COMPARATIVE OF PHYTOCHEMICAL AND ANTIOXIDANT PROPERTIES OF SELECTED MILLET VARIETIES IN KATSINA METROPOLIS, NIGERIA

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Abstract
The study revealed a high nutritional quality and possible therapeutic effect of the studied millet varieties which are locally sourced and relatively cheaper source of food for a teeming population like ours. The millet varieties were obtained from the central market in Katsina state, Nigeria. The millet varieties (finger millet, pearl millet and fonio millet) were cleaned by washing in water, de-watered, sun dried, milled into flour and stored in sealed polythene bags. Amino acid profile was determined spectrometically using a gas chromatography (GC), antioxidant property was measured by determination of free radical scavenging ability (DPPH,FRAP and ABTS) and data was analyzed by one way analysis of variance (ANOVA) using SPSS (16.0) software. The result obtained from studied millet varieties showed the fatty acid profile contain more than 70% unsaturated fatty acid. Amino acid profile showed the presence of essential amino acid of nutritional importance (especially the sulphur containing amino acids). Phytochemical analyses showed the presence of plant chemical such as: tannin, terpenoid, alkaloid, cardiac glycoside, saponin, oxalate, phytate, flavonoids and total phenol. Antioxidant analyses showed they possess ability to serve as reducing agent hence a rich source of antioxidant of health importance.

Keyword: finger millet, fonio millet, pearl millet, phytochemical analyses, antioxidant

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1. INTRODUCTION

Millet can be referred to as the store-house of nutrition by any nutritional criterion. They are more advanced then rice and wheat (Adekunle, 2012). Depending on the species, the proximate composition varies. The fibre content of millets is higher than that of wheat and rice, with Barnyard millet having fifty times the fiber content of rice (Bavec and Bavec, 2006). Millet is a rich in B-group vitamin and also in minerals like potassium, phosphorus, iron, copper, magnesium, zinc and manganese (Adekunle, 2012). Millets have oil content of 4.2% of which 50% is polyunsaturated. Millets are important cereals besides wheat, rice, and maize. Millets serve as a major food source for millions of people, especially those who live in hot and humid areas of the world such as Nigeria. They are grown mostly in marginal areas under agricultural conditions in which major cereals fail to give substantial yields (Adekunle, 2012). Millets are important foods in many under developed countries because of their ability to grow under adverse weather conditions such as limited rainfall. In contrast, millet is the major source of energy and protein for millions of peoples especially those with low socio-economic status. It has been reported millet has many nutritive and medical functions (Obilana and Manyasa, 2002; Yang *et al.*, 2012). The term millet refers to various group of small seeded cereal crops which are known for their small coarse grains (Weber and Fuller, 2006). There are about 6000 varieties of millets grown around the world, the four major types are pearl millet (*pennisetum glaucum*), which comprises 40% of the world production, fonio millet (*setaria italica*) (Yang *et al.*, 2012), finger millet (*Eleusine coracana*) and proso millet or white millet (*panicum miliceum*). Pearl millet produces the largest seeds and it is the variety most commonly used for human consumption (Mariac *et al.*, 2006; ICRISAT, 2007). Nigeria as a country is faced with the problem of feeding its teeming population; therefore it is important to explore local biodiversity such as millet which are at present underutilized. In many developing countries such as Nigeria, malnutrition is an endemic dietary problem characterized by protein-energy malnutrition and micro-nutrient

deficiency (WHO, 2005). The determination of the nutritional composition of these millet varieties will go a long way in providing information (nutritional data) about the selected millet varieties, which in turn will create awareness about the underlying potentials of this underutilized cereal, hence increasing utilization both industrial and household levels, hereby going a long way in achieving the core objectives of this country in feeding its teeming populace with safe and nutritious food. Fonio millet (*Setaria italic*) is also known as Italian, Hungarian, German and Siberian millet (Bavec and Bavec, 2006). The plant height varies between 1-1.5m. The inflorescence is tight, has short side branches and varies from 7.5-25cm in length and 1.2-5cm in diameter ((Bavec and Bavec, 2006; Rachie, 1975; FAO, 1995). The panicle resembles the tail of a fox; the colour of the grain varies from yellow to orange to red to brown and black. The weight of 1000 seeds is about 2g (Bavec and Bavec, 2006). Finger millet (*Eleusine coracana*) represents a staple food for a large segment of the population (Bavec and Bavec, 2006). It has high nutritional value and is a good source of calcium, phytochemicals and dietary fibre. As the grains can be stored for long duration without damage from pests and insects, it plays a major role during natural calamities. The height of plants reaches from 0.4 to 1m and the length of the spikes are between 3-13cm. The grains are smaller than those of pearl millet and vary in colour from white to orange-red to deep brown to almost black. Pearl millet (*pennisetum glaucum)* is also known as spiked millet and bulrush millet. It is certainly the most important and widely grown millet with more than 15,000 lines in the World Germplasm Collection in India. Pearl millet originated in tropical western Africa, where the greatest number of both wild and cultivated genotypes occurs. Depending on the genotype, the plant may grow from 0.5 to 3.5-4m and the seeds can be white, light yellow, gray, brown, purple or slate blue in colour. The thousand seed-weight lies between 2.5 to 14g with an average weight of 8g. Thousand seed-weight varies from crop to crop and can vary between varieties of the same crop.

2. MATERIALS AND METHODS

2.1 Source of Material

The millet varieties were obtained from the central markets in Katsina state, Nigeria. All reagents used were of analytical grades and were purchased from a chemical store in Katsina State, Nigeria. The millet varieties (finger millet, pearl millet and fonio) were cleaned by washing in water, de-watered, sun dried, milled into flour and stored in sealed polythene bags.

2.1.1 Determination of Phytochemicals

2.1.2 Determination of flavonoid content

Total flavonoid determination was conducted using aluminum chloride colorimetric method of Marinova et al., (2005). 1ml of extracts was added to 4 ml of distilled water in a flask. Then, 0.3 ml of 5% $NaN0_2$ was added. After 5 mins, 0.3 ml of 10% $AlCl_3$ was be added and after 6 mins, 2 ml of MNa0H was also added. The mixture was diluted to 10 ml with distilled water. The absorbance of the solution was measured at 510 nm using a spectrophotometer (Spectrum 23A Spectrophotometer, Gulfex medical and scientific, England). The results were expressed as mg catechin equivalents (CE)/g samples.

2.1.3 Determination of alkaloid content

The alkaloid content was determined gravimetrically (Harbone, 1973). 5g (W_1) of each sample was weighed using a weighing balance and dispersed into 50 ml of 10% acetic acid solution in ethanol. The mixture was well shaken and then allowed to stand for about 4 hrs before it was filtered. The filtered was then evaporated to one quarter of its original volume on hot plate. Concentrate ammonium hydroxide was added drop wise in order to precipitate was alkaloids. A pre-weighed filter paper (W_2) was used to filter off the precipitate and the precipitate was washed with 1% ammonium hydroxide solution. The filter paper containing the precipitate was dried in an oven

at 60° C for 30 mins, transferred into dessicator to cool and then reweighed (W_3), until a constant weight was obtained. The constant weight was recorded. The weight difference of the alkaloid was determined by weight difference of the filter paper and expressed as percentage of the sample weight analysed. The experiment was repeated thrice for each food stuff sample and the reading recorded as the average of three replicates.

% Alkaloid= $(W_3 - W_2)/(W_1) \times 100$
Where
W_1= weight of sample, W_2 = weight of filter paper, W_3 = weight of filter paper and the precipitate after drying. (%)

2.1.4 Determination of total phenol content
The total phenol content was carried out according to the method described by Singleton et. et., (1999). About 0.2 ml of the extract was mixed with 2.5ml of 10% folin ciocalteau's reagent and 2 ml of 7.5% Sodium carbonate. The reaction mixture was subsequently incubated at 45 °C for 40 mins, and the absorba nce measured at 700 nm in the spectrophotomet er (Spectrum 23A Spectrophotometer, Gulfex medical and scientific, England). Total phenol content was expressed as mg garlic acid equivalents (GAE)/g samples, garlic acid will be used as standard phenol.

2.1.5 Determination of saponin content
The spectrophotometric method of Brunner, (1994) was used for saponin determination. 2g of the finely grinded sample was weighed into a 250 ml beaker and 100 ml of isobutyl alcohol or (But-2-ol) was also added. Shaker was used to shake the mixture for 5 hrs to ensure uniform mixing. The mixture was then filtered with No 1 Whatman filter paper into 100 ml beaker containing 20 ml of 40% saturated solution of magnesium carbonate ($MgCo_3$). The mixture obtain was again filtered through No 1 Whatman filter paper to obtain a clean colourless solution. One ml of the colourless solution was taken into 50 ml volumetric flask using pipette, 2 ml of 5% iron (iii) chloride ($FeCl_3$) solution was added and made up to the mark with distill water. It was allowed to stand for 30 min for the colour to develop. The absorbance was read against the blank at 380nm.

2.1.6 Determination of oxalate content
The titration method as described by Day and Underwood, (1986) was used. 1g of the sample was weighed into 100 ml conical flask. 75 ml 3M $H_2SO_4$was added and stirred for 1 hour with a magnetic stirrer. The mixture was filtered using a Whatman No 1 filter paper, 25 ml of the filtrate was then taken and titrated while hot against 0.05M $KMnO_4$solution until a faint pink colour persisted for at least 30 sec.

2.1.7 Determination of phytate content
Phytate was determined according to the method described by Wheeler and Ferrel, (1971). 4g of the sample was soaked in 100 ml of 2% HCl for 3 hrs and then filtered through a No 1 Whatman filter paper. 25 ml was taken out of the filtrate and place inside a conical flask and 5 ml of 0.3% of ammonium thiocyanate solution was added as indicator. 53.5 ml of distill water was added to give it the proper acidity and this was titrate against 0.00566 g per milliliter until a brownish yellow colouration persist for 5 mins.

2.1.8 Determination of tannin content
About 0.2 g of finely ground sample was weighed into a 50 ml sample bottle. 10 ml of 70% aqueous acetone was added and properly covered. The bottle was put in an ice bath shaker and shake for 2 hrs at 30 ° C. Each solution was then centrifuged and the supernatant store in ice. 0.2 ml of each solution was pipetted into the test tube and 0.8 ml of distilled water was added. Standard tannin acid solution was prepared from 0.5 mg/ml of the stock and the solution made up to 1ml with distilled water. 0.5ml of Folin Ciocateau reagent was added to both sample and standard, followed by 2.5 ml of 20% Na_2CO_3, the solution was then vortexed and allowed to incubate for 40 mins at room temperature, its absorbance was read at 725 nm against a reagent blank concentration of the same

solution from a standard tannic acid curve prepared (Makkar and Goodchild, 1996).

2.1.9 Determination of cardiac glycoside content

The procedure described by Sofowora, (1995) was used. 10 ml of the extract was pipetted into a 250 ml conical flask. 50 ml chloroform was added and shaken on vortex mixer for 1 hour. The mixture was filtered into 100 ml conical flask. 10ml of pyridine and 2 ml of 29% of sodium nitroprusside were added and shake thoroughly for 10 mins. 3 ml of 20% NaOH was added to develop a brown yellow colour. A concentration which range from 0-50 mg/ml was prepared from stock solution and the absorbance was read at 510 nm.

2.1.10 Determination of terpenoid content

The procedure described by Sofowora, (1995) was used. Finely ground sample (0.5g) was weighed into a 50 ml conical flask. 20 ml of chloroform: methanol in the ratio 2:1 was added to the mixture, shaken thoroughly and allowed to stand for 15 mins at room temperature. The suspension was centrifuged at 3000 rpm, the supernatant was discarded and the precipitated was re-washed with 20 ml of chloroform: methanol in the ration 2:1 and then re-centrifuged again. The added and allowed to stand for 30 mins before the absorbance was taken at 510 nm.

2.1.11 Determination of anti-oxidant activity

2.1.12 Determination of ferric reducing property

The reducing property of the extract was determined using method described by Pulido *et al.*, (2000). 0.25 ml of the extract was mixed with 0.25 ml of 200 mM of sodium phosphate buffer pH 6.6 and 0.25 ml of 1% $K_3Fe(CN)_6$. The mixture was incubated at 50 ^{o} C 20 mins, thereafter 0.25 ml of 10% TCA was also added and centrifuge at 2000 rpm for 10 mins, 1 ml of the supernatant was mixed with 1 ml of disttled water and 0.1% of $FeCl_3$ and the absorbance was measured at 700 nm.

2.1.13 Determination of DPPH free radical scavenging ability

The free radical scavenging ability of the extract against DPPH (1,1- diphenyl-2-picryhydrazyl) using Gyamfi et al., (1999) method. One 1 ml of the extract was mixed 1 ml of the 0.4 Mm methanolic solution of the DPPH the mixture was left in the dark for 30 mins before measuring the absorbance at 516 nm. The activity was expressed as percentage DPPH scavenging relative to control using the following equation.

DPPH Scavenging Activity (%) =

$$\frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}} \times 100$$

2.1.14 ABTS 2, 2'- azino-bis (3-ethylbenthiazoline-6-sulphonic acid) scavenging ability

The ABTS scavenging ability of the extract was determined according to the method described by Re *et al.*, (1999). The ABTS was generated by reacting an (7mM) ABTS aqueous solution with $K_2S_2O_8$ (2.45mM/1, final conc.) in the dark for 16 hrs and adjusting the absorbance at 734 nm to 0.700 with ethanol 0.2 of the appropriate dilution of the extract was then added to 2.0 ml of ABTS solution and the absorbance was read at 732 nm after 15 mins. The TROLOX equivalent antioxidant capacity was subsequently calculated.

2.1.15 Determination of amino acid profile

Amino acid analyses were carried out according to the method described by Na *et al.*, (1986). Ground samples were prepared for amino acid determination by acid hydrolysis with 6 NHCl for 24 hrs at 110 ^{o} C in vial under vacuum and N_2atmosphere. Sample solution was evaporated and dissolved in sodium citrate buffer (Ph. 2.2). The hydrolysates were analyzed by a post-column derivative method using a High Pressure Liquid Chromatography (HPLC), which was combined with a Pickering PCX5200 derivatizer (Pickering Laboratories, Inc., USA) and ion exchange columm (3.0×250 mm, 8µm). The identification of amino acids

was spectrometrically performed by measuring at 570nm.

2.1.16 Determination of fatty acid profile

The fatty acid profile was determined using the method described by Ohks, (1994). Fatty acids were extracted using a mixture of chloroform and methanol (2:1, v/v) solution. The samples were centrifuged at 3000 rpm; the supernatants collected were added with 0.9% NaCl solution and centrifuged at 3000 rpm. The chloroform phase was evaporated under nitrogen gas treated with 14% boron trifluoride method solution (BF_3-MeOH) for 10 mins at 100 ^{o} C. After cooling to room temperature, 1.0 ml of water and 2.0 ml of pentane were added. The pentate phase was evaporated under nitrogen gas and dissolved in n-hexane. Fatty acid composition was analyzed using a gas chromatography GC (Acme 6000, Young- Lin Co.), which was equipped with a flame ionization detector (FID) and SPBTM-fused silica capillary column (130 mm× 1000.25 mm, 0.25 µm, Supelco Co., USA) nitrogen gas was used for the carrier. The injector and detector temperature were 150 and 280 ^{o} C, respectively. The temperature gradient of the GC oven was programmed to be initiated at 180 ^{o} C for 8 mins and raised 3^{o}C/min until it reached a final temperature of 230^{o} C for 15 mins. Individual fatty acid methyal esters (FAME) were quantified as a percentage of total FAME analysed.

2.1.17 Statistical Analyses

Data were analyzed by one way analysis of variance (ANOVA) using SPSS (16.0) software. Means were compared by the Duncan's multiple range tests (DMRT); significant was accepted at the 5%.

3. RESULTS AND DISCUSSION

3.1Amino Acid profile of the millet varieties

The amino acid profile of finger millet compared with literature values is shown in table 1. The values obtained suggested that leucine, proline and glycine are the bulk in finger millet, this agrees with the report by Kunyanga et al., (2013) and Shimelis et al., (2009).

Table 2 shows the various amino acid present in pearl millet. The values obtained suggested that leucine, proline and alanine are the bulk amino acid in pearl millets, this agrees with the report by Fasasi, (2009) and Abdelrahman et al., (2005).

Table 1: Amino acid profile of Finger Millet

S/N	Parameters	Mg/100g of Protein	% of protein	mg/g of Nitrogen
1	Histidine	140.25±0.03	0.15	130
2	Alanine	160.34±0.01	0.39	
3	Arginine	159.08±0.03	0.27	300
4	Leucine	320.06±0.02	0.55	690
5	Lysine	101.04±0.02	0.21	220
6	Cysteine	26.35±0.02	0.14	140
7	Methionine	86.33±0.03	0.21	210
8	Phynylalanine	160.26±0.01	0.32	310
9	Threonine	142.26±0.01	0.26	240
10	Glycine	165.35±0.02	0.24	
11	Tryptophan	26.36±0.01	0.09	100
12	Proline	205.56±0.02	0.36	
13	Valine	142.26±0.01	0.45	480
14	Serine	162.26±0.01	0.33	
15	Tyrosine	136.34±0.02	0.19	220
16	Isoleucine	155.24±0.03	0.23	400
17	Aspatic Acid	163.34±0.02	0.39	
19	Histidine	140.25±0.03	0.15	
		**	***	***

NB: **** = Value obtained from Data Analyses
*****=** Value obtained from literature (Kunyanga et al., 2013)
*****=** Value obtained from literature (Goplan et al., 2009)

Table 2: Amino acid profile of Pearl Millet

S/N	Parameters	Mg/100g of Protein	Mg/100g protein	g/100g protein	Mg/g of Nitrogen
		133.35±0.03	32.66	2.01	140
1	Histidine	162.25±0.02	703.88	7.84	
2	Alanine	152.26±0.01	110.27	4.06	
3	Arginine	308.85±0.01	407.01	12.02	300
4	Leucine	93.64±0.01	10.96	1.95	750
5	Lysine	23.36±0.01		0.89	190
6	Cysteine	80.45±0.02	20.11	5.00	110
7	Methionine	155.45±1.73	129.78	4.94	150
8	Phynylalanine	133.37±0.01	37.56	3.79	290
9	Threonine	160.25±0.02	7.69	4.34	240
10	Glycine	20.38±0.01			
11	Tryptophan	212.26±0.01	812.68	10.61	110
12	Proline	124.27±0.02		6.50	
13	Valine	135.37±0.02	35.56	4.86	410
14	Serine	121.16±0.01	14.71	2.05	200
15	Tyrosine	140.13±0.01	242.61	4.06	260
16	Isoleucine	138.34±0.02	156.06	6.18	
17	Aspatic Acid	19.34±0.01	114.63	20.33	
18	Glutamic Acid	133.35±0.03	32.66	2.01	140
19	Histidine	162.25±0.02	703.88	7.84	
		**	***	***	***

**NB: ** ** = Value obtained from Data Analyses
*****=** Value obtained from literature (Kunyanga et al., 2013)
*****=** Value obtained from literature (Goplan et al., 2009)
***= Value obtained from literature (Anuonye et al ., 2010)

Table 3: Amino acid profile of Fonio Millet

S/N	Parameters	Mg/100g protein	Mg/100g protein	g/16g nitrogen	Mg/100mg dry weight of acha
1	Histidine	135.24±0.02	1.33±0.02	0.145	2.20
2	Alanine	154.47±0.03	4.23±0.01	0.596	3.00
3	Arginine	150.25±0.01	1.34±0.02	0.211	3.80
4	Leucine	314.43±0.02	4.40±0.02	0.536	9.90
5	Lysine	94.47±0.02	1.90±0.01	0.147	2.35
6	Cysteine	21.16±0.02	3.10±0.04	0.164	2.90
7	Methionine	82.26±0.01	2.98±0.02	0.362	4.80
8	Phynylalanine	164.55±0.03	2.37±0.01	0.409	5.00
9	Threonine	137.47±0.02	1.89±0.02	0.233	3.95
10	Glycine	158.57±0.03	1.93±0.01	0.173	3.40
11	Tryptophan	22.24±0.03	0.95±0.03		3.50
12	Proline	210.24±0.02	3.26±0.02	0.373	3.30
13	Valine	135.28±0.01	2.34±0.01	0.345	5.75
14	Serine	147.74±0.02	2.10±0.03	0.369	3.50
15	Tyrosine	122.23±0.03	0.91±0.01	0.179	
16	Isoleucine	128.25±0.01	1.37±0.03	0.282	4.00
17	Aspatic Acid	142.26±0.01	3.50±0.02	0.432	3.60
18	Glutamic Acid	20.43±0.01	6.97±0.02	1.46	4.00
19	Histidine	135.24±0.02	1.33±0.02	0.145	2.20
		154.47±0.03	4.23±0.01	0.596	3.00
		*	**	***	****

**NB: * ** = Value obtained from Data Analyses
****=** Value obtained from literature (Chukuma and Abdul-kadir (2008)
*****=** Value obtained from literature (Glew et., al (2013))
****= Value obtained from literature (Anuonye et al ., 2010)

Table 3 shows the various amino acid present in fonio millet. The values obtained suggested that leucine, proline and isoluecine are the bulk amino acid in fonio millets, this agrees with the report of Anounye et al., (2010).

The results of Amino acid analyses of these millet varieties showed that the contain high propotions of major amino acid such as leucine, proline, glycine, alanine and isoleucine (Shimelis et al., 2009; Shashi et al., 2007; Fasasi, 2009. The millet varieties were found to be rich sources of essential amino acid such as valine, isoleucine, histidine, methionine, tryptophan, threonine, lysine and phenylalanine which are required for vital body processes (Kunyanga *et al.,* 2013; Azhari *et al.,* 2015; Glew *et al.,* 2013; Chukwu and Abdul-kadir, 2008). Though millets are said to be limited in lysine like other cereals, they are excellent source of the sulphur containing amino acids; methionine and cysteine, two human-vital amino acids almost deficient in the major cereals like sorghum, rice, wheat or barley (Fliedel *et al.,* 2004). This two amino acids supply sulphur and other compounds required by the body for normal metabolism and growth (De- Lumen *et al.,* 1993).

3.2 Fatty Acid Profile of the Millet Varieties

Table 4 shows the fatty acid profile of finger millet which was compared with literature values. Table 5 shows the fatty acid profile of pearl millet which was compared with literature values. Table 6 shows the fatty acid profile of fonio millet which was compared with literature values.

Table 4: Fatty Acid Profile of Finger millet

S/N	Parameters				
1	Stearic Acid (%)	1.20±0.01	4.80±0.35	0.58	
2	Palmitic Acid (%)	18.17±0.05	20.80±0.01	23.06	25.00
3	Oleic Acid (%)	22.19±0.02	38.40±0.09	47.17	49.00
4	Linolei Acid (%)	48.05±1.43	20.30±0.00	24.78	25.00
5	Stearic Acid (%)	1.20±0.01	4.80±0.35	0.58	
		*	**	***	****

NB: * = Value obtained from Data Analyses
****=** Value obtained from literature (Kunyanga et al., 2013)
*****=** Value obtained from literature (Poonia et al., 2012)
****= Value obtained from literature (Gull et al., 2015)

Table 5: Fatty Acid Profile of Pearl millet

S/N	Parameters				
1	Stearic Acid (%)	1.27±0.01	5.00	3.90	
2	Palmitic Acid (%)	18.34±0.02	19.00	20.30	20.60
3	Oleic Acid (%)	22.26±0.01	25.00	26.70	28.54
4	Linolei Acid (%)	45.57±0.03	46.00	45.30	45.55
5	Stearic Acid (%)	1.27±0.01	5.00	3.90	
		*	**	***	****

NB * = Value obtained from Data Analyses
****=** Value obtained from literature Rooney, (2006)
*****=** Value obtained from literature RIRDC (2013)
****= Value obtained from literature Daniel et at., (2015)

Table 6: Fatty Acid Profile of Fonio millet

S/N	Parameters				
1	Stearic Acid (%)	1.13±0.01	3.03±012	4.10	1.68
2	Palmitic Acid (%)	18.20±0.03	15.10±0.25	16.80	17.20
3	Oleic Acid (%)	22.22±0.02	30.50±0.25	28.60	28.34
4	Linolei Acid (%)	46.33±0.02	47.40±0.25	45.70	49.64
		*	**	***	****

NB: * = Value obtained from Data Analyses
****=** Value obtained from literature Glew et al., (2013)
*****=** Value obtained from literature Ballogou et al., (2013)
****= Value obtained from literature Pragyani (2013)

The studied millet varieties contained bulk amount of unsaturated fatty acids namely oleic and linoleic fatty acid which accounts for (70%-75%) of the total fatty acid with some small amount of saturated acids such as palmitic and stearic acid. This is in agreement with the works of several researchers (Poonia *et al.*, 2012; Kunyanga *et al.*, 2013; Glew *et al.*, 2013; Fliedel *et al.*, 2004). These unsaturated fatty acid of great health importance, linoleic acid which is an omega 6-fatty acids, is highly significant because this acid is easily converted to n-6 eicosanoids, n-6 prostaglandin and n-6 leucotriene hormones. These are all of great importance in drug development etc. linoleic acid is also very popular in beauty products as it helps in moisture retention, acne reduction, and treatment of inflammatory related diseases. Lack of linoleic acid causes dry hair, hair loss and wound healing. Therefore, the consumption of these millet varieties will yield the same advantages to the consumer. Oleic acid, which is an omega-9 fatty acid as a major fatty acid also is equally important having all the health benefits of linoleic acid. In cases of reduced availability of omega-6-fatty acids, omega-9-fatty acids are converted to omega-6-fatty acids (Poonia et al., 2012).

3.3 Phytochemical Properties of the Millet Varieties

The phytochemical properties of finger millet determined in this work is shown in Table 6 compared with literature values.

Table 7 shows the phytochemical constituents of pearl millet as determined in this work compared with literature values.

Table 8 shows the phytochemical constituents of fonio millet as determined in this work compared with literature values.

Table 7 Phytochemical Properties of Finger Millet

S/N	Parameters			
1	Tannin (mg/g)	7.70±0.02	0.40 (%)	1.60±0.10
2	Terpenoid (mg/g)	11.92±0.01		
3	Alkaloid (%)	72.83±0.03		
4	Cardiac glycoside (mg/g)	12.32±0.04		
5	Saponin (mg/g)	28.00±0.04		5.40±0.00
6	Oxalate (mg/g)	0.63±0.01		0.68±0.00
7	Phytate (mg/g)	18.54±1.24	260.00 (mg/100g)	3.10±0.01
8	Flavonoid (mg/g)	1.70±0.02		
9	Total phenol (mg/g)	2.61±0.02		
		*	**	***

NB: * = Value obtained from Data Analyses
****=** Value obtained from literature Shashi et al., (2007)
*****=** Value obtained from literature Rotimi, (2011)

Table 8 Phytochemical Properties of Pearl Millet

S/N	Parameters				
1	Tannin (mg/g)	6.56±0.02	1.75±0.20	0.51	1.03
2	Terpenoid (mg/g)	8.49±0.06			
3	Alkaloid (%)	25.54±0.09			
4	Cardiac glycoside (mg/g)	9.76±0.05			
5	Saponin (mg/g)	38.64±0.28			
6	Oxalate (mg/g)	0.36±0.01			
7	Phytate (mg/g)	14.66±0.24	0.80±0.20		84.64
8	Flavonoid (mg/g)	11.05±0.10			
9	Total phenol (mg/g)	4.79±0.01		0.21	
		*	**	***	****

NB: * = Value obtained from Data Analyses
****=** Value obtained from literature Laminu et al., (2014)
*****=** Value obtained from literature Ballogou et al., (2013)
****= Value obtained from literature Onyangon et., al (2012)

Table 9 Phytochemical Properties of Fonio Millet

S/N	Parameters			
1	Tannin (mg/g)	5.92±0.01	0.13	3.00 (mMol/L)
2	Terpenoid (mg/g)	5.71±0.10		
3	Alkaloid (%)	57.64±0.01		
4	Cardiac glycoside (mg/g)	14.18±0.01		
5	Saponin (mg/g)	23.82±0.18		Trace
6	Oxalate (mg/g)	0.71±0.01		Trace
7	Phytate (mg/g)	18.94±0.02	1.14	5.00 (mg/ml)
8	Flavonoid (mg/g)	7.93±0.01	1.22	
9	Total phenol (mg/g)	1.96±0.01		6.10 (mMol/L)
		*	**	***

NB: * = Value obtained from Data Analyses
****=** Value obtained from literature Echendu et al., (2009)
*****=** Value obtained from literature Anuonye et al., (2010)

Table 10 Antioxidant properties of finger millet

S/N	Parameters			
1	DPPH (%)	67.06±0.04	1.73 (mg/g)	63.00 (µg/ml)
2	FRAP (mg/g)	20.86±0.05	471.71 (mol/g)	
3	ABTS (mMol/g)	0.02±0.01		109.00 (ug/m/)
		*	**	***

NB: * = Value obtained from Data Analyses
****=** Value obtained from literature Sreeramulu et al., (2009)
*****=** Value obtained from literature Banerjee et al., (2012)

Table 11 Antioxidant properties of pearl millet

S/N	Parameters				
1	DPPH (%)	61.80±0.10	51.70 (%)	83.20 (%)	68.10 (%)
2	FRAP (mg/g)	25.75±0.02	669.33 (mg AAE/g)	404.20 (mg TE)	3.16 (Mmol Fe
3	ABTS (mMol/g)	0.02±0.01	3.125 (TE)		
		*	**	***	****

NB: * = Value obtained from Data Analyses
****=** Value obtained from literature Kaddafi et al., (2015)
*****=** Value obtained from literature Minaxi et al., (2013)
******=** Value obtained from literature Singh et al., (2013)

Table 12 Antioxidant properties of fonio millet

S/N	Parameters			
1	DPPH (%)	60.64±0.07	69.33(%)	74.70 (%)
2	FRAP (mg/g)	15.36±0.05	17.45 (mg/g)	40.65 (mg/g)
3	ABTS (mMol/g)	0.02±0.01	140.00 (ug/m/)	
		*	**	***

NB: * = Value obtained from Data Analyses
****=** Value obtained from literature Singh and Naithani (2012)
*****=** Value obtained from literature Glew et al., (2013)

Phytochemical screening and quantification of the studied varieties millets reveals the presence of different types of plant bioactive substances such as; tannin, terpenoid, alkaloids, cardiac-glycosides, saponin, oxalates, flavonoids and total phenol. Some of these bioactive substances in food could limit the bio availability (hence called anti-nutrients) while others (e.g flavonoids and total phenols which are known for their anti-nutrients activity) could be of great health importance (Shashi et al., 2007). Though the incidence of these anti-nutrients which are high in the studied varieties has been reported to be reduced to the barest minimum levels by simple processing methods such as cooking, soaking, milling, fermentation, extrusion, alkali and acidic treatments, e.t.c. (Fasasi, 2009)

3.4 Antioxidant properties of the Millet Varieties

The antioxidant properties of finger millet as determined is presented in Table 9 values obtained for the various antioxidant test are compared with other literature.

Table 10 shows the antioxidant properties of pearl millet with values obtained for the various antioxidant test which compared with other related literature.

Table 11 shows the antioxidant values for fonio millet which compare with other literature.

The result obtained in this study, revealed that extract from the millet varieties possesses ability to serve as reducing agent and therefore can serve as a source of antioxidants which counter the accumulation of free radicals in the body; free radicals are organic materials that antagonize the proper functioning of body metabolism.

This finding agrees with the report of (Sies, 1993) that antioxidants are reducing agents. The result also agrees with the finding of (Oboth and Rocha, 2007) on reducing power of pepper. Phenols and phenolic compounds have been reported to possess significant antioxidant activities (Aiyegoro and Okoh, 2009) and since whole millet grain varieties were considered which are believed to be rich in phenolic compounds, hence their antioxidant property is influenced. The total phenolic content of these millet varieties are higher than what was reported by (Oboh *et al.*, 2008) for fermented African locust bean. This indicates that regular consumption of these millet varieties may serve as a dietary source of antioxidants. Also, the values obtained were higher than what was obtained for Carica papaya and Cajanus cajan by (Imaga *et al.*, 2009). Plants with antioxidant activities have been reported to possess free radicals scavenging activity, free radicals are the major contributors to severe diseases and disorders such as cancer, diabetes, liver disease, renal failure and degenerative diseases

4. CONCLUSIONS

The results obtained from this work showed that the selected millet varieties (finger millet, pearl millet and fonio) are all good sources of essential nutrients which could make substantial contribution to the intakes of phytochemical and antioxidant. Consequently, these selected millet varieties when properly utilized through effective products development programs, have the potential of helping in overcoming malnutrition and hunger among the vulnerable groups in Nigeria.

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