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Nutritional Composition and Physio-Chemical Properties of Peeled and Unpeeled Yam Flour (White Yam, Dioscorea Rotundata)

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Abstract-Yam is one of the major food crops in West Africa, the Caribbean, Asia, India, and part of Brazil. Yam is the common name for some species in the genus Dioscorea (family Dioscoreaceae). Yam tubers have been used as a traditional food in the home with little industrial use; however, the traditional uses are diverse and the crop has more utilization potentials. The main shelf-stable product of yam is the traditional yam flour (Elubo), Yams (Dioscorea spp.) which are regarded as traditional foods that are consumed in various ways but majorly consumed as yam flour in the southwest region of Nigeria. This study investigated the physical, functional, and sensory properties and anti-nutrient contents of peeled and unpeeled yam flour. The results of the study using SPSS.PC version 23 to calculate frequency, mean, and standard deviation to confirmed the significant difference in the micronutrient content, vitamins, minerals content, and anti-nutrient properties of the 'Amala' made from the two products (peeled and unpeeled yam flour). The energy content derived from the 'amala' made from unpeeled yam flour is lesser than that of peeled yam flour, the proximate of unpeeled yam four indicated a high value than that of peeled yam flour. There is no significant difference in both samples' sensory evaluation except in the taste level. The result has shown that the consumption of unpeeled yam flour can be useful to improve nutrition status and treatment of nutrient deficiencies diseases.

Keywords: Yam flour, Peeled, unpeeled, proximate, sensory, anti-nutrients

1. Introduction

Yam is one of the major food crops in West Africa, the Caribbean, Asia, India, and part of Brazil (Ihekoroye and Ngoddy, 2005). Yam is the common name for some species in the genus Dioscorea (family Dioscoreacea).
Yam, Dioscorea species is an important staple in much of West Africa (Omonigho and Ikenebomeh,2000). Yam is among the oldest recorded food crops and ranks second after cassava in the supply of starch in West Africa (Nweke *et al*., 2011).

Yam is an economically useful plant belonging to the genus Dioscorea of the tubers or rhizomes of the plants. The structure of the yam tuber is highly variable depending on the species. The environment and genetic composition play significant roles in determining tuber shape and size (Coursey, 2013).
Yams (Dioscorea species) are annual root tuber bearing plants with more than 600 species out of which six are socially and economically important in terms of food, cash, and medicine (IITA, 2009). Some of the yam species are water yam (Dioscorea alata), white yam (Dioscorea Rotundata), yellow yam (Dioscorea Cayanensis), Chinese yam (Dioscorea Escumulanta), and three-leaf yams (Ike and Inoni, 2006; Olubukola and Bolarin, 2006; Zaknayiba and Tanko, 2013).
Households' demand for yam consumption is very high in Sub-Saharan Africa. Nutritionally, yam is a major staple food consumption, providing food for millions of people in West Africa. (Verter Nahanga, Bečvářová Věra. 2015). In 2013, Ghana became the first in West Africa to launch a national yam strategy, which aims to increase fresh yam exports, address poverty, develop the value chain, and better a lot of Ghanaians engaged in the sector. Ghana's export value for yams hit around $27.5m in 2016. In June 2017, Nigeria started a yam export programme targeting Europe and the US and created a technical committee to manage the programme. The current goal is to export at least 480 tonnes of yams every month. (African Business Magazine, 2019)

Yam is an important source of carbohydrate for many people of the Sub Saharan region especially in the yam zones of West Africa. It is one of the important crops in the farming systems of Nigeria with more than 2.8 million hectares of land under cultivation annually (IITA, 2012).

Yam tuber is essentially a starchy food, its principal nutritional function being the supply of calories to the body (Onwueme, 2008).

Yam tubers consist of about 21% dietary fiber and are rich in carbohydrates, vitamin C, and essential minerals. Worldwide annual consumption of yams is 18 million tons, with 15 million in West Africa. Annual consumption in West Africa is 61 kilograms per capita. In West Africa, a major proportion of yam is eaten as boiled yam, roasted yam, fried yam, pounded yam, and Amala which is stiff glutinous dough. Yams have over 21% dietary fibre and are rich in carbohydrates, VitaminC, potassium, manganese, and other essential minerals (IITA,2009: *iita.org/cropsnew/dioscoria)*. The most processed traditional yam product is yam flour (Abioye *et al*., 2013) which contains protein carbohydrates and trace amounts of minerals and vitamins. Yam flour is traditionally processed by peeling, sometimes slicing parboiling in hot water (65 0C) for a varied time followed by steeping for 13-24 hrs by sun-drying to give a dry yam which is milled into flour 'Elubo'.

It contributes significantly to dietary calories per capita daily and serves as an important source of income for the people (Olaoye and Oyewole 2012).

There are many varieties of yam species widespread throughout the humid tropics, the most economically important species which are grown are:

- White yam (*D.rotundata),*
- Yellow yam (*D.cayensis),*
- Water yam(*D.alata),*
- Chinese yam (*D.esculenta)*
- Aerial *yam (D.bulbifera)*

Trifolate yam (D.dumentorum) (Ike and Inoni, 2006).

The most economically important species are white yam (Dioscorea *rotundata poir*), yellow yam (*Dioscorea cayenesis*), water yam (*Dioscorea alata*), and bitter yam (*Dioscorea dumetorum*)

(Kay 2014). Yam is eaten in different forms such as boiled, fried, and roasted as fufu (the so-called poundo yam and Amala in Nigeria. (Verter Nahanga, Bečvářová Věra. 2015).

Olayemi et al. (2012) reported postharvest losses of yam in Nigeria to be about 37% which underscores the need for processing this staple food crop into the product(s) of longer shelf life such as flour. In Nigeria, the major processed product is yam flour (Elubo) which is reconstituted by stirring in boiling water to form a paste (amala) and eaten with favoured sauces (Ige & Akintunde 1981). oduct is yam ¯our (Elubo) which is reconstituted by stirring in boiling water to form a paste (amala) and eaten with ¯avoured sauces (Ige & Akintunde 1981).

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2. Materials & Methods

White Yam (*Dioscorea rotundata*) tubers were purchased at oje olobi a local market in Ede, Osun State, Nigeria.

Methodology

Production of peeled yam flour (Elubo)

FIG 1: PRODUCTION FLOWCHART OF PEELED & UNPEELED YAM FLOUR 'ELUBO'

Washing	Washing
⇩	⇩
Peeling	
⇩	
Slicing	slicing
⇩	⇩
Parboiling (10mins at 100^0c)	Parboiling (10mins at 100^{oc})
⇩	⇩
Steeping (24 hrs)	Steeping (24hrs)
⇩	⇩
Draining	Draining
⇩	⇩
Sun drying	Sun drying
⇩	⇩
Dry yam chips	Dry yam chips
⇩	⇩
Milling	Milling
⇩	⇩
Packaged Yam flour (Elubo)	Packaged yam flour (Elubo)

(Babajide *et al*, 2009)

Methods of analysis

Determination of Proximate Composition

The proximate nutrient composition of the two samples was determined using the standard methods of analysis of the Association of Official Analytical Chemists (AOAC, 2004). The crude protein of the samples was determined using the micro-Kjeldahl method. Crude Fat was determined by Soxhlet extraction method petroleum ether as extracting solvent, the content was determined using a muffle furnace set at 550°C for 4 h. Ash was determined using the muffle furnace set at 550ºC Moisture content of the samples was determined by an automatic moisture analyzer at 115°C. Crude fibre and Carbohydrate were determined spectrophotometrically by the Anthrone method and were determined as described by AOAC (2004). All analyses were done in triplicates**.**

Determination of Minerals
Minerals in the samples were analyzed from the solution obtained when 5g of the ash sample was digested with 10ml of 5N hydrochloric acid. Iron (Fe), and Zinc (Zn) content of samples were determined by atomic absorption spectrometry according to the methods of AOAC (2004).

Anti-nutrients determination
Tannin
The absorbance of the Tannic acid standard solutions, as well as samples, were read after color development on a Spectronic 21D spectrophotometer at a wavelength of 760nm. (A.O.A.C ,1984)

Cyanide determination

Electrochemical procedures were conducted using a steam distillation accepted as the standard method of the American Organization for Analytical Chemistry (AOAC) Cock 1985

3. Data analysis

Data was analyzed using SPSS latest version of 23.0 to calculate for mean, standard deviation to find the correlation between the two samples, and simple percentage

4. Results

Table 1 shows the proximate content of both samples.

SAMPLE	% CP	% CFAT	%C FIBRE	% ASH	%Moisture	%CHO
A	2.38	0.64	1.31	2.32	13.61	79.0
B	7.47	1.86	3.09	3.59	11.82	72.17

CP – crude protein, Crude Fat, Crude Fibre, Ash, Moisture content, and Carbohydrate all in percentage (%)

Table 2 shows minerals determination

SAMPLE	Zn(mg\kg)	Fe(mg\kg)
A	13.48	95.2
B	22.92	126.9

Table 3 shows some vitamins composition

SAMPLE	VIT. K(µg/100g)	VIT. B1(mg/100g)
A	6.96	0.37
B	11.80	0.87

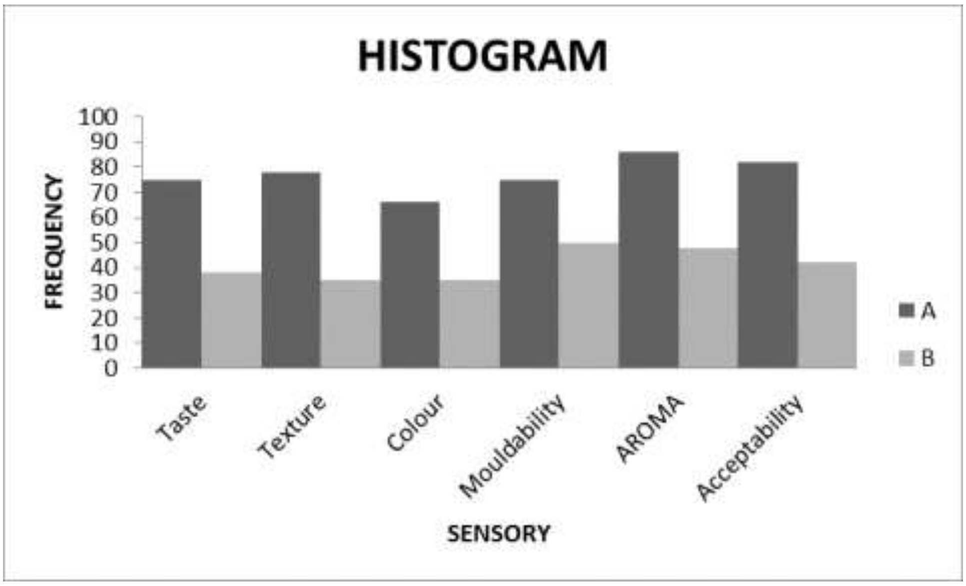
Table 4 shown the anti-nutrient properties of the samples

SAMPLE	%TANNIN VALUE	HCN (mg/kg) VALUE
A	0.0024	0.91
B	0.0011	1.02

Table 5 shows the percentage sensory evaluation of both samples

Characteristic	Mean Sample A	Mean Sample B	T-Statistic	P-value
Taste	6.8	4.8	6.81	0.000
Texture	7.5	5.0	5.24	0.000
Colour	6.6	3.5	4.84	0.000
Mouldability	7.8	3.5	7.7	0.000
Aroma	7.5	3.8	7.47	0.000
Acceptability	8.0	4.2	7.28	0.000

Fig.1I shows the histogram representation of sensory evaluation.



5. Discussion

The proximate content (in g/100g) of sample A (peeled yam flour) and Sample B (unpeeled yam flour) was carried out in this study. shown that the protein content of unpeeled yam flour is more than the peeled yam flour (7.43%, 2.32%/100g), this is contrary to the study done by Jimoh and Olatiloye (2009) who reported a higher value of protein content (3.16%) of peeled yam flour (Amala) this may be due to soil content, processing methods and many other variables. The crude protein content reported for yam peels by Kalio et al. (2007) is in line with the report of this study. The yam peel has been confirmed to have more proteins than triple the amount found in the peeled yam flour.

The result also has shown that crude fat present in the peels of yam is a bit higher than that of peeled yam, thus, the flour derived from the peels of yam contain more crude fat, which align with the work of Oyeyiola et al.(2014) another study revealed low-fat content which was low as (0.69), Adewale et al. (2014) and Ojokoh and Gabriel (2010) reported higher content of fat in peeled yam flour.

The crude fiber of the unpeeled yam flour is higher than that of the peeled yam flour. The quantity of fibre in plant foods are in varying amounts(1,21). Fibre provides satiety that reduce appetite, fibre is useful in so many ways such as slowing the emptying of the stomach, shortening intestinal transit time, delaying absorption of glucose that control blood sugar levels (1,105), it also reduce the riskof cardiovascular disease through LDL cholesterol

The mineral content of both samples are identically low, never less, the mineral content of peeled yam flour is a bit lower than the unpeeled yam flour, the result is in close agreement with the study done by Adepoju et al. (2010) who reported that soaking of food items in water results in loss of minerals due to leaching into the soaking water.

The fat-soluble vitamins analyzed in both samples show that sample A contains less amount of vitamin K as compared to sample B, thus, it indicates that the amount of fat-soluble vitamins present in the unpeeled yam flour is considerably higher than that of those present in peeled yam.

This also applies to the water-soluble vitamins, the results have shown that vitamin B1 is more abundant in the peel of yam as compared to the peeled yam.

The result of the moisture content of both samples was collected and it was seen that the flour from the peeled yam has more concentration of water compared to the flour from unpeeled yam flour, but in contrast, after making ‘amala’ from both samples, it was discovered that after a while, the ‘amala’ made from unpeeled yam flour becomes a little watery in the presence of air, It is concluded that though the peeled yam has a higher moisture content, this is in agreement with the study conducted by (Karim et al., 2013). Which showed that the perishability nature of yam, due to its high moisture content suggests the need to process it into less perishable products such as yam chip through a drying process which can resist water from external sources, such as air, unlike the unpeeled yam flour.

The Carbohydrate Content of both samples is very high, but the carbohydrate in the ‘amala’ made from sample A (peeled yam flour) is higher than that of the unpeeled yam flour. This result also confirmed that the energy content derived from the ‘amala’ made from sample B (unpeeled yam flour) is lesser than that of peeled yam flour. Values obtained for crude protein, crude lipid, ash, and crude fibre of raw yam sample were in close agreement with (Oyenuga, 1968) report. Raw yam was very low in crude lipid, crude fiber, and protein, moderate in ash content, and high in moisture, carbohydrate, and gross energy content. The high gross energy content of yam explains why it serves as a staple source of energy in Nigeria.

Though most of the edible, matured yam does not contain any compound, however, the result of this study shows that tannin and Hydrocyannide are present in both samples, with sample A (peeled yam flour) having the higher percentage of Tannin compared to the other sample. Meanwhile, the occurrence of Hydrocyannide is more distributed in sample B (unpeeled yam flour) as compared to sample A (peeled yam flour). The affect of Tannins are known especially on the digestive tracts and their metabolites are toxic (Muhammed et al, 2011). The precise toxic amount of tannin that can cause depression in human is not known, but the levels in both samples were too small that can result to toxicity 0.0011mg – 0.0024mg/100g. the studies has shown that Hydrogen cyanide is an extremely poisonous substance formed by the action of acids on metal cyanides. Large dose of hydrogen cyanide can cause death within few minutes, while smaller dosages may result to stiffness of the throat, chest, palpitation and muscle weakness. The result obtained in this study falls within the threshold value as it could not even be detected making the both samples safe for human consumption . In 1991 however, FAO/ WHO recommended that HCN levels in mammals should be 10mg/kg dry weight (10ppm) which was much than what was obtained in this study (Ekpa & Sani, 2018)

The sensory evaluation data derived was used to carry out the statistical analysis results using a t-test of two samples of equal variance method. Sample A (peeled yam flour) and sample B (unpeeled yam flour) were examined under six characteristics and properties considering the possible variability that is observed from the sensory evaluation data.

Usin g a t-test of two samples of equal variance on the characteristics of taste according to the sensory evaluation data derived, the statistical result indicates a significant difference between the two samples of amala but result revealed significant difference in all the chararistics of the two samples: Texture, Colour, Mouldability, Aroma, and Acceptability.

Conclusion

This study examined the nutrients and physio-chemical properties of peeled and unpeeled yam flour, it is observed that the nutrients present in unpeeled yam flour is more abundant than those in peeled yam,

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