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Nutritional Evaluation of some Cereals and Tubers Cultivated and Consumed in Yola, Adamawa State Nigeria

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Research Paper

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The study was designed to evaluate the nutritional and anti-nutritional content of the food cereals and tubers commonly consumed in Yola, Adamawa state Nigeria. The investigations were carried out on proximate (moisture, fiber, ash, protein, nitrogen, fat, carbohydrate and energy), mineral elements (Na, K, Zn, Cu, Pb and Mn) vitamins (β-carotene, vitamin C, vitamin E, vitamin B_1 and vitamin B_2 and anti-nutrient contents (phytate, oxalate and Tannins). The percentage moisture ranges between 1.04 % for white rice to 62.50 % in sweet potato revealing that tubers generally has high moisture contents than cereals. The carbohydrates, proteins and fats contents of cereals are higher than in tubers. In fact rice (white) contained highest amount of carbohydrate with 80.40%.The study showed that sodium, zinc, copper, potassium and manganese were detected in the investigated samples and potassium was found to be higher in cereal grains. Lead was not detected in the cereal grains and tubers. Vitamin C was detected in both cereals and tuber samples; the value ranges between 0.034 mg/100g in maize (white) to 6.0 mg/100g in tubers (yam), respectively. Vitamin $B_1$was low in cereal grains (rice). Riboflavin (B_2) was lowest in cereal grains with 0.01mg/100g. The values for phytate were higher in cereals than in tubers. Oxalate was lower in tuber (sweet potato) with 0.03 mg/100g. Our investigation revealed that tannins was lower cereal Sorghum durra (white) with 0.37 mg/100g and seen higher in sweet potatoes. Our findings also revealed that the levels of the anti-nutritional factors may not affect the availability and utilization of nutrients present in the food stuff.

Key words: Cereals, Tubers, Proximate composition, Anti-nutrient, Vitamins and Mineral elements.

INTRODUCTION

Data on composition of food are essential for diversity of purposes in many fields of activity (Greenfield and Southgate, 2003). They are important to spectrum of users ranging from international organizations to private individuals (Rand et al., 1991). The knowledge of nutritional composition of foods is quite essential in dietary treatment of diseases and in any qualitative study of human nutrition. Food composition data are used primarily for the assessment and the planning of human energy and nutrient intake (Greenfield and Southgate, 2003).The need for composition information is increasingly growing because consumers in all countries want more detailed information about raw and processed foods so that the information will continue to serve traditional users in schools and institutional feeding programmers as well as food technology and nutrition programmers (Lupien, 1994).

Although, there are various food composition tables

available for use in developing countries; many of these tables however do not containing sufficient information on food values and several nutrients. Besides, most of these tables contain data that are not recent and have information mostly on raw foods. The gaps may be as a result of minerals content of the soil, used fertilizer, method of processing, the length and method of storage, the moisture content of the sample and the method of analysis (Sanusi and Adebiyi, 2009). The data is significant in dietary formulations for infants and children which are essential for optimal growth and development and for good health as well as in the dietary formulation and management of diseases such as scurvy, kwashiorkor or other health threatening conditions like obesity, diabetes and osteoporosis etc. (Osho, 1988.The aim of this research was to carry out chemical analysis of some cereals and tubers food stuff produced in Yola, Adamawa state- Nigeria.

MATERIALS AND METHODS

Chemicals

All chemicals were of analytical were obtained from M&B lab, Chemical, Dagenham, England.

Equipment

The following equipment were used: Atomic absorption spectrophotometer (Bulk Scientific, USA), soxhlet apparatus extraction unit, hot air ovum (Gallenkamp), muffle furnace (M-525), flame photometer, colourimeter, HPLC (bulk scientific, BLC10/11), Analytical balance (Metler Toledo AB 204).

Methods

Samples collection

Nine food stuff commonly used as staple food in Adamawa state were used for this research work and was grouped into two groups namely; Cereals and Tubers. The used cereal grains were; maize (*Zea-mays*) - white and yellow maize, Sorghurm (*bicolor)* - red sorghurm, Sorghum durra (white and red), and brown and white long grain rice. The used tubers include, yam (*Discorea spp)* and sweet potato (*Ipomeabatatas lam*).All the samples were obtained in Yola with a geographical location at latitude 9.2 °N and longitude 12.32 °E of Adamawa state.

Proximate analysis of the food samples

Moisture content determination

The standard method of AOAC, (1995) was used to determine the moisture content of the samples. Briefly, clean crucibles with lids was labeled and dried in an oven at 100 ^{o}C for 30 min, cooled in a suitable desiccators containing CaO as a desiccant, and weigh to a constant weight. The sample was grinded to fine powder and mixed to obtain a homogenous sample of large surface area. An analytical balance was used to obtain the weight of the crucibles with the lids. In each of the crucibles 2.0 g were placed in, then dried in an oven at 100 ^{0}C for 17 h. The samples were removed from the oven and the lids were replaced, the samples were then being transferred to a dessicator containing CaO as desiccant to room temperature (28±1^{0}C) and were weighed. The process was continued until a constant weight was obtained.

Calculation

The percentage moisture content was calculated as follows:

$$Moisture\ (\%) = \frac{t-u}{s}\ X\ 100$$

Where s = weight of sample for analysis, t = weight of sample + crucible before drying, U = weight of sample + crucible after drying t – U = loss of weight or moisture content.

Ash content determination

The ash content was determined by method of AOAC (1990).Briefly, porcelain crucibles with lids was ignited for 5 minutes in a muffle (M-525) at 550 ^{o} C, cooled in a desecrator and weighed. Two g of each sample was separately weighed into the appropriately labeled crucible and weighed again. Crucible and content was ignited in the muffle (Model M-525) at 550 ^{o} C for 18 h to light grey ash. Thereafter, they was removed and placed immediately in a desecrator to cool and weighed.

Calculation

The difference in weight or loss in weight of the crucible and sample before ashing gave the organic matter content of each diet, while the difference between the weight of the crucibles alone and crucible and ash, and gave the weight of the ash of each sample. Values for ash were calculated and expressed in percentages as:

$$Ash\ (\%) = \frac{100\ (x-Y)}{Z}$$

Where x = weight of crucible and content after drying. Y = weight of empty crucible. X - Y = weight of ash. Z = weight of sample.

Crude fiber determination

This was carried out according to the procedure of AOAC

(1980). Briefly, four g of each moisture-free sample was weight into a 250 ml beaker, and 50 ml of 4 $^{o}/_{o}$ H_2SO_4 was added followed by distilled water to a volume of 200 ml. Sample was then heated to boiling and kept boiling for exactly 30 min on a Bunsen flame, with constant stirring using a rubber-tipped glass rod to remove all particles from sides of beaker.

The volume was kept constant by addition of hot distilled water. After 30 min of boiling, the content was poured into a butchner funnel fitted with an ashless Whatman no. 40 filter paper and connected to a vacuum pump. Beaker was washed several times with hot distilled water and then transferred quantitatively with a jet of hot water. Washing continued on the funnel until the filtrate was acid-free as indicated by litmus paper. The acid-free residue was transferred quantitatively from the filter paper into the same beaker removing the last traces with 5 $^{o}/_{o}$ NaOH solution and hot water to a volume of 200 ml. The mixture was boiled for 30 min with constant stirring as described earlier, keeping the volume constant with hot water.

The mixture was then filtered and washed as described earlier until it's alkaline free. Finally, the resultant residue was washed with two portions of 2 ml 95% alcohol. Residues on filter paper were transferred to a pre-weighed porcelain crucible. The content of the crucible was then dried in an oven maintained at 110 ^{o}C to a constant weight after cooling in a desecrator. Crucible content was then ignited in a muffle furnace at 550 ^{o}C for 8 h, cooled and weighed. A triplicate determination was carried out on each sample. The percentage crude fiber was therefore calculated as:

$$Fiber\ (\%) = \frac{y - a}{X}\ X\ 100$$

x = weight of sample (g) , y = weight of insoluble matter (g) , a = weight of ash (g)

Crude fat determination

The method of Pearson (1973) was employed; this method was based on the principle that non-polar components of samples are easily extracted into organic solvents. 3 g, (moist-free) of each sample, was placed into fat free thimbles. These were then weighed plugged with glass wool and introduced into soxhlet extractors containing 160 ml petroleum ether (b.p 60-80 ^{o}C). Clean dry receiver flask weighed and fitted to the extractors. The extraction unit was then assembled, and cold water was allowed to circulate, while the temperature of the water bath was maintained at 60 ^{o}C. Extraction was carried out for eight h. At the end of this time, the thimble containing the sample was removed and placed in an oven at 70 ^{o}C for 3 h and dried to constant weight. The weight of the dish and the content was then obtained using a standard analytical balance.

Calculations

The crude fat was obtained as the difference in weight before and after the exhaustive extraction.
Hence the percentage fat was therefore calculated as:

$$Fat\ (\%) = \frac{x - y}{z}\ X\ 100$$

Where, x = weight and thimble and oil, Y = weight of empty thimble , Z = weight of sample.

Crude protein determination

A modified method of micro-Kjeldahl as described by AOAC (1990) was used for crude protein determination. The nitrogen content of proteins varies from 15–18 %. Assuming an average value of 16 %, then crude protein is estimated as the nitrogen content multiplied by the appropriate factor (AOAC, 1990).

Equations

The digestion involves oxidation of the organic matter with sulphuric acid:

$$\text{Organic N} \xrightarrow{Conc.H_2SO_4} (NH_4)_2SO_4$$

$$\text{Carbon} \xrightarrow{Conc.H_2SO_4} CO_2$$

Distillation is carried out on Markham"s steam distillation apparatus. This involves liberation of ammonia by caustic soda, which is trapped in an (excess) acidic buffer and the excess acid titrated with standardized 0.1 M NaOH solution.

Procedure for Digestion

3 g each of the de-fatted samples was separately weighed on pre-weighed Whatman ashless filter paper No. 4 and placed in micro-Kjeldahl digestion flask together with few anti-bumping granules. 2 g of catalyst mixture ($CuSO_4$: Na_2SO_4: SeO_2, 5:1:02 w/w) was added to each flask, and then 10 ml nitrogen free concentrated H_2SO_4 also added to each flask. The flasks were placed in inclined position on a heating mantle in a fume cupboard. Digestion was started at temperature of 30 ^{o} C until frothing ceased, and then heating was increased to 50 ^{o}C for another 30 min, and finally at full heating (100 ^{o}C) until a clear solution was obtained. Simmering was continued below boiling point for another 30 min to ensure complete digestion and conversion of nitrogen to ammonium sulphate. After digestion was completed, samples were allowed to cool, and then transferred quantitatively to 100 ml volumetric flasks with washing and cooling to room temperature. Volumes were made up to mark with distilled water.

Distillation

10 ml of each digested sample was pipette separately into the Markham steam distillation apparatus, followed by the addition of 20 ml 40 % NaOH solution. Distillation was started and the liberated ammonia was trapped into 2 % boric acid in a 100 ml conical flask containing 4 drops of mixed indicator (0.1% BCG and 0.1% methyl red in 95 % alcohol) to a volume of 50 ml. Titration the ammonia trapped in the boric acid was titrated against 0.01M HCl to an end point of light gray color. Titer values were obtained in triplicate for each sample and blanks.

Calculation

Percentage nitrogen in the food samples were calculated

$$\% \text{ Nitrogen} = \frac{(a-b) \times 0.01 \times 14.005 \times C \times 100}{D \times Ex \times 1000}$$

Where:
a = average titer value for samples, b = titer value for blank, C = volume to which the digest was made up to., D = aliquot taken for distillation, E = weight of dried samples taken for digestion, % Crude Protein = % Nitrogen x 6.25 (AOAC, 1975).

Estimation of Total Carbohydrate

The total carbohydrate content of the diet samples was obtained by subtracting the sum of percentage crude protein, crude fat, moisture, fiber and ash from 100 (AOAC, 1995).

Calculation of food caloric value

When carbohydrate, fat and protein samples were burnt in a bomb calorimeter, the amount of produced heat (heat of combustion) is always the same for each of these nutrients. It is the maximum amount of energy that the sample is capable of yielding when it is completely burnt or oxidized. Values of 4.1 Kcal/g for carbohydrate, 9.45 Kcal/g for fat and 5.65 Kcal/g for protein had been obtained. However, the net heat of combustion in the human body is slightly different from that in the bomb calorimeter. In the calorimeter, the heat of combustion comes from the energy produced by oxidation of C to CO_2, hydrogen to water and nitrogen (from protein) to nitrous oxide. The body is capable of releasing the energy potential of carbon and hydrogen, but cannot use the energy of nitrogen. Therefore, the heat from the oxidation of nitrogen cannot be considered available to the body. This amount to1.3 Kcal a potential of only 4.3 Kcal/g of protein is therefore available to the body (Guthrie, 1989).

Calculation

Based on these values, the factors 4, 9 and 4 representing the approximate amount of energy available to the body per gram of carbohydrate, fat and protein, respectively; (physiological fuel value) were used in arriving at the caloric values of the diets analyzed as follows:
Total caloric value = Sum (gram of each nutrient in diet x factor)

Assay of anti-nutritional factors in the food samples.

Determination of phytate

This was achieved using the method of AOAC (1990). Phytate was extracted using dilute HCl and then extract mixed with Na_2 EDTA – NaOH solution, and placed in an ion-exchange column. The extracted phytate is diluted with 0.7 ml NaCl solution and wet-digested with H_2SO_4/HNO_3 mixture to release phosphate, which is measured colorimetrically after reacting with ammonium molybdate solution. The amount of phytate in original sample is obtained as hexaphosphate equivalent.

Procedure

Two g of each diet sample was separately weighed into labeled 150 ml Erlenmeyer flasks. Exactly 40 ml of 2.4 % HCl was added to each sample, covered and shaken vigorously on an MSE orbital shaker for 3 h at room temperature. Meanwhile, a column was prepared by adding 3 ml of distilled H_2O to the slurry of 0.5g-anion exchanger resin AG 1-x 4 chlorides obtained from BIO-Rad laboratories. This was allowed to settle and then washed with 15 ml of 0.7 M NaCl solutions, followed by 15ml of distilled water.

Samples were removed from the shakers and filtered through Whatman filter paper No. 42. One ml of each filtrate was separately mixed with 1.0 ml EDTA – NaOH reagent in a 25 ml volumetric flask. Mixtures were diluted to the mark with distilled water, mixed and transferred quantitatively to the prepared column. The first eluent from the column was discarded. The Column was washed with 15 ml 0.1 M NaCl, which was also discarded. The column was then washed with 15 ml 0.7 M NaCl and fraction collected into a digestion flask. Concentrated H_2SO_4 (0.5 ml) and 3.0 ml concentrated HNO_3 were added to the flask. Before the next sample was added to the column, 15 ml of distilled water was passed through it. Mixtures in flasks were digested on micro-Kjeldahl rack at 50 ^oC until active boiling ceased and thick yellow vapor was given out. Heating continued for another 10 min before burner was turned off. Flasks were allowed to cool to room temperature.

Exactly 10 ml distilled water was added to flask and swirled to dissolve the digests. All solutions were separately transferred quantitatively to labeled 50 ml volumetric flasks. 10 ml molybdate solution was added to each sample, mixed thoroughly, then followed by 1.0 ml sulfonic acid reagent and mixed again. The solutions were then diluted to volume with more distilled water. Mixtures were allowed to stand for 15 min and absorbance was read at 640 nm. A blank solution was prepared by mixing 1 ml 2.4 % HCl with 1.0 ml Na_2 EDTA – NaOH reagent, and diluted to 25 ml with distilled water before pouring into column and treated as samples preparation of standard curve. A standard curve was prepared by pipetting 1.0, 3.0, 5.0, 7.0 ml phosphate standard solution containing 80, 240, 400 and 560 µg phosphorus, respectively, into labeled 50 ml volumetric flasks. 20 ml distilled water was added to each flask, mixed thoroughly, followed by 2.0 ml Molybdate solution with continuous mixing. 1 ml sulfonic acid solution was added, mixed well, diluted to volume with distilled water and mixed again. Absorbances of the solutions were read at 640 nm. A standard curve was generated. Triplicate determinations were carried out on all the samples and standards.

Calculation

Phytate concentration in the diet samples was extrapolated from the generated standard curve, and expressed as mg/100 g sample.

Determination of total oxalate

Total oxalate in the diet samples was assayed using the method of AOAC (1990).

Oxalate is precipitated as insoluble calcium oxalate, which was collected by centrifuging. The precipitate is dissolved in an excess of hot dilute H_2SO_4 and the oxalate titrated (in hot) with standardized $KMnO_4$.

Procedure

2 g of the powdered diet samples were separately weighed into labeled 250 ml beaker, and 150 ml distilled water and 55 ml 6 M HCl was added. Two drops of alcohol were added and mixture boiled for 15 min, cooled, and transferred quantitatively into 500 ml volumetric flask, diluted to volume with distilled water and mixed again. Mixture was allowed to stand overnight, mixed thoroughly, and then filtered through No. 42 Whatman filter paper.

Exactly 25 ml of the filtrates was separately pipette into labeled 50 ml flasks and then 5 ml tungstophosphoric acid was added, mixed and let to stand for 5 h. Mixtures was filtered through Whatman filter paper, and 20 ml of filtrates was pipette again into centrifuge tubes followed by ammonium hydroxide solution drop wise until a pH of 4.5 was achieved using indicator paper. Five ml acetate buffer (pH 4.5) was then added to maintain a constant pH. Mixtures were allowed to stand again overnight at room temperature, after which they were centrifuged for 15 min at 1700 rpm to compact the precipitate. Supernatants were carefully decanted and calcium oxalate precipitates washed three times with centrifugation and decantation using cold washing liquid (12.5 ml HoAc, diluted to 250 ml with distilled water). Precipitates were re-dissolved in 5 ml dilute H_2SO_4 (1:9 v/v). The dilute H_2SO_4 also served as the blank solution. All mixtures were then heated in a boiling water bath for 15 min and the hot solutions titrated with 0.01N $KMnO_4$ until a persistent pink color was obtained.

Calculation

The volume of $KMnO_4$ used to titrate the hot solution of each sample was used to calculate the oxalate content of each sample as follows:

$$\text{Mg oxalate/100g sample} = \frac{\text{ml of 0.01N } KMnO_4 \times 1350}{\text{Weight of taken sample}}$$

Where,1350 = 0.45 (mg oxalic acid equivalent to 1ml 0.01N $KMnO_4$) x [(30/20) x (50/25) dilution factors] x 100 (to convert to 100 g sample)

Tannins determination

The method of AOAC (1980) was also used in this determination.

Procedure

Two g residues of petroleum ether extracts as earlier described were boiled with 300 vml distilled water for 2 h, cooled and diluted to 500 ml with more water and then filtered. Twenty five ml of the filtrates was transferred separately into 2 L porcelain dish. Twenty ml indigo solution and 750 ml distilled water were added, followed by 1ml of $KMnO_4$ (earlier standardized with 0.1N oxalic acid) at a time until the blue solution turned green; then few drops until solution became golden yellow. A triplicate analysis was carried out on all the samples. Mixture of 20 ml indigo solution and 750 ml distilled water was titrated with $KMnO_4$ as blank.

Calculation

The difference between the sample and the blank titer values was multiplied by the factor of 0.006235* to obtain

the concentration of tannin in the samples.
*1ml oxalic acid solution = 0.006235 querci tannic acid

Mineral content determination

2 g of powdered food sample were weighed into a porcelain crucible and preheated to 600 ^{0}C for four h. The crucible was then transferred directly to desiccators and was allowed to cool. The weight of the ash was recorded.

Digestion

The ash was treated with a few milliliters of 5 N HCl and a few drops of concentrated HNO_3 and boiled. This was then cooled, filtered, and the filtrate then makes up to 100 ml in a standard volumetric flask with de-ionized water. This solution was used for the determination of Pb, Mn, Zn and Cu by atomic absorption analysis as described by FAO, (1989). The procedure was carried out five times. Mineral elements such as Na and K were determined using flame photometer.

Assay of vitamins content

Determination of vitamins A and E

The HPLC (high performance liquid chromatography) was used in determination of vitamin E. Briefly, analysis was performed by injecting 20 ul of carefully prepared sample into a bulk scientific (USA) BLC 10/11 – model HPLC equipped with UV-325 nm and UV 254 nm detectors for fat soluble vitamins. AC18, 4.6 x 150 mm, 5 um column and a mobile phase of 95:5 (methanol: water) was used at a flow rate of 1.00 mL / minute and an ambient operating temperature. Then 01 mg of the mixed standards were analyzed in a similar manner for identification. Peak identification was conducted by comparing the retention times of authentic standards and those obtained from the samples. Concentrations were calculated using a four way calibration curve.

Ascorbic acid estimation

Sample analysis

2 g of the samples were extracted in 4% oxalic acid and made up to known volume (100 ml) and centrifuged and ascorbic acid contents were estimated. Briefly, 5 ml of the working standard solution were pipetted out into 100 ml conical flask and l0 ml of 4 % oxalic acid were added and titrated against the dye solution .The end point was the appearance of pink color, which persists for a few minutes. The amount of dye consumed is equivalent to the amount of ascorbic acid present in the test sample.

Thiamin estimation (flourimetric analysts)

2 g of the sample were grinded in a mortar and 30 ml of hydrochloric acid were added by portions. The content was thoroughly mixed and filtered using filter paper, analysis comprises of three (control, test sample and standard). To the first (control), 5 ml of hydrochloric acid solution were transferred to the second l (sample). To 1 ml of the extract of the sample and 4 ml of hydrochloric acid were transferred. To the third (standard) 5 ml of thiamin solution were transferred. 1.5 ml of oxidizing mixture was poured into each phial and mixed to homogeneity. Then 5 ml of butanol was added to eachphial and stopper-using flask shaker and shaken vigorously for 5 min. The phials were then allowed to stand until the contents were separated into two layers. Then 0.5 ml of ethanol was added cautiously to further clarifying of butanolic phase. The cleared butanolic layer was cautiously decanted into a flourimeter cell and successive measurement of the fluorescence intensity for the three (test sample, control and standard) solutions of all the samples sativa were recorded.

Vitamin B_2 (riboflavin) determination

This assay was based on the method of Stroebecker and Henning (1965). Dry samples such as cereal products and feeding stuffs, were powdered and then defatted by extraction with ether or light petroleum Powdered moisture free samples were defatted using light petroleum ether (40 – 60 ^{o}C) for 8 h. 1 g of the each defatted samples was weighed into a 50 ml conical flask and shaken with 120 ml of 0.1N HCl on a water bath set at 70 ^{o}C for 90 min. Fifteen of acetone were added and shaken for 5 min. Mixtures were filtered through No.1 Whatman filter paper. Excess acetone in the filtrate was evaporated on water bath until odor-free. Each extract was diluted to 10 ml with distilled water; 1 ml of glacial acetic acid was added, and then shaken.

Assay

Standard solutions of riboflavin were prepared by accurately weighing out 50, 100, 200, 400 and 600 mg riboflavin and dissolving in 10 ml distilled water to give concentration of 5, 10, 20, 40, 60 mg/ml, respectively.

To 10 ml of both sample extracts and standard solutions of riboflavin, 0.5 ml of 4 % $KMnO_4$ solution was added with shaking and allowed to stand for exactly two minutes.

To this 0.5 ml of 3 % H_2O_2 solution was added and shaken vigorously to expel excess oxygen. Solutions that were turbid or had precipitates of $KMnO_4$ were centrifuged before absorbance of the resultant yellow color solution was measured at 444 nm.

Calculation

Obtained absorbance for the different concentrations of standard riboflavin were used to plot a calibration curve while the vitamin B_2 concentration of each sample extract was read from the linear curve.

Data analysis

All the data were expressed as mean ± standard deviation. The proximate and mineral element was carried out five times and vitamins and anti-nutrients was determined in triplicates and was analyzed using one-way anova and means differences were compared using the Duncan's multiple test and was processed using SPSS 17.0 software version for windows computer software package and $P < 0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Nutritional composition of cereal grains

The proximate composition of strains of different cereal grains was presented in (Table1), the elemental composition in (Table 2), the vitamin composition in (Table 3) and the anti-nutrient factors in (Table 4). The moisture content varied between 1.04 to 20.04% ($p < 0.05$). The values agree with the values quoted for cereals (20 g/100 g and 10.0 g/100 g) (Wooot-Tsuen et al., 1968; Olusola et al., 2000; Loren, 1999). The presence of low moisture in these cereals suggested that the cereals would be kept well for a long period of time. Sorghum durra (red) had the highest crude lipid value as compared to maize, rye, barley and wheat. The fat or lipid content might contribute to the daily energy requirement, more importantly; the low fat content may be an advantage in preventing rancidity and deterioration especially in long term stored cereals. The crude protein ranged between 6.49 % and 14.48 % ($p < 0.05$). The highest crude protein level was seen in sorghum durra (white) and was comparable to the values reported for rye, oat, sorghurm and wheat (Uddoh, 1980, Mustapha and Magdi, 2003). Cereal grains are normally used as a source of protein, besides some amino acids such as Lysine, Tryptophan and sulphur containing amino acids are present in low level and as such the protein cannot support growth if used as a sole source of protein. However, the protein could serve as additional source of energy in humans.

The ash content of the cereal grains used for this study ranges between 1.02 to 2.14 %. There was significant difference ($p < 0.05$) in the levels of ash. Sorghum bi-color being the highest and the lowest was observed in rice (boiled). In general sorghum durra (white) and sorghum durra (red) are better cereals nutritionally (Pooter and Hotchkiss, 1968). The proximate composition of two tubers commonly consumed in Adamawa state was presented in (Table 2). Our findings revealed that yam (*Discorea spp*) and sweet potato (*ipomea batatas*) had moisture of 60.40 % and 62.50 %, respectively. Generally, the moisture contents of the two tuber samples were high, indicating that the samples are prone to microbial attack in the course of storage. The moisture content of the two samples however indicated that they could not be stored favorably for a long period of time because they will detoriate. The obtained results were compared favorably with the data obtained by (Senanayake et al., 2011; Abubakar et al., 2010, Olayiwola et al., 2009). On the other hand, the obtained data differs with the results obtained by Oladebeye et al., 2008a which mentioned that sweet potato has moisture 8.72 %. The result of this analysis showed that the flours of yams and sweet potatoes have ash 2.46 and 4.60 %, respectively. The results varied with the that obtained by (Alinnor and Akalezi, 2010; Olayiwola et al., 2009 and Abubakar et al., 2010). The results were compared favorably with (Senanayake et al., 2011 and Margaret et al., 2000). High ash contents in the samples revealed that the samples could be a good source of mineral elements having nutritional importance.

The crude fiber content of the flour sample yam and sweet potatoes (*Ipomea batatas*) were 1.04% and 1.02%, respectively. The results indicated that both tuber samples had higher fiber content. The obtained fiber values was higher than the obtained values by (Margaret et al., 2000 and Senanayake et al., 2011) and were similar with Alinnor and Akalezi, 2010. Fiber has useful role in providing roughage that aids digestion (Eva, 1983). Dietary fiber reduces the risks of cardiovascular diseases such as diabetes, coronary heart diseases colon cancer and various digestive disorders (Augustin et al., 1978).

Furthermore, high dietary fiber observed in the diets has some beneficial biological effects such as laxative effect on GIT, increased fecal bulk and reduce plasma cholesterol level (Okoye, 1992). The fat content of the samples were 0.49% and 1.20% for yam and sweet potatoes, respectively.

The values were similar with the value (2.70%) obtained by (Alinnor and (Alakaezi, 2010; Martin et al., 2010; Senanayake et al., 2011) and differ from the value (2.60%) obtained by (Margret et al., 2000; Abubakar et al., 2010 and Olayiwola et al., 2009). It was also reported that fat is used as source of energy (Oladebeye et al., 2008b). It had been reported that 1g of fat provides about 37 Kcal of energy (Gaman and Sherrington, 1996). The crude protein content of yam and sweet were 7.30% and 4.57%, respectively. The values were compared favorably with the value (6.24%) obtained by Senanayake et al., 2011; Margret et al., 2000; Martin et al., 2010 and differs from the value (0.087%) obtained by (Alinnor and

Table 1. Proximate composition of cereal grains and Tubers commonly used as staple food.

SAMPLE	Moisture (%)	Ash (%)	Fibre (%)	Nitrogen (%)	Protein (%)	Fats (%)	Cho (%)	Energy (kcal)
Maize (White) *(Zeamays)*	10.20±0.11^{d}	1.24±0.16^{e}	1.54±0.08^{d}	1.30±0.07^{d}	6.49±0.45^{d}	8.34±0.18^{d}	70.83±0.37^{b}	380.95±21.00^{b}
Maize (Yellow)	20.04±0.17^{a}	1.76±0.05^{d}	1.82±0.04^{c}	1.41±0.01^{c}	8.79±0.10^{c}	9.42±0.38^{c}	57.45±1.87^{c}	349.68±4.60^{c}
Sorghum (Red) *(Sorghum bi-color)*	10.56±0.34^{c}	2.15±0.95^{a}	1.33±0.03^{e}	1.82±0.07^{b}	11.40±0.42^{b}	5.98±0.11^{e}	65.75±6.30^{b}	362.42±25.07^{bc}
Sorghum durra (White)	11.30±0.19^{b}	1.91±0.04^{b}	2.20±0.11^{b}	2.29±0.05^{a}	14.48±0.35^{a}	3.8 ± 0.51^{f}	66.08±1.07^{b}	357.36±1.60^{bc}
Sorghum durra (Red)	12.46±0.11^{f}	1.94±0.15^{b}	1.95±0.04^{c}	2.29±0.05^{a}	14.32±0.54^{a}	18.40±1.46^{a}	54.18±6.15^{d}	439.67±33.96^{a}
Rice (White)*(oryza sativa)*	1.04±0.03^{f}	1.24±0.15^{d}	1.22±0.19^{e}	0.89±0.05^{e}	5.60±0.23^{f}	10.50±0.20^{b}	80.40±0.24^{a}	438.50±1.83^{a}
Rice (Brown)	8.38±0.16^{e}	1.02±0.11^{e}	3.98±0.23^{a}	1.23±0.24^{d}	6.89±0.96^{e}	2.50±0.11^{g}	77.28±0.96^{a}	358.95±0.69^{bc}
Yam (*Discorea Spp*)	60.40±0.37	2.46±0.11	1.04±0.87	1.16±0.11	7.30±0.68	0.49±0.49	30.33±4.8	143.76±8.22
Sweet Potato (*Ipomea batatas*)	62.5±0.10	4.60±0.23	1.02±0.15	0.73±0.03	4.57±0.20	1.20±0.37	26.08±0.3	133.46±4.38

Values are expressed as mean ± standard deviation for five determinations.
Values with different superscript down the column are significantly different from each other at $p < 0.05$.

Table 2. Mineral element contents of commonly consumed cereals and tubers (mg/ kg).

SAMPLE	Sodium	Potassium	Zinc	Copper	Lead	Manganese
Maize (White)	2.80 ± 0.26^{f}	174.00 ± 2.30^{e}	3.54 ± 0.23^{c}	0.37 ± 0.03^{b}	N.D	N.D
Maize (Yellow)	2.20 ± 0.07^{g}	264.00 ± 0.70^{c}	4.50 ± 0.03^{b}	0.38 ± 0.01^{b}	N.D	0.16 ± 0.02^{c}
Sorghurm (Red)	5.50 ± 0.12^{e}	308.00 ± 1.14^{b}	5.80 ± 0.08^{a}	0.60 ± 0.03^{a}	N.D	0.20 ± 0.01^{b}
Sorghum durra (White)	10.20±0.07^{a}	360.00 ± 3.16^{a}	2.80 ± 0.01^{d}	0.20 ± 0.01^{d}	N.D	0.10 ± 0.01^{d}
Sorghum durra (Red)	8.20 ± 0.01^{b}	338.00 ± 0.70^{a}	2.65 ± 0.01^{e}	0.12 ± 0.01^{e}	N.D	0.10 ± 0.02^{d}
Rice (White)	7.00 ± 0.15^{d}	223.00 ± 1.50^{d}	2.02 ± 0.01^{f}	0.27 ± 0.01^{c}	N.D	0.35 ± 0.02^{a}
Rice (Brown)	7.20 ± 0.15^{c}	225.00 ± 1.58^{d}	1.89 ± 0.03^{f}	0.20 ± 0.02^{d}	N.D	0.11 ± 0.01^{d}
Yam (*DiscoreaSpp*)	3.2 ± 0.07	156± 0.71	2.70 ± 0.71	N.D	N.D	0.35 ± 0.01
Sweet Potato (*Ipomeabatatas*)	3.2 ± 0.07	201± 1.00	2.08 ± 0.04	N.D	N.D	N.D

Values are expressed as mean ± standard deviation for five determinations.
Values with different superscript down the column are significantly different from each other at $p<0.05$.

Akalazi, 2011).

The results showed that protein content was generally low and therefore yam and sweet potatoes are not good source of protein. The carbohydrates content of yam and sweet potatoes were 30.33 % and 26.08 %, respectively as shown in (Table 1). It had been reported by Senanayake et al. 2011, that the carbohydrate content of sweet potato was 78.08 % and sweet potato was reported by Gordon, (2000) that the carbohydrate content of sweet potato was 86.90 %. The values for this analysis were low compared to the reported values. Carbohydrate supplied energy to cells and brain, muscles and blood. It contributed to fat metabolism and spare proteins as and energy source and act as mild natural laxative for human being and generally to bulk of the diet (Gordon, 2000; Gaman and Sherrington, 1996). The calculated metabolisable energy was 143.76 and 133.46 Kcal. The high energy value may be attributed to high carbohydrate content.

Sodium and potasium were higher in sorghum durra (white) with 10.20 mg/kg, 360.00 mg/kg ($p < 0.05$) and were within the range reported values for other type of cereals, 180-380 mg/100g (Woot-Tsuen et al., 1968). This may be due to differences in soil and environmental conditions. Sodium is an important mineral element that assists in the regulation of body tissues (Soetan et

Table 3. Vitamins composition of the commonly consumed cereal grains and tubers.

Sample	β-Caotene (µg/100g)	Vitamin C (mg/100g)	Vitamin E (mg/100g)	Vitamin B_1 (mg/100g)	Vitamin B_2 (mg/100g)
Maize (White)	127.41 ± 0.01^{b}	0.034 ±0.03^{d}	0.52 ± 0.01^{b}	0.32± 0.02^{b}	0.10±0.01^{d}
Maize (yellow)	151.40 ± 0.03^{a}	0.056 ± 0.21^{c}	0.72 ± 0.02^{a}	0.32± 0.01^{b}	0.12±0.02^{c}
Sorghum (Red)	106.33 ± 0.01^{c}	0.056 ± 0.10^{c}	N.D	0.36±0.05^{a}	0.17±0.05^{a}
Sorghum durra (White)	78.35 ± 0.05^{e}	0.067 ± 0.50^{b}	0.02 ± 0.01^{d}	0.03±0.01^{d}	0.14±0.01^{b}
Sorghum durra (Red)	98.55 ± 0.02^{d}	0.067 ± 0.20^{b}	0.05 ± 0.01^{d}	0.33±0.21^{b}	0.15±0.12^{b}
Rice (White)	82.10 ± 0.50^{e}	0.079 ± 0.01^{a}	0.68 ± 0.01^{a}	0.06±0.02^{c}	0.03±0.07^{e}
Rice (Boiled)	58.64 ± 0.01^{f}	0.056 ± 0.70^{c}	0.44 ± 0.02^{c}	0.01±0.04^{e}	0.01±0.01^{f}
Yam (DiscoreaSpp)	N.D.	6.0 ± 0.40	0.35 ± 0.01	0.04 ± 0.03	0.02±0.02
Sweet Potato (*Ipomeabatatas*)	N.D.	2.2 ± 0.02	0.82 ± 0.02	0.09 ± 0.02	0.05±0.10

Values are expressed as mean ± standard deviation for five determinations.
Values with different superscript down the column are significantly different from each other at p<0.05.

Table 4. Anti-nutrients content of commonly consumed cereal grains and tubers.

SAMPLE	Phytate (mg/100g)	Oxalate (mg/100g)	Tannin (mg/100g)
Maize (White)	2.50±0.03^{a}	2.60±0.08^{a}	1.50±0.03^{c}
Maize (Yellow)	2.48±0.35^{a}	2.50±1.00^{b}	1.80±0.04^{b}
Sorghum (Red)	2.50±0.01^{a}	2.30±0.04^{e}	2.20±0.08^{a}
Sorghum durra (White)	2.50±0.02^{a}	1.46±0.50^{f}	0.37±0.04^{f}
Sorghum durra (Red)	2.50±0.05^{a}	1.35±0.07^{g}	0.81±0.01^{e}
Rice (White)	2.53±0.06^{a}	2.40±0.06^{d}	0.37±0.02^{f}
Rice (Brown)	2.16±0.07^{b}	2.45±0.03^{c}	0.89±0.03^{d}
Yam (*DiscoreaSpp*)	0.23± 0.03	0.81± 0.01	2.10 ±0.02
Sweet Potato (*Ipomeabatatas*)	1.07 ± 0.04	0.03 ± 0.02	6.22 ± 0.07

Values are expressed as mean ± standard deviation for three determinations.
Values with different superscript down the column are significantly different from each other at p<0.05.

al., 2010). On the other hand potassium is important in the regulation of hearth beat, neurotransmission and water balance of the body. The zinc content ranges between 1.89 mg/kg and 4.50 mg/kg as shown in Table 2, which are comparable with the value (3.4 mg/100g) obtained by (Olusola et al., 2000). The zinc level was higher in sorghum (red). Zinc serve as a cofactor and as a constituent of many enzymes like lactate dehydrogenase, alcohol dehydrogenase,glutamic dehydrogenase, alkaline phosphatase, carbonic anhydrase, carboxypeptidase, superoxide dismutase, retinene reductase, DNA and RNA polymerase. Zn dependent enzymes are involved in macronutrient metabolism and cell replication (Hays and Swenson, 1985; Arinola, 2008). Mineral elements are important component of the diet because of their physiological and metabolic function in the body. The results showed that yam and sweet potatoes contain sodium of 3.15 mg/kg and 3.20 mg/kg ($p < 0.05$), respectively. Sodium is an important mineral element that assists in the regulation of the body fluid and in the maintenance of electric potential in the body tissue. The world health organization (WHO) recommended intake of sodium per day as 500 mg for adult and 400 mg for children. The results indicated that the sodium content of yam and sweet potatoes were below the recommended standard value. The study also showed that yam and sweet potatoes have potassium 156.00 mg/kg and 201mg/kg ($p < 0.05$), respectively. Potassium is important in the regulation of heartbeat, neurotransmission and body water balance. It was recommended that the daily intake of potassium as 2000 mg for adult and 1600 mg for children . This study reveals that the potassium content in yam and sweet potatoes were below the WHO standard. The results of this analysis also showed that yam and sweet potatoes contained 2.70 mg/kg and 2.08 mg zinc, respectively. The WHO recommended the daily intake for zinc in adult as 15 mg/kg and 10 mg/kg in children. On the other hand, zinc deficiency limits the rate of recovery protein – energy in malnourished children. Finally, copper and lead not detected in both the samples used for this analysis. Copper is required in the body for enzyme production and biological electron transport (Soetan et al., 2010). However, the availability of a particular nutrient in the diet may due to some factors which directly or indirectly affecting the particular. The factors may include both environmental and genetic factors (Gordon, 1977).

β-carotene was detected. The β-carotene values ranged between 58.64 µg/100 g to 151.40 µg/100 g. It

was higher in maize (yellow) as shown in Table 3. Group B vitamins such as B_1 and B_2 of the cereal grains showed that B_1 ranges between 0.01 mg/100 g to 0.36 mg/100 g. The lowest was observed in rice (boiled) and the highest is observed in sorghurm (red). In a related development, Onibi et al.,(2008) reported that the low B_1 content of the rice (boiled) may be due to the fact that the rice have undergone processing which results to loss of the thiamin in the sample. Vitamin B_2 (riboflavin) ranges between 0.01mg/100 g to 0.17 mg/100 g with the lowest observed in rice (boiled) and the highest value in sorghurm (red), respectively. The vitamins composition of the tubers used for this research was analyzed. β-carotene were not detected in both tuber samples. However, 6.0 mg/100 g of vitamin C was seen in yam and 2.2 mg/100 g was observed in sweet potato. The value of vitamin C was higher than the quoted values by USDA, 2012 and was compared favorably with USDA**,** 2012 values. Our research also revealed that 0.35 mg/100 g of vitamin E was seen in yam and 0.82 mg/100 g in sweet potatoes. This also falls within the range of values quoted by USDA, 2012. Both thiamin and riboflavin was detected in both samples and the values were 0.04 mg/100 g, 0.02 mg/100 g and 0.09 mg/100 g, 0.05mg/100 g, respectively as shown in Table 3.

The anti-nutrients composition of the commonly consumed cereal grains were analyzed, the values for phytate ranges between 2.16 mg/100 g to 2.53 mg/100 g ($p < 0.05$) as shown in Table 4; the lowest is observed in boiled rice and the highest is observed in white rice. The obtained results were comparable with the values 1.5 mg/100 g quoted by (Olusola et al., 2000). The results showed that there were significant differences in the levels of phytate in the cereal grains. The tannin content ranges between 0.37 mg/100 g in rice (white) and sorghum durra (white) to 2.20 mg/100 g ($p < 0.05$) in sorghurm (red).The results showed that there is significant difference in the level of tannin in the cereal grains.

The anti-nutritional composition of the tubers (yam and sweet potatoes) was analyzed and the results revealed that some tubers contained high amount of anti-nutrient compared to others, while the level of some may be very minute. Yam contained higher oxalate with 0.81mg/100 g than sweet potatoes which contain 0.03 mg/100 g. Oxalate if preset in large quantity can cause gastroenteritis shock, convulsive symptoms and renal damage.

The effect can be reduced through post-harvest processing. However, oxalates play an important role in limiting the availability of some elements like calcium, manganese and phosphorus in the food crops (Pearson, 1994). Sweet potatoes contain higher phytate, tannin than yam with glycosides being absent in sweet potatoes. The disparity in the concentration of these anti-nutrients from food samples may be ascribed to soil factors like pH of the soil or other environmental influences (Eka, 1985).

CONCLUSION

The main objective of this study was to provide useful and current information on the nutrient composition (proximate, mineral element and vitamins) and the anti-nutritional factors (phytate, oxalate and tannins) of some selected commonly consumed food in Adamawa state. However, the fact that series of disparities were noticed between the existing food compositional data and the one produced by this study cannot be over emphasized and the reasons are not farfetched. The study showed that sodium, copper potassium and zinc were detected in the food stuff investigated. Potassium was found to be higher in cereal grains. Lead was not detected in the cereal grains and tubers. It was also observed that the level of anti-nutritional factors was found to be high in cereals. We have also observed that, the levels of some anti-nutritional factors may not affect the availability and utilization of nutrients.

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