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Proximate Composition, Mineral Content and Anti-nutrient of Raw and Sun-dried Sweet Potato Peel

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Abstract

This study was conducted to evaluate the proximate composition, mineral content, and anti-nutrients of raw and sun-dried sweet potato peel. The sweet potato peel was obtained from restaurateurs in ABU Zaria main campus. The fresh sweet potato peel was properly washed, sun-dried and analysed in triplicate at Institute for Agricultural Research, ABU, Zaria. The percentage nitrogen free extract, crude protein content and ash of sun-dried sweet potato peel were higher than those obtained from raw sweet potato peel, while higher percentage of moisture, ether extract and crude fibre content were recorded in raw sweet potato peel. The macro and micro mineral compositions of raw and sun-dried sweet potato peel indicates no significant difference (p>0.05) in their concentrations. Sodium (Na) has the highest mean concentration among the macro minerals with a value of 5.5521mg and 5.5611mg followed by potassium (K) with a mean concentration of 2.9290mg and 2.9190mg for the raw and sun-dried sweet potato peel, respectively. Analysis of anti-nutritional factors of the raw and sun-dried sweet potato peel indicates that all the components determined were greatly reduced after drying except oxalate which was 0.22mg in the raw sweet potato peel increased to 0.29mg in the sun-dried sweet potato peel. This study concluded that the sun-dried sweet potato peel had good

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proximate composition and least antinutrients.

Keywords: Sweet Potato Peel, Nitrogen Free Extract, Sun-dried, Sodium, Crude Protein

Introduction

Sweet potato (*Ipomoea batatas* Lam) is one of the main root and tuber crops commonly grown in the tropical and subtropical parts of the world. It is the seventh most important food crop in the world (Okorie and Onyeneke, 2012). It originated from Central America but is now widely grown and consumed as subsistence staples in many parts of Africa (including Nigeria), Latin America, the Pacific Islands and Asia. Nigeria is the single largest producer of sweet potato in Africa with 3.46 million metric tonnes and second only to China globally. Sweet potato is valued for its short growing period of about 3-4 months, high nutritional content and its sweetness. Sweet potato is considered as an important food security crop, especially in Nigeria and is also identified as the all year-round source of dietary vitamin A (especially the orange fleshed type) among the poor. In parts of East Africa tubers are sometimes sliced and sun-dried to produce chips, which are later ground into flour. Sweet potatoes are rich source of energy, antioxidants and vitamins (especially vitamin C) as well as carotenoids (Wakjira *et al.,* 2011). They are also an excellent source of fibre and minerals, which are important in reducing blood cholesterol and aid digestion (Effah-Manu *et al.,* 2013).

Sweet potato peels produced from industrial processes are responsible for an enormous amount of waste (Akoetey *et al.,* 2017). It has been estimated that approximately 30% of the raw material coming into sweet potato canning operations is discarded and not used for human consumption. If they are used at all, the peels are typically used for either fertilizer or animal feed. The present study was, therefore, initiated to analyze the sun-dried sweet potato in order to know its potential as an energy source in fish and livestock feed.

Materials And Methods

Experimental Site

The experiment was carried out in the Fisheries Research Laboratory of Biology, Ahmadu Bello University, Zaria which is located at Latitude: 11º 03' 60.00" N and Longitude: 7º 41' 59.99" E in Kaduna state of Nigeria (Abdullahi *et al.*, 2022).

Collection and preparation of the sweet potato peel

The sweet potato peels were obtained from restaurateurs in ABU Zaria main campus. The fresh sweet potato peels were properly washed and sun-dried under hygienic conditions, after which they were winnowed and sieved to get rid of foreign materials. The peels were then milled into a fine powder and sieved through a 0.5 mm mesh screen.

Determination of Nutrient Contents

The proximate composition of sweet potato peels and whole body fish were determined using the standard methods of the Association of Official Analytical Chemists (AOAC, 1995) in the Institute for Agricultural Research, Ahmadu Bello University, Zaria.

Moisture Content

A clean crucible was dried to a constant weight in an air oven at 110°C, cooled in a desiccator and weighed (W_1). 2g of finely pulverized sample was weighed in the crucible and then re-weighed (W_2). The crucible and its content was dried in an oven to a constant weight (W_3). The percentage moisture was calculated thus

$$\% \text{ Moisture content} = \{(W2-W3)/ (W_2-W_1)\} \times 100$$

Ash content

The porcelain crucible was dried in an oven at 100°C for 10 minutes, cooled in a desiccator and weighed (W_1). 2g of finely pulverized sample was weighed (W_2) into the previously weighed clean crucible which was ignited in the muffle furnace at 550°C for 1 hour and cooled in a

desiccator. The crucible and its content were transferred into the muffle furnace and the temperature was gradually increased until it reached 550°C, the sample was left in the furnace for 8 hours to ensure proper ashing. The crucible containing the ash was allowed to cool to 200°C, the crucible was removed and cooled in a desiccator until constant weight is obtained (W_3).

$$\textbf{\% Ash content} = \{(W_2-W_3)/ (W_2-W_1)\} \times 100$$

Crude Lipid Content

Four grams of sample was weighed (W_1) into a clean, dried 500ml round bottom flask containing few anti-bumping granules was weighed (W_2) and 300ml of petroleum ether (40-60°C) for the extraction was poured into the flask fitted with soxhlet extraction unit. The round bottom flask and a condenser were connected to the soxhlet extractor, and cold water circulation was put on. The heating mantle was switched on and the heating rate adjusted until the solvent was refluxing at a steady rate. Extraction was carried out for 6 hours. The solvent was recovered and the oil was dried in the oven at 70°C for 1 hour. The round bottom flask and oil was cooled and then weighed (W_3).

$$\% \text{ Crude Content} = \{(W_2-W_3)/ (W_2-W_1)\} \times 100$$

Fibre content

Two grams of finely pulverized sample was weighed into an extraction apparatus, fat was extracted with liquid petroleum spirit (40-60°C), the extracted was removed and dried at 105°C for 30 minutes. Two grams of the defatted sample was weighed into a dry 600cm round bottom flask. 100cm^3 of (0.023M) sulphuric acid was added and the mixture boiled under reflux for 30 minutes. The hot solution was quickly filtered under suction. The insoluble matter was washed several times with hot water until it is acid free. This was quantitatively transferred into the flask and 100cm^3 of hot (0.312) sodium hydroxide solution was added and the mixture boiled under reflux for 30 minutes and quickly filtered under suction. The insoluble residue was washed with boiling water until it was base free. It was dried to constant weight in the oven set at 100°C, cooled in a desiccator and weighed (C_2). The weighed residue was incinerated in a muffle furnace at 550°C for 2 hours, cooled in a

desiccator and reweighed (C_3).

The loss in weight on ashing (incineration) = $C_2 - C_3$

Weight of original sample = W

% Crude Fibre = $\{C_2-C_3)/W\} \times 100$

Crude Protein

Two grams of the sample was weighed into 100cm^3 Kjeldahl digestion flask and about lg of catalyst mixture (K_2S0_4 and $CuS0_4$) was added to speed up the reaction. 25ml of concentrated sulphuric acid was added into the flask. The content in the Kjeldahl digestion flask was heated slowly at first in Kjeldahl heating unit frotting subsides and then more vigorously with occasional rotation of the flask to ensure even digestion and avoid over heating of the content. The heating continued until a clear solution is obtained. After cooling, the solution was transferred into 100cm^3 volumetric flask and diluted to mark with distilled water. 10ml aliquot of the diluted solution or digest was pipette into Markham semi macro nitrogen steel and 10cm^3 of 40% sodium hydroxide solution was added. The liberated ammonia was trapped in a 100cm^3 conical flask containing l0cm^3 of 40% boric acid and 2 drops of methyl red indicator. Distillation was allowed to continue until pink colour of the indicator turn green. The content of the conical flask was titrated with 0.1M HC1, with end point indicated by a change from green to pink colour. The volume of the acid used for the distillate as well as the blank was noted.

% Nitrogen = $\{(0.014 \times M \times (V_1-V_0)\}/ \{\text{weight of test sample}\} \times 100$

Where M = actual molarity of acid,

V_1 = volume of HC1 required for 10ml sample solution,

V_0 = volume of HC1 required for the blank

Atomic weight of nitrogen = 0.014

% Crude = % Nitrogen (N_2) × 6.25

Nitrogen Free Extract

The total carbohydrate content was determined by subtracting of the percentage moisture, % ash, %crude lipid, % crude protein and % crude fibre from 100.

NFE = 100 - (ash+ crude lipid + crude protein + crude fibre)

Mineral determination

Mineral contents of fresh and sun-dried sweet potato peels were determined by atomic absorption spectrometry, flame photometry and spectrophotometry according to the methods of AOAC (2003).

Wet digestion of sample: For wet digestion of sample, exactly (1.0000 g) of the powdered sample was taken in digesting glass tube. Twelve milliliters (12ml) of HNO_3 was added to the food samples and mixture was kept for overnight at room temperature. Then 4.0 ml perchloric acid ($HClO_4$) was added to this mixture and was kept in the fumes block for digestion. The temperature was increased gradually, starting from 50°C and increasing up to 250-300°C. The digestion completed in about 70-85min as indicated by the appearance of white fumes. The mixture was left to cool down and the contents of the tubes were transferred to 100 ml volumetric flasks and the volumes of the contents were made to 100 ml with distilled water. The wet digested solution was transferred to plastic bottles labeled accurately. Stored the digest and used it for mineral determination.

Determination of Iron (Fe), Zinc (Zn), Calcium (Ca), Copper (Cu), Manganese (Mn) and Magnesium (Mg) by Atomic Absorption Spectrometry

In this technique the atoms of an element were vaporized and atomized in the flame. The atoms then absorbed the light at a characteristic wavelength. The source of the light was a hollow cathode lamp, which was made up of the same element. The lamp produces radiation of an appropriate wavelength, which while passing through the flame was absorbed by the free atoms of the sample. The absorbed energy was

measured by a photo-detector read-out system. The amount of energy absorbed was proportional to the concentration of the element in the sample.

Determination of Sodium (Na) and Potassium (K) by flame photometer

Na and K analysis of the sample were done by the method of flame photometry. The same wet digested food sample solutions as used in AAS were used for the determination of Na and K. Standard solutions of 20, 40, 60, 80 and 100 milli equivalent/L was used both for Na and K. The calculations for the total mineral intake involve the same procedure as given in AAS.

Determination of Phosphorus (P) by spectrophotometry

Calorimetric determination was based upon the principle that certain elements or compounds on reaction with suitable reagent develop color. The intensity of the color was measured with colorimeter or spectrophotometer. The inorganic phosphorus reacts spectrophotometer. The inorganic phosphorus reacts phosphomolybdate was formed, which on reaction produce molybdenum blue. The blue color of the solution was measured and the amount of the phosphorus was determined.

Phosphorus analysis: Sample from final blue solution was taken in a cuvette and introduced to spectrophotometer. The readings of the phosphorus were recorded in ppm.

Calculation of phosphorus: The calculations for the total mineral intake involve the same procedure as given in AAS.

Determination of Antinutritional Factors

Triplicate samples of the fresh and sun-dried sweet potato peels were taken to the Department of Animal Science, Ahmadu Bello Zaria for analysis of anti-nutritional factors according to methods described by AOAC (2000).

Tannin

Two grams (2g) of ground sample was defatted for 2 hours using Soxhlet extraction apparatus. The residue was placed in an oven for 24 hours, retrieved and boiled at 100˚C with 300ml of distilled water, diluted to 500ml in a standard volumetric and filtered through non-absorbent cotton wool. A volume of 25ml of the infusion was measured into 2litre porcelain dish and titrated with 0.1N oxalic acid until blue solution changed to green, then few drops of 0.1 potassium permanganates was added. The difference between the two titration was multiplied by 0.006235 to obtain the amount of tannin in sample, since 0.1N oxalic acid = 0.006235g tannin.

Oxalate

Two grams (2g) of aliquot of the ground sweet potato peel was weighed to a 250ml flask, 190ml distilled water and 10ml of 6m hydrochloric acid was added. The mixture was digested for 1 hour on boiling water bath, then cooled, transferred in to a 250ml volumetric flask, diluted to volume and filtered. Four drops of methyl indicator were added followed by concentrated ammonia until the solution turn to faint yellow. It was then heated to 100^{o}C and allowed to cool and filtered. The filtrate was boiled and 10ml of 5% calcium chloride was also be added with constant stirring and was allowed to stand overnight. The mixture was filtered through whatman No. 40 filtered paper. The precipitate was rinsed several times with distilled water, transferred to a beaker and 5ml of 25% sulphoric acid was added to dissolve the precipitate. The resultant solution was maintained at 80^{o}C then cooled and titrated against 0.5% potassium permanganate until the pink colour persisted for approximately one minute. Blank test was also run for the test sample. From the amount potassium permanganate, the oxalate was calculated. Thus,

1ml of potassium permanganate = 2.24mg oxalate.

Saponin

A gravimetric method employing the use of soxhlet extractor and two different organic solvents was used. The first solvent extracts lipids and

interfering pigments while the second solvent extracts the saponin proper. A known weight of the dried ground sample was weighed and fitted unto the soxhlet apparatus (bearing the sample containing thimble) and methanol poured into the flask. The methanol was enough to cause a reflex. The saponin was then be exhaustively extracted for 3 hours. The flask was re-weighed. The difference in weight represents the weight of saponin extracted.

Phytic acid (Phytate)

Phytic phosphorus was determined by the method of (2006). A known weight of each ground sample was soaked into 100ml of 2% HCl in a conical flask, 50cm^3 of 0.3% potassium thiocynate solution was added. The mixture was titrated in a standard solution of $FeCl_3$ until a brownish-yellow colour persisted for 5 min. The concentration of the $FeCl_3$ was 1.04% w/v

Mole ratio of Fe to Phytate = 1:1

Table 1 Proximate Composition of Raw and Sun-dried Sweet Potato Peel (g/100gDM)

	Moisture	Ash	CP	EE	F	NFE
RSPP	37.50±0.05^a	5.45±0.03^b	5.37±0.01^a	8.16±0.25^a	3.63±0.15^a	39.89±0.60^b
SSPP	4.05±0.50^b	7.63±0.88^a	5.61±0.58^a	2.30±0.40^b	3.05±0.59^a	77.36±0.51^a

Means with the same superscripts across columns were not significantly different (P>0.05) **Key:** RSPP= Raw Sweet, Potato Peel, SSPP= Sun-dried Sweet Potato Peel, WM= White Maize, CP= Crude Protein, EE=Ether Extract, F= Fiber, NFE= Nitrogen Free Extract

The mean concentrations of macro and micro minerals in raw and sun-dried sweet potato peel were represented in Table 2. The macro minerals determined include; sodium (Na), magnesium (Mg), calcium (Ca), potassium (K), phosphorus (P), chlorine (Cl) and sulphur (S), while the micro minerals determined are manganese (Mn), iron (Fe), zinc (Zn) and copper (Cu). There is no significant difference (p>0.05) in all the macro and micro minerals observed for both the raw and sun-dried sweet potato peel. Sodium (Na) has the highest mean concentration among the macro minerals with a value of 5.5521mg and 5.5611mg followed by potassium (K) with a mean concentration of 2.9290mg and 2.9190mg for the raw and sun-dried sweet potato peel,

respectively. Sulphur (S) has least mean concentration of 0.0310mg for the raw and 0.0300mg for the sun-dried sweet potato peel among the macro minerals. The highest micro mineral concentration of 2.7371mg and 2.7071mg for the raw and sun-dried sweet potato peel, respectively was obtained in iron (Fe) while the least was obtained in copper (Cu) with a mean concentration value of 0.0041mg and 0.0040mg for RSPP and SSPP, respectively.

Table 2 Mean Concentration of Macro and Micro Minerals in Raw and Sun-dried Sweet Potato Peel

Elements (mg/100g)	RSPP	SSPP
Sodium (Na)	5.5521±0.29[a]	5.5611±0.18[a]
Magnesium (Mg)	1.1445±0.18[a]	1.1455±0.08[a]
Calcium (Ca)	0.1684±0.06[a]	0.1644±0.17[a]
Potassium (K)	2.9290±0.06[a]	2.9190±0.06[a]
Phosphorus (P)	0.0670±0.12[a]	0.0680±0.02[a]
Chlorine (Cl)	0.4870±0.19[a]	0.4970±0.12[a]
Sulphur (S)	0.0310±0.12[a]	0.0300±0.15[a]
Manganese (Mn)	0.0125±0.35[a]	0.0127±0.31[a]
Iron (Fe)	2.7371±0.31[a]	2.7071±0.35[a]
Zinc (Zn)	0.0065±0.00[a]	0.0066±0.00[a]
Copper (Cu)	0.0041±0.00[a]	0.0040±0.00[a]

Means with the same superscripts across rows were not significantly different (P>0.05)
Key: RSPP=Raw Sweet Potato Peel, SSPP=Sun-dried Sweet Potato peel

Analysis of anti-nutritional factors as presented in Table 3 indicates that all the components determined were greatly reduced except oxalate which was 0.22±0.05 in the raw sweet potato peel increased to 0.29±0.05 in the sun-dried sweet potato peel. Saponin and Tannin contents of the raw and sun-dried sweet potato peel were recorded as 10.85±0.09 and 1.00±0.35; 1.80±0.06 and 1.05±0.03, respectively.

Analysis of anti-nutritional factors as presented in Table 3 indicates that all the components determined were greatly reduced except

	Phytate	Tannin	Alkaloid	Oxalate	Saponin
RSPP	0.09±0.02[a]	1.80±0.06[a]	0.72±0.01[a]	0.22±0.05[a]	10.85±0.09[a]
SSPP	0.07±0.10[a]	1.05±0.03[b]	0.50±0.11[a]	0.29±0.05[a]	1.00±0.35[b]
%Reduction	22.00%	41.66%	30.56%	-	90.78%

Means with the same superscripts across columns were not significantly different (P>0.05)

Key: RSPP= Raw Sweet Potato Peel, SSPP= Sun-dried Sweet Potato Peel

Discussion

The proximate composition of the raw and sun-dried sweet potato peel indicates a significant increase in the hydrolysable carbohydrate (Nitrogen Free Extract) composition from 39.89% to 77.36%, respectively. The hydrolysable carbohydrate obtained in this study is higher than 71.16% and 74.60% reported by Solomon *et al.* (2015) and El-Nadi *et al.* (2017) for sun-dried sweet potato peel, respectively. The difference obtained could be as a result of variety of the sweet potato peel used in this experiment. Crude protein composition of the raw and sun-dried sweet potato peel reveals no significant increase from 5.37% to 5.61%, respectively. The crude protein obtained for the sun-dried sweet potato peel in this experiment is higher than 4.64% reported by Faramarzi *et al.* (2012), but is lower than 5.91% reported by Solomon *et al.* (2015). The ash content (7.63%) obtained is higher than 4.56%, 6.02% and 4.53% reported by Faramarzi *et al.* (2012), Solomon *et al.* (2015) and El-Nadi *et al.* (2017), respectively. The differences observed in this study may be as a result of differences in geographical location, harvesting time and the variety the sweet potato peel used.

The macro and micro mineral compositions of raw and sun-dried sweet potato peel indicates no significant difference (p>0.05) in their concentrations. This study revealed that sun drying method has no significant effect on the macro and micro mineral concentrations of sweet potato peel. Sodium (Na) has the highest mean concentration among the macro minerals followed by potassium (K) in the raw and sun-dried sweet potato peel. Among the macro minerals, Sulphur (S)

has least mean concentration in the raw and the sun-dried sweet potato peel. The highest micro mineral concentration of iron (Fe) was obtained in the raw and sun-dried sweet potato peel, while the least was obtained in copper (Cu). The concentrations of the macro and micro minerals obtained in the study were higher than the mineral requirement for African catfish *Clarias gariepinus* reported by Food and Agriculture Organization of the United Nations (2021).

The results of the anti-nutritional factors of the raw and sun-dried sweet potato peel showed significant reduction of these factors following the drying of the peel. Phytate, tannin, alkaloid, and saponin were reduced by 77.8%, 58.3%, 69.4% and 9.18%, respectively. This significant reduction of the anti-nutritional factors may be as a result of efficacy of sun drying as method of removing anti-nutrient in the peel as suggested by Solomon *et al.* (2015). However, the oxalate content was slightly higher in the sun-dried sweet potato peel, although the value is still within the permissible limit <5g/kg of diet reported as tolerable by African catfish (*Clarias gariepinus*) (Yimer, 2019). Saponin and tannin contents tend to be effectively removed by the treatment method as they were higher in the raw sweet potato peel compared to the values obtained in the sun-dried sweet potato peel.

Conclusion

In conclusion, sweet potato peel contains a high concentration of hydrolysable carbohydrate (77.36g/100g), high concentration of macro and micro mineral compositions and low concentration of anti-nutrients. Therefore, it is recommended for fish and livestock farmers to use sun-dried sweet potato peel as a source of energy in feed ration formulation for their animals in order to reduce the cost of production and make their venture more profitable.

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