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Original Article

EVALUATION OF PHYTOCHEMICALS, PROXIMATE, MINERALS AND ANTI-NUTRITIONAL COMPOSITIONS OF YAM PEEL, MAIZE CHAFF AND BEAN COAT

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ABSTRACT

Yam peel, maize chaff and bean coat were analyzed for their phytochemicals, proximate, mineral and antinutritional composition using standard procedures and methods. Phytochemical analysis revealed the presence of Alkaloids, Tannins, flavonoids, saponins glycoside and steroids in all the three samples analysed. Anthraquinones were absent in yam peel but present in maize chaff and bean coat, while phlobatannins where detected only in beans coat sample. Quantification of the phytochemicals and antinutritional content (in g/100g) showed yam peel, maize chaff and been coat to contain alkaloids concentration of 0.03±0.01, 0.07±0.01 and 0.09±0.00; tannin concentration of 8.19±0.01, 8.51±0.65 and 9.20±0.02; Oxalate concentration of 0.028±0.01, 0.06±0.01, 0.01±0.03;Phytate concentration; 0.36±0.00, 0.34±0.4, 0.08±0.00 and cyanide concentration of 1.06±0.01, 1.35±0.03, 1.41±0.04, respectively. Analysis of mineral composition (in mg/100g) showed that the yam peel contained 99.5±0.14 Na, 137.0±0.88 K, 68.5±0.70 Fe, and 45.5±0.23 Ca. Bean coat contained (in mg/100g) 106.5±0.71 Na 68.5±0.62 K, 19.9±0.09 Fe, and 154.0±0.63 Ca. Maize chaff contain 110.5±0.16 Na, 61.0±0.91 K, 7.0±0.11 Fe, and 14.0±0.91 Ca. Proximate analysis revealed that fiber, carbohydrate ash and moisture content occurred in appreciable amounts in all the three samples while lipid and protein contents of the 3 samples were low. The highest fiber content was detected in yam peel (41.0±0.9%) followed by bean coat (26.0±0.8%) and the least was maize chaff with fiber content of 20.0±0.6. The highest carbohydrate content was recorded for maize chaff (57.90±0.7%) followed by bean coat (45.5±0.4%) and then yam peel (32.49±0.5%). The moisture content occurred in the order of yam peel (11.75±0.03), bean coat (11.5±0.02%), and maize chaff (5.50±0.46%). The ash content in the order of yam peel

(10.0±0.1%), bean coat (9.0±0.02%) and maize chaff (6.2±0.27%). It was concluded that Yam peel, maize chaff and bean coat could play a significant nutritional role in human and livestock health.

Key words: Anti-nutritional, bean coat, maize chaff, minerals, phytochemicals, Proximate, Yam peel

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INTRODUCTION

Although conventional food plants have the capabilities of providing most of the nutrients needed for energy, body building, maintenance and regulation of body processes, the need to explore some seemingly unappealing sources of nutrients have become imperative owing to the serious threat to growth, development and survival posed by increasing human population, food insecurity and economic crises in most developing nations like Nigeria (Hassan *et al.*, 2007).

Over the years, maize has not only served as a staple food for humans and a major raw material for most industries but, also a major source of energy in poultry diets, which makes it expensive and sometimes unavailable due to its seasonality (Ezieshi and Olomu, 2011). Maize can be eaten directly after cooking or smoking. Maize is also dechaff, grinded and processed into other African food products like *ogi and Tuwo* by the northerners in Nigeria. The Chaff material is, however, converted into durable silage which is primarily used for animal feeding. According to Ilori *et al.* (2013), Maize seed contain grain/chaff ratio of 3.04:1.However to the best of our knowledge there is paucity of information on the nutritional, and chemical composition of the chaff.

Food legumes like beans, peas, lentils, and ground nuts belong to the Family "Leguminosae", also called "Fabaceae". They are mainly grown for their edible seeds, and thus also named as grain legumes. They play an important role in human nutrition because they are rich source of protein, calories, certain minerals and vitamins (Deshpande, 1992). In Nigeria, It is often used in the preparation of traditional dishes such as "moinmoin" or "akara", bean pudding and bean soup amongst others. For most food uses, the seed coats of beans are removed to reduce the anti-physiological factors thus result in better appearance, texture, cooking quality, palatability and digestibility of the products (Akinjayeju and Enude, 2002).Anti-nutritive factors limit the use of many plants for food because they elicit deleterious effects in both man and animals (Kubmarawa *et al.*, 2008).

Yams, the tubers of *Dioscorea* spp., are important staple foods in many tropical countries (Omonigho and Ikenebomeh, 2000). Even more interestingly, yams have also been used as health food and herbal medicinal ingredients in traditional Chinese medicine (Liu *et al.*, 1995). According to Chan (1983), the major yam producing countries in West Africa, in order of importance are Nigeria, Ivory Coast, Ghana, Togo, Benin Republic and Republic of Guinea. Yam are consumed differently in forms of boiled yam, pounded yam, mashed, fried, baked, and roasted, also as yam flakes or chips (Adetoro, 2012).

Yam peels are basic wastes or by-products when yam is peeled during processing for cooking and other purposes. They are largely sourced from yam processing centres, commercial eateries, markets and are fed to animals such as goats and sheep (Ekenyem *et al*., 2006), used as feed for snails (Omole *et al*., 2013), Broiler Chicks (Ekenyem *et al*., 2006) and Weaner Rabbits (Akinmutimi *et al*., 2006). Yam peels also possess biosorptive capacity for the removal of dye from aqueous solutions (Hilary *et al*.,2013).The peels constitute about 10% of the yam (Ijaiya and Awonusi, 2005), and have been reported to contain 2 to 6% of crude protein depending on the varieties, the crude fibre ranges between 9 to 15% (Akinmutimi *et al*., 2006). However, their utilization is sometimes limited as a result of poor understanding of their nutritional, antinutritional and economic values as well as proper use in livestock diets (Albrecht and Muck, 1991).They constitute environmental hazard where it is not properly utilized. Therefore, the objective of this study was to investigate the proximate, mineral, anti-nutritional and phytochemical composition of yam peel, beans coat and maize chaff in order to elucidate their chemical and nutritional composition, optimize their utilization and ascertain their usefulness to the economy, health and nutritional benefits.

MATERIALS AND METHODS

Source of Materials

The yam tubers (Discorea *rotundata*), Bean seed (Phaseolus *vulgaris*) and maize seeds (Zea *mays)* used for this study were obtained from Bosso market, in Minna, Niger state. Nigeria. All chemicals used were of analytical grade and were products of Sigma Chemical Co., USA. Distilled water was use for all the washing, cleaning and preparation of solutions

Sample Preparation

The Bean and maize seeds were manually cleaned to remove extraneous materials and unwholesome seeds. The cleaned Bean seeds were soaked in distilled water overnight to facilitate the removal of the coat. The maize seed were dechaffed and bean coat were dried for one week at room temperature. The Yam tubers were pealed manually with the aid of Knife and the peels were dried at room temperature. The dried samples were pulverized using electronic blending machine and stored in plastic container prior to the analysis.

Proximate Analysis

Determination of Moisture content:

Two (2) grams of each of the sample was placed in the crucible and heated at 105˚C, until a constant weight was attained. The moisture content of each sample was calculated as loss in weight of the original sample and expressed as percentage moisture content (FAO, 1980).

$$\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - w_1} \times 100$$

Where:

W_1 = initial weight of empty crucible

W_2 = weight of crucible +sample before drying

W_3= final weight of crucible + sample after drying

Determination of Crude Protein

Two (2) grams of each samples was weighed along with 20cm3 of distilled water into a micro – Kjeldahl digestion flask. It was shaken and allowed to

stand for some time. One tablet of Selenium catalyst was added followed by the addition of 20cm^3 concentrated Sulphuric acid. The flask was heated on the digestion block at 100^{0}C for 4 hours, until the digest became clear. The flask was removed from the block and allowed to cool. The content was transferred into 50cm^3 volumetric flask and diluted to the mark with water.

An aliquot of the digest (10cm^3) was transferred into another micro-Kjeldahl flask and placed in the distilling outlet of the micro – Kjeldahl distillation unit. A conical flask containing 5cm^3 of boric acid indicator was placed under the condenser outlet. Sodium hydroxide solution (10cm^3, 40%) was added to the content in the Kjeldahl flask by opening the funnel stopcock. The distillation starts and the heat supplied was regulated to avoid sucking back. When all the available distillate was collected in 5cm^3 of Boric acid, the distillation was stopped. The Nitrogen in the distillate was determined by titrating with 0.01M of H_2SO_4; the end point was obtained when the colour of the distillate changed from green to pink. The percentage Nitrogen was calculated and multiplied by 6.25 to obtain the value of the crude protein (AOAC, 1990).

$$\% \text{ Nitrogen} = \frac{Vs - V_b \times N_{acid} \times 0.01401}{W} \times 100$$

Where: Vs =titer value of the sample
V_b= Volume of acid required to titrate

Nacid= normality of acid

W= weight of sample in grams

Determination of Crude Lipid

This estimation was performed using the Soxhlet extraction method. Ten grammes of each of the samples were weighed and wrapped with a filter paper and placed in a thimble. The thimble was covered with cotton wool and placed in the extraction column that was connected to a condenser. 200 ml of n–Hexane was used to extract the lipid (A.O.A.C., 1990).

$$\%\text{Fat} = \frac{W_2 - W_3}{\text{Weight of sample}} \times 100$$

Where, W_2=Weight of filter paper and sample before extraction

W_3=Weight of filter paper and sample after extraction

Determination of Crude Fibre

The estimation was done using the method of A.O.A.C. (1990). Five grammes of each of the sample and 200 ml of 1.25% H_2SO4 were heated for 30 min and filtered with a Buchner funnel. The residue was washed with distilled water until it was acid-free. 200 ml of 1.25% NaOH was used to boil the residue for 30 minutes, it was filtered and washed several times with distilled water until it was alkaline-free. It was then rinsed once with 10% HCl and twice with ethanol. Finally it was rinsed with petroleum ether three times. The residue was put in a crucible and dried at 105^{o}C in an oven overnight. After cooling in a desiccator, it was ignited in a muffle furnace at 550^{o}C for 90 minutes, to obtain the weight of the ash.

$$\textbf{\% of Crude Fibre} = \frac{W_2 - W_3}{W_1} \times 100\ \textbf{\%}$$

Determination of Ash Content

This was done using the method of A.O.A.C (1990). The total ash content of a substance is the percentage of inorganic residue remaining after the organic matter has been ignited. 2 g of each of the sample was placed in a

crucible and ignited in a muffle furnace at 550^{o}C for 6 hours. It was then cooled in a desiccator and weighed at room temperature to get the weight of the ash, using the formular:

$$\%\text{Ash content} = \frac{\text{Weight of ash}}{\text{Weight of original food}} \times 1000$$

Carbohydrate Determination

The carbohydrate content was determined by subtracting the summed up percentage compositions of moisture, protein, lipid, fibre, and ash contents from 100 (Otitoju, 2009).

%Carbohydrate: = 100 – (%Protein + %Moisture + %Ash + % Fibre)

Mineral Analysis

The method of A.O.A.C (1990) was employed for the determination of mineral content. One gramme of the pulverized samples was placed in a crucible and ignited in a muffle furnace at 550^{O}C for 6 hours. The resulting ash was dissolved in 10 ml of 10 % HNO3 and heated slowly for 20 minutes. After heating, it was filtered and the filtrate was used for the determination of mineral content. Atomic absorption spectrophotometer (AAS) was used to determine Ca and Fe, while flame photometer was used for the determination of Na and K in the filtrate.

Qualitative Phytochemical Analysis

Glycoside

A 0.5g portion of each of the sample was mixed with 2ml of glacial acetate and 1 drop of ferric chloride solution, after which 1ml of concentrated sulphuric acid were added. The reaction was observed for a brown ring formation (Sofowora, 1996).

Steroids

A 0.5 g portion of the ethanolic extract fraction of each plant was mixed with 2 ml of acetic anhydride followed by 2 ml of sulphuric acid. The colour changed from violet to blue or green in some samples indicated the presence of steroids (Sofowora, 1993).

Flavonoids

A portion of powdered plant in each case was heated with 10 ml of ethyl acetate in a test tube over a steam bath for 3 minutes. The mixture was filtered and 4 ml of the filtrate was shaken with 1 ml of dilute ammonia solution. Yellow coloration was observed that indicated the presence of Flavonoids (Harborne, 1973; Sofowora, 1993).

Tannins

A 0.5 g portion of the dried powdered sample was boiled in 20 ml of distilled water in a test tube and filtered. 0.1% ferric chloride ($FeCl_3$) solution was added to the filtrate. The appearance of brownish green or a blue-black colouration indicates the presence of tannins in the test samples (Harborne, 1973).

Saponins

A 2.0 g portion of the powdered sample was boiled in 20 ml of distilled water in a test tube in boiling water bath and filtered. 10 ml of the filtrate was mixed with 5 ml of distilled water and shaken vigorously to form a stable persistent froth. The frothing was mixed with 3 drops of olive oil and shaken vigorously for the formation of emulsion characteristic of saponins (Obadoni and Ochuko, 2001).

Anthraquinones

A 0.5 g portion of the plant extract was shaken with 5 ml of chloroform. The

chloroform layer was filtered and 5.0 cm^3 of 10 % ammonia solution was added to the filtrate. The mixture was shaken thoroughly and the formation of a pink/violet or red, yellow colour in the ammoniacal phase indicates the presence of Anthraquinones (Harborne, 1973).

Alkaloids

A 0.5g portion of the extract was stirred with 5cm^3 of 1% aqueous HCl on a steam bath. Few drops of picric acid solution was added to 2cm^3 of the extract. The formation of a reddish brown precipitate was taken as a preliminary evidence for the presence of alkaloids (Harborne, 1976: Trease and Evans 1989).

Phlobatannins

A 2.0 g portion of the powdered sample was boiled with 1% aqueous hydrochloric acid; the formation of red precipitate thus indicated the presence of phlobatanins (Harborne, 1973; Sofowara, 1993)

Quantitative Phytochemicals and Anti-nutritional Analysis

Determination of Alkaloids

A 0.5 g portion of the sample was dissolved in 96% ethanol: 20% H_2SO_4 (1:1). 1 ml of the filtrate was added to 5ml of 60% tetraoxosulphate (VI), and left undisturbed for 5 minutes. Then, 5 ml of 0.5% formaldehyde was added and left to stand for 3 hours. The absorbance was read at 565 nm. The extinction coefficient (E_{296}, ethanol {ETOH} =15136M^{-1} cm^{-1}) of vincristine was used as reference alkaloid (Harborne, 1976).

Determination of Tannins

A 0.2 g portion of the sample was measured into a 50 ml beaker. 20 ml of 50 % methanol was added and covered with para film and placed in a water bath at 77-80^oC for 1hour. It was shaken thoroughly to ensure a uniform mixture. The extract was quantitatively filtered using a double layered Whatman No. 1 filter paper into a 100 ml volumetric flask, 20 ml of water was added, 2.5 ml Folin-Denis reagent and 10 ml of 17% Na_2CO_3 were added and mixed properly. The mixture was made up to the marked level with distilled water mixed well and left undisturbed for 20minutes for the development of a bluish-green colour. The absorbances of the tannic acid standard solutions as well as the samples were read after colour development on a UV-Vis spectrophotometer model 752, at a wavelength of 760 nm (AOAC, 1999).

Determination of Phytate

The phytic acid content was determined using a modified indirect colorimetric method of Wheeler and Ferrel (1971). The method depends on an Iron to phosphorus ratio of 4:6 and is based on the ability of standard ferric chloride to precipitate phytate in dilute HCI extract of the sample. 5g of the sample was extracted with 20ml of 3% trichloroacetic acid and filtered. 5ml of the filtrate was used for the analysis; the phytate was precipitated as ferric phytate and converted to ferric hydroxide and soluble sodium phytate by adding 5ml of IM NaOH. The precipitate was dissolved with hot 3.2M HNO_3 and the absorbances were read immediately at 480nm. Preparation of standard curve for phytic acid was done as follows: standard curve of different Fe $(NO_3)_3$ concentrations was plotted against the corresponding absorbance of spectrophotometer to calculate the ferric iron concentration. The phytate phosphorus was calculated from the concentration of ferric iron assuming 4:6 iron: phosphorus molar ratio.

Determination of oxalate:

The titrimetric method of Day and Underwood (1986) was used in the determination of oxalate in each of the sample. 150 ml of 15 N H_2SO_4 was added to 5 g of the pulverized sample and the solution was carefully stirred intermittently with a magnetic stirrer for 30 minutes and filtered using Whatman No 1 filter paper, after which 25 ml of the filtrate was collected and titrated against 0.05M standardize $KMno_4$ solution until a faint pink color appeared that persisted for 30 seconds.

Determination of Cyanide

Cyanide content was determined by alkaline picrate method according to Wang and Filled method as described by Onwuka (2005). 5g of powdered sample was dissolved in 50ml of distilled water in a cooked conical flask and the extraction was allowed to stand over-night, filtered. 1ml of sample filtered was mixed with 4ml alkaline picrate in a corked test tube and incubated in a water bath for 5mins. After colour development (reddish brown colour) the absorbance was read at 490nm, the absorbance of the blank containing 1ml distilled water and 4ml alkaline picrate solution was also recorded. The cyanide content was extrapolated from cyanide standard curve prepared from different concentration of KCN solution containing 5-50µg cyanide in a 5001 conical flask followed by addition of 25ml of 1NHCI

Statistical analysis

All determinations were carried out in triplicates. The results generated from the analysis were subjected to statistical analysis using the Statistical Package for Social Science (SPSS) Version 16. Descriptive statistics was used to interpret the results obtained.

RESULTS

Phytochemical

Table 1 shows the result of qualitative phytochemical analysis of the 3 samples. The results revealed the presence of Alkaloids Tannis, flavonoids, saponins glycoside and steroids in all the three samples analysed. Anthraquinones were absent in yam peel but present in maize chaff and bean coat, while phlobatannins where detected only in beans coat sample.

Quantification of the phytochemicals showed yam peel, maize chaff and been coat to contain alkaloids in concentrations (g/100g) of 0.03 ± 0.01, 0.07 ± 0.01 and 0.09 ± 0.00 respectively, and tannin concentration of 8.19 ± 0.01, 8.51 ± 0.65 and 9.20 ± 0.02g/100g respectively (Table 2).

Antinutritional

Antinutritional analysis of the samples gave (in g/100g): oxalate (0.028 ± 0.01), phytate (0.36 ± 0.00) and cyanide (1.06 ± 0.01) for the yam peel sample; Oxalate (0.06 ± 0.01), phytate (0.34 ± 0.4) and cyanide (1.35 ± 0.03) for maize chaff sample while, the bean coat had the composition of oxalate (0.01 ± 0.03) phytate (0.08 ± 0.00) and cyanide (1.41 ± 0.04) (Table 2).

Proximate

The quantitative estimation of the Proximate content in yam peel, bean coat and maize chaff are shown in table 3: fiber, carbohydrate ash and moisture content occurred in appreciable amounts in all the three samples while

Table 1: Qualitative Phytochemicals composition of yam peel, maize chaff and bean coat

	Samples		
Phytochemicals	Maize Chaff	Yam Peel	Bean coat
Alkaloids	+	+	+
Flavonoids	+	+	+
Saponins	+	+	+
Tannis	+	+	+
Steroids	+	+	+
Glycoside	+	+	+
Phlobatannins	-	-	+
Anthraquinones	+	-	+

Key + = present - = absent

Table 2: Quantitative phytochemicals and antinutritional composition of yam peel, maize chaff and bean coat

Sample	Phytochemicals and Anti-nutrient (g/100g)				
	Alkaloids	Tannins	Cyanide	Phytate	Oxalate
Yam	0.03±0.01	8.19±0.01	1.06±0.01	0.36±0.00	0.028±0.01
Maize	0.071±0.01	8.51±0.65	1.35±0.03	0.34±0.04	0.06±0.01
Bean	0.09±0.00	9.20±0.02	1.41±6.04	0.08±0.00	0.61±0.03

Data are Mean ± SEM of triplicate determination

Table 3: Proximate composition of yam peel, maize chaff and bean coat

Sample	Proximate Composition (g/100g)					
	Moisture	Lipid	Protein	Ash	Fiber	Carbohydrate
Yam Peel	11.75±0.03	1.30±0.20	3.46±0.90	10.00±0.10	41.00±6.90	32.49±0.50
Maize Chaff	8.50±0.46	6.75±0.03	3.65±0.60	6.20±0.27	20.00±0.60	54.90±0.70
Beans Coat	11.50±0.02	1.25±0.11	6.75±0.80	9.00±0.02	26.00±0.80	45.50±0.40

Data are Mean ± SEM of triplicate determination

Table 4: Minerals composition of yam peel, maize chaff and bean coat

Sample	Minerals (mg/100g)			
	Sodium	Potassium	Iron	Calcium
Yam Peel	99.50±0.14	137.00±0.88	68.50±0.70	45.50±0.23
Maize Chaff	110.50±0.16	61.00±0.91	7.00±0.11	14.00±0.91
Bean Coat	106.50±0.71	68.50±0.62	17.00±0.09	154.00±0.63

lipid and protein contents of the 3 samples were low. The highest fiber content were detected in yam peel (41.0±0.9%) followed by bean coat (26.0±0.8%) and the least was maize chaff with fiber content on 20.0±0.6 the highest carbohydrate content was recorded for maize chaff (57.90±0.7%) followed by bean coat (45.5±0.4%) and then yam peel (32.49±0.5%). The moisture content occurred in the order of yam peel (11.75±0.03%) bean coat (11.5±0.02%) and maize chaff (5.50±0.46%). The ash content in the order of yam peel (10.0±0.1%), bean coat (9.0±0.02%) and maize chaff (6.2±0.27%).

Minerals

Table 4 presents the results of mineral analysis of yam peel, bean coat and maize chaff. It shows that the yam peel contained (mg/100g): 99.5±0.14 Sodium, 137.0±0.88 Potassium, 68.5±0.70 Iron, and 45.5±0.23 Calcium. Bean coat contained (mg/100g) 106.5±0.71 Sodium, 68.5±0.62 Potassium, 19.9±0.09 Iron, and 154.0±0.63 Calcium. Maize chaff contained (mg/100g) 110.5±0.16 Sodium, 61.0±0.91 Potassium, 7.0±0.11 Iron, and 14.0±0.91 Calcium.

DISCUSSION

Phytochemical

Phytochemicals are secondary plant metabolites that occur in various parts of plants, they have diverse roles in plants which include provision of vigour to plant; attraction of insect for pollination and feeding defence against predators, provision of colour while some are simply waste products (Igwe *et al.*, 2007). However this phytochemicals elicit varied biochemical and pharmacological actions when ingested by animals (Trease and Evans, 1989).This study revealed the presence of various medically important phytochemicals in yam peel, maize chaff and bean coat. Flavonoids are the most diversified groups of phenolic compounds found in plants. The presence of flavoids in maize chaff, bean coat and yam peel, Suggest the ability of this by-product to play an important role in preventing disorders associated with oxidative stress.

Alkaloid are the most efficient therapeutically significant plant substance (Njoku and Akumefula, 2007).Although the alkaloid content of yam peel (0.03±0.01g/100g) maize chaff (0.07±0.01g/100g) and bean coat (0.09±0.00 g/100g) is lower comparably with alkaloids content of some medicinal plants, its presence in the three samples make them recommendable for patients as alkaloids possess a significant pharmacological property

Tannin is non-toxic and can generate physiological responses in animals that consume them (Scalbert, 1991). The presence of tannin in the yam peel, bean coat and maize chaff suggests the ability of these plants to play major roles as antifungal, antidiarrheal, antioxidant and antihemorrhoidal agents (Asquith and Butter, 1986). In the present study, the levels of tannin in all the by-product is comparable with the 9.0±0.17 g/100g reported for BaelPulp (Uttara *et al.*, 2012)

Saponin has been reported to have anti-inflamatory, cardiac depressant and hyper-cholesterolemic (Trease and Evans, 1985). Saponin & Steroid also have relationships with sex hormones like oxytocin which regulate the onset of labour in pregnant women and subsequent release of milk (Okwu and Okwu 2004). The presence of this

phytochemicals in yam peel, maize chaff and bean coat is an indication that this by-product can be given to expectant ruminant animals and those that deliver without the expulsion of their placenta.

Glycoside showed positive result in the yam peel, maize chaff and bean coat. This perhaps suggests the ability of this by-product in the treatment and management of hypertension (Taiwo *et al.*, 2009).The presence of important phytochemicals in yam peel, maize chaff and bean coat is an indication that this by-product if properly screened could yield a drug of pharmaceutical significance. However, the absence of phlobatannins in maize chaff, yam peel but present in bean coat and the absence of anthraquinone only in yam peel agree with early studies which also found that not all phytochemicals are present in all plants (Tijjani *et al.*, 2009).

Anti-Nutrients

Anti-nutritive factors limit the use of many plants for food because they elicit deleterious effects in both man and animals (Kubmarawa *et al.*, 2008). Fortunately, the levels of anti-nutrients in these plant materials were found to be low compared to other agricultural product. Oxalates from plant sources have been known to cause irreversible oxalate nephrosis when ingested in large doses. The Oxalate contents (0.028± 0.01) yam peel, (0.61± 0.03) Beans coatand (0.06± 0.01) maize chaff found in this study was low as compared to 1.26 % early reported for yam peel and1.04%reported for Sweet potato peel (Akinmutimi and Anakebe, 2008) and 0.024% reported for orange peel (Oluremi *et al.*, 2010).

The knowledge of the phytate level in foods is necessary because high concentration can cause adverse effects on the digestibility. In present study, the observed phytic acid values 0.36± 0.00g/100g (yam peel); 0.08± 0.00g/100g (Beans coat) and 0.34± 0.04g/100g (maize chaff) is comparably lower than 0.94% early reported for yam peel and 0.740 reported for Sweet potato peel (Akinmutimi and Anakebe, 2008). High level of HCN has been implicated in cerebral damage and lethargy in man and animal. The cyanate level in the present study was found to be low and non-toxic to humans and animals.

It is established that only high content of these antinutrients prevent the absorption of mineral like iron, magnesium, potassium and calcium which are essential for metabolism in the body. Reduction of antinutrients in foods may be necessary especially when their levels are higher than those generally regarded as safe for human consumption. This can be accomplished through different hydrothermal treatments, which also enhances the nutritional qualities: increase palatability and digestibility of foods (Adeniji *et al.,* 2007).

Proximate analysis

Analysis of proximate composition gives information on the basic chemical composition of the by-products. The compositions is moisture, ash, crude fat, protein and carbohydrate. Moisture content is an index of water activity of many food the observed moisture content of yam peel (11.75%), maize chaff (8.50%) and bean coat (11.50%) was comparable with 6.70% reported for banana peel (Anhwange *et al.*, 2009), and 9.96% reported for mango peel (Ashifat *et al.*, 2011). The observed moisture content in this study was considered moderately good as water has been reported to enhance ease transportation of nutrient and other necessary metabolic reactions. The

moderately low moisture content of this by-product will favour their preventive properties against microbial attacked and thus the storage life will be high (Adeyeye and Ayejugo 1994).

The protein content of yam peel (3.46%), maize chaff (3.65%) and bean coat (6.75%) is an indication that this by-product could support growth and movement, body defence in both livestock and human being. This value are comparably with 4.32% obtained for mango peel (Ashifat *et al.*, 2011) but higher than 0.9% for Banana peel (Anhwange *et al.*,2009) and lower than 11.74% reported for plantain bract (Adeolu and Enesi *et al.*, 2013). However the protein content of the yam peel in this study fall within the range of protein value of yam peel (2-6%) reported by (Akinmutimi *et al.*, 2006).

The lipid content 1.30% yam peel, 6.75% maize chaff and 1.25% bean coatobtained in this study was quiet reasonable as excess fat consumptions is implicated in the etiology of certain cardiovascular disease such as cancer and aging (Anha *et al.*, 2006). The lipid content of yam peel and bean coat is comparable with 1.7% reported for banana peel (Angwange *et al.*, 2009) 1.83% for plantain bract (Adeolu and Enesi, 2013) but lower than 4.32% report for mango peel (Ashifat *et al.*, 2011). The low content of these byproducts can be recommended as part of weight reducing diets.

The high carbohydrate content of maize chaff (54.90%), bean coat (45.5%) and yam peel (32.49%) is an indication that this by-product could serve as a good source of energy for both livestock and human being. Similar high level of carbohydrate has been reported for 57.92% for mango peel (Ashifat *et al.*, 2010) 51.1% cassava peel (Ganiyu, 2006) and 48.18% for banana peel. However high carbohydrate contents of these byproduct of maize chaff (54.90%),

These study also revealed that the by-product are excellent source of fiber especially the yam peel (41%) and bean coat (26%) this is an important consideration for people who suffer from elevated cholesterol level (Ekumakana, 2005). Fiber aid absorption of trace element, reduce the absorption of cholesterol, starch and guard against metabolic disorder such as hypertension and diabetes mellitus (Mensah *et al.*, 2012). The fiber content of yam peel in this study is relatively higher than 9 to 15% early reported by Akinmutimi *et al.*, (2006) and 16.50% reported for mango peel (Ashifat *et al.*, 2011).

The ash content gives a measure of total amount of inorganic compounds like minerals present in a sample. The ash content of yam peel (10.0%) obtained in this study correspond with the reported value (10.17%) for the same sample by (Akinmutimi and Anakebe, 2008). The ash content of bean coat (9.00%) and maize chaff (6.27%) is higher than that of orange peel (3.88%) (Oluremi *et al.*, 2010) and 3.41% reported for plantain and banana bybrids pulp and peel mixture (adeniji *et al.*, 2007). High ash content of the yam peel, bean coat and maize chaff obtained in this study is an indication that these by-product could serve as an important source of minerals for both livestock and humans.

Mineral

Calcium is necessary for the strong bones and teeth. It is relatively high in cereals, nuts and vegetable (James, 1996) The RDA value of calcium is 600-1400mg/kg (Bolt and Bruggenwert, 1978). The Bean coat was determined to have the highest concentration of

Calcium (154.0 ± 0.63 mg/100g). However Considering the importance of Calcium, its low concentration in yam peel (45.5± 0.23 mg/100g) and maize chaff (14.0± 0.91 mg/100g) implies that this by product can slightly contribute to the amount of dietary calcium

Excess sodium consumption leads to hypertension (NRC, 1989).The concentration of sodium in the yam peel (99.5±0.14 mg/100g), maize chaff (110.5±0.16 mg/100g) and bean coat (106.5±0.71 mg/100g) was lower than the 128.12 ±0.01 mg/100g reported for Velvet beans [*Mucuna pruriens)* seed *(*Kalidass and Mahapatra, 2014) and 280.05±0.05mg/100g reported for african Oil Bean (*Pentacle thrama crophylla*) seeds (Oyeleke *et al*., 2014).

The yam peel was determined to have the highest concentration Iron (68.5 ± 0.70 mg/100g). The Iron concentration of bean coat (17.9mg/100g) is higher than 11.34mg/kg reported for mung bean *(*Habibullah *et al*., 2007) and 14.74 ±0.04 reported for Velvet beans seed *(*Kalidass and Mahapatra, 2014). This by product from the result obtained can be used in improving the anaemic condition in iron deficient diabetic patients.

Of the minerals analyzed in the yam peel, potassium was the most abundant (137.01 ± 0.12 mg/100 g) element, and this is in agreement with many reports that potassium is the most abundant mineral in Nigerian agricultural products (Afolabi *et al*., 1995). Also the yam peel was determined to have the high concentration Potassium (137.01 ± 0.88 mg/100g) as compared to maize chaff (61.00±0.91mg/100g) and bean coat (68.50±0.62mg/100g). The high level of potassium in these by-products is good indication that its consumption will enhance the maintenance of the osmotic pressure and acid-base equilibrium of the body (Odoemena and Ekanem, 2006). However This values are higher compare to 43.21 reported for horse eye bean *(Mucuna poggei),* (Oko *et al*., 2012) and 40.00 ± 0.00 mg/100g reported for plantainbract (Adeolu and Enesi, 2013) but lower compare to 1443 mg/ 100g, reported for mung bean *(*Habibullah *et al*., 2007).

CONCLUSION

It was concluded that yam peel, maize chaff and bean coat contain an appreciable amount of macro- and micronutrients which could be included in the daily dietary pattern of human. This will help to minimize the risk of nutrients deficiency in the consumers. The three by-products also appear to be potential good sources of nutrients for production of animal feeds, and their utilization for this purpose should be encouraged, thereby enhancing solid wastes management and reducing environmental pollution This by-products also contain important phytochemicals needed to combat various kinds of infection in humans, thus, efforts should be directed towards harnessing their potentials in drug formulation and development. Finally, cooking of yam should be done together with the peel so as to ensure the availability of the fiber in the cooked ya

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