3$ of distilled water. The mixture was vigorously shaken in a calibrated cylinder. Frothing occurred and then later formed 1 $cm^3$ layer to indicate positive result for saponin.

**Foam test**: 2 $cm^3$ portion of the extract was shaken with 5 $cm^3$ of distilled water. The mixture was vigorously shaken in a calibrated cylinder. Persistent foaming for several minutes was observed to indicate positive result for saponin.

**Discussions**

**Proximate Composition**

**Table 1: The mean proximate contents (%) of both water extract and whole powdered sorghum stalks**

| Content | WS | ES |
|---|---|---|
| Moisture | 6.00 ±0.25 | D |
| Ash | 3.00±0.12 | 15.00±0.38 |
| Crude fat | 16.00±0.31 | 11.50±0.62 |
| Crude fibre | 36.47±0.43 | N.D |
| Crude protein | 6.12±0.10 | 0.45±0.05 |
| Carbohydrate | 32.41±0.51 | 73.05±0.76 |

**WS:** Whole Sample, **ES:** Water Extract Sample, **D:** Disregarded, **ND:** Not Detected. Results are presented as means of six replicates (n=6)

The results in Table 1 represent the percentage proximate composition of both water extract and the ground whole stalk samples. The proximate composition of the water extract was devoid of fibers and by virtue of its being water based with water at infinitum, the moisture composition was disregarded. However, its ash content (15.00± 0.25) was quite substantial relative to that of the whole stalk (3.00±0.12). The ash value is also higher than what was obtained by Oyetayo and Ogunrotimi (2012) for whole sorghum leaf. The medicinal plants: *Xylopia aethiopica, Blighia sapida* and *Parinari polyandra* (Abolaji *et al*, 2007) also have values (2.53±1.20 to 4.37±0.85) which are comparable with that obtained for whole stalk in the study but still lower than that of the aqueous extract. This substantial constituent of ash depicts the aqueous extract as a nutritional potential source of mineral elements. The water extracted

sample has more appreciable carbohydrate content as well as comparable crude fat than that of the whole stalk samples. The value reported by Agoreyo *et al* (2012) of similar plants of the round and oval varieties of unripe fruits of *Solanum melongena*. The water extracted sorghum sample is by this, a good source of energy nutrients as demonstrated by Aremu et al (2006 and 2007). However, the set back of the sorghum extract lied in its poor content of protein and fibres which are quite substantial in its whole stalk stuff.

**Mineral Analysis**

**Table 2: The mean mineral content (mg/100g) of both water extract and whole powdered sorghum stalks**

| Elements | WS(mg/100g) | ES(mg/100g) |
|---|---|---|
| Ca | 45.30±0.33 | 40.30±0.23 |
| Na | 23.30±0.28 | 15.70±0.14 |
| K | 212.20±0.55 | 142.90±0.48 |
| Mg | 14.00±0.12 | 13.30±0.15 |
| Fe | 52.00±0.51 | 25.00±0.49 |
| Zn | 5.60±0.15 | 5.10±0.13 |
| Mn | 14.00±0.24 | 2.80±0.10 |
| Cu | 0.70±0.11 | 0.30±0.09 |

**WS**: Whole Sample, **ES:** Water Extract of Sample.
Results are presented as means of six replicates (n=6)

The results of the mineral contents of water extract and whole stalk samples were shown in Table 2. In both samples, potassium has the highest presence (142.90±0.48 and 212.20±0.55 mg/100g) respectively. The value obtained for water extract compares well with the value reported by Salau (2012a) for Ginger fruit juice (100.60 – 113.80 mg/100g). As expected, the values of the mineral elements of the whole stalk sample are generally higher than the water extract especially potassium, iron and manganese. However, the overall values of mineral elements obtained portrayed the water extract samples as nutritious because of the presence of these beneficial elements (Aremu *et al*, 2005). Manganese and copper are in trace quantities which are typical of many stuff of edible plants origin (Oyetayo & Ogunrotimi, 2012; Abolaji *et al*, 2007). Their values in the water extract samples still shows that its consumption would be a source of these essential trace elements. These elements were found to be only detectable in local soya milk preparations as well as cow milk (Salau, 2012b). The value of iron obtained for the aqueous extract could satisfy the adequate intake (A.I.) of 8-30 mg as recommended by CDC-MMWR (1998). The investigation by Oladiji, *et al* (2007) on the water extract of Sorghum stem bark indicated its efficacy in the management of iron deficiency in a local set up.

**Phytochemical Screening of Sample Extract**

**Table 3: The phytochemical constituents of the aqeous extract of sorghum stalk**

| S/No | Phytochemicals | Degree of phytochemicals' presence |
|---|---|---|
| 1 | ***Alkaloid*** | |
| | Mayer's Reagent | **+++** |
| | Hager's Reagent | **+++** |
| 2. | ***Flavonoid*** | |
| | Alkaline Reagent | **+** |
| | Lead Acetate Test | **++** |
| | Shinoda Test | **+++** |
| 3 | ***Carbohydrate*** | |
| | Molisch's Test | **++** |
| | Benedict's Test | **+** |
| | Fehling's Test | **+** |
| 4. | ***Cardiac glycoside*** | |
| | Keller-Kiliani Test | **+++** |
| 5. | ***Tannin*** | |
| | Gelatin | **+++** |
| | Ferric Chloride Test | **+++** |
| 6. | ***Saponin*** | |
| | Froth Test | **++** |
| | Foam Test | **++** |

**+++ =**Highly present**, ++ =** Moderately present**, + =** Fairly

The screening of the aqueous extract of the *Sorghum vulgare,* in Table 3, revealed the presence of alkaloids, cardiac glycosides and tannins in relatively high degree. These chemical contents are comparable to reports made by (Mamta & Jyoti (2012), Prachant et al (2011) and Edeoga *et al* (2005) on plants parts suspected to be of medicinal importance. The presences of other phytochemicals: saponins, flavonoids and carbohydrate are to lesser degree. The activities of these phytochemicals have proved relevant in pharmaceutical formulations, therapeutic purposes as well as medical prophylaxis (Sofowora, 1993). Alkaloids, tannins, flavonoids and saponins are known to be antimicrobial, antidiarrheal and anthelmintic in activities (Remington, 2005). Cardiac glycoside is especially beneficial as antidiarrheal. The presence of these phytochemicals indicates how beneficial the common local water extract of guinea corn stalk could be.

**Conclusion**

The results of this study revealed that aqueous extract of sorghum stalk has substantial nutritive values when extracted which is the form in which people consume it. It was observed that the iron, sodium, potassium, calcium and magnesium contents were high. *Sorghum vulgare* decoction is therefore a potential mineral source. It could be especially relevant in the management of anaemia based on its richness in iron which is an active element in the

haemoglobin and red blood cells formation. Prominent calcium presence and its presence in reasonable amount in the extract, is a material for strong bones and teeth structure. Calcium is contained in marrows where red blood cells are built. *Sorghum vulgare* was also found to contain phytochemicals of medicinal importance such as: flavonoids, tannins, alkaloids and saponins. All these phytochemicals, collectively, play crucial roles as antimicrobial, anthelmintic and antidiarrheal agents. The *Sorghum vulgare* stalk decoction drink, as locally prepared, has a great nutritional and medicinal potential. It will also find great utilities in the pharmaceutical a well as food and feed industries.

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