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Original Research Article

Effects of Processing Methods on the Nutritional Properties of Sweet Potato and Sorghum

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Abstract

Sweet potato (*Ipomoea batatas*) is an important food crop in the tropical and sub tropical countries and belongs to the family *convolvulaceae*. It is cultivated in more than 100 countries worldwide. Nigeria is the third largest producer of sweet potato in the world with china leading, followed by Uganda. Sweet potato ranks seventh among the world food crops, third in value of production and fifth in caloric contribution to human diet. The study was carried out to determine a processing method that has less or no effect on the nutritional properties of sweet potato and sorghum. The results of the proximate analysis showed whole sorghum flour (WSF) to contain 10.6 moisture, 3.7 lipid, 0.9 ash, 13.1protein, 70.0 carbohydrates and 1.7 fiber as against malted sorghum (MSF) which has 9.9 moisture, 2.2 lipid 1.1 ash, 10.7 protein, 1.4 fiber and 73.3 carbohydrate. Similar analyses were carried out in sweet potatoes as in sorghum and results obtained. The research result obtained showed that the whole sorghum flour processing method has less effect on the nutritional properties of sorghum and the grated potato flour processing method has less effect on the nutritional properties of sweet potato.

Keywords: Processing, Nutritional, Sweet potato, Sorghum

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is a major food crop in the tropical and sub tropical countries and it belongs to the family *convolvulaceae*. It is grown in more than 100 countries of the world (Bibiana, & Julius, 2014). Nigeria is the third largest producer of sweet potato in the world with china leading, followed by Uganda. Sweet potato ranks seventh among the world food crops, third in value of production and fifth in caloric contribution to human diet (Bouwkamp, 1985). Sweet potatoes are rich in dietary fibre, minerals, and vitamins and antioxidants such as phenolic acids, anthocyanins, tocopherol and ß carotene. Besides acting as antioxidants, carotenoids and phenolic compounds also provide sweet potatoes with their distinctive flesh colours like cream, deep yellow, orange and purple. Sweet potato blends with rice, cowpea and plantain in Nigerian diets. It is also becoming popular as a substitute to yam and garri. It can be reconstituted into fufu or blended with other carbohydrate flour sources such as wheat and cassava for baking bread, making of biscuits and other confectioneries. The leaves are rich in protein and the orange flesh varieties contain high beta carotene and are very important in fighting against vitamin A deficiency especially in children (Bibiana and Julius, 2014).

Sorghum (S. bicolor) is a tropical plant belonging to the family of *poaceae,* and is one of the most important crops in Africa, Asia and Latin America. More than 35% of sorghum is grown directly for human consumption. The rest is used primarily for animal feed, alcohol production and industrial products (Dykes and Rooney, 2006). The current annual production of 60 million tons is increasing due to the introduction of improved varieties and breeding

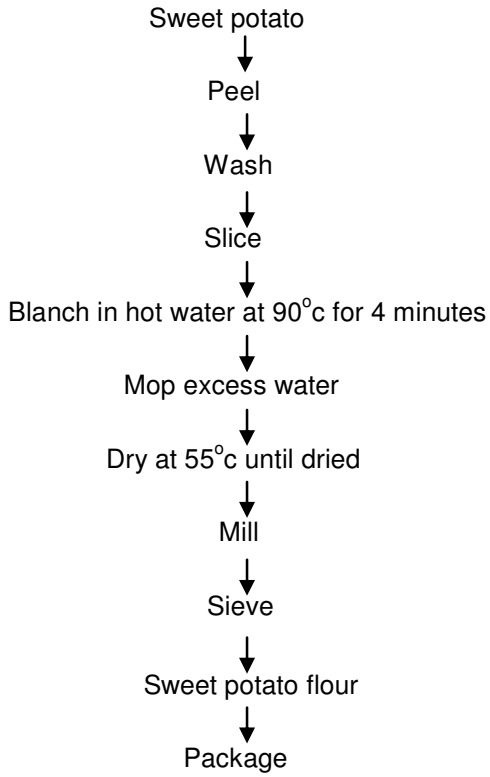
conditions. Several improved sorghum varieties adapted to semi arid tropic environments are released every year by sorghum breeders. Selection of varieties meeting specific local food and industrial requirements from this great biodiversity is of high importance for food security. In developing countries particularly in West Africa, demand for sorghum is increasing. This is due to not only the growing population but also to the countries policy to enhance its processing and industrial utilization (Austin, 1978). A lot of sorghum varieties have so far been identified. Therefore there is a need of their further characterization to the molecular level with respect to food quality.

METHODS

The methods of processing sweet potato tuber

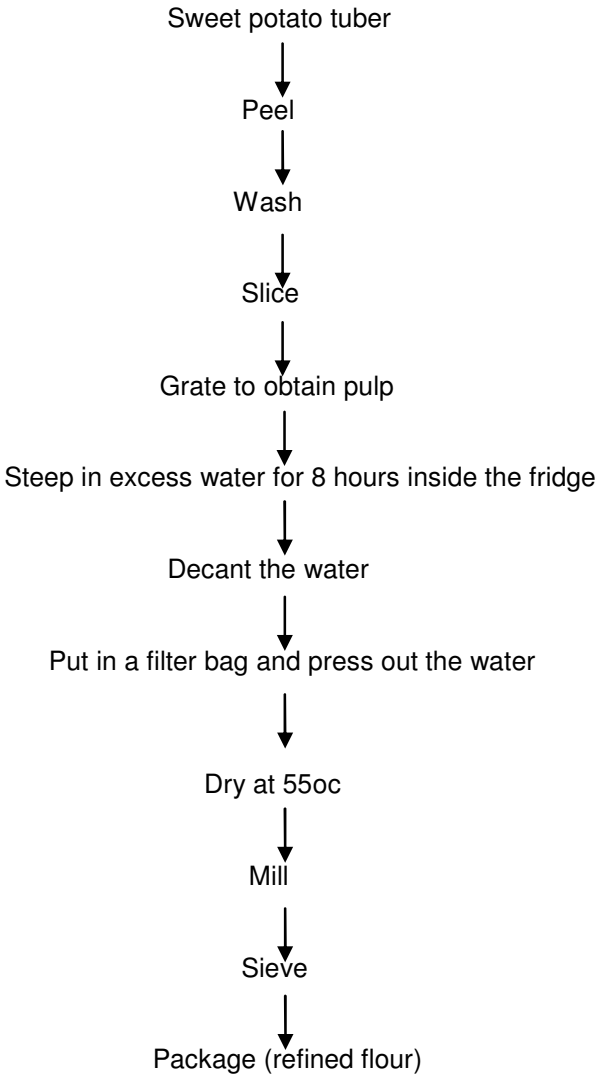
The sweet potato tubers were shared into two different parts

First part processing method: The first half was peeled and then washed. It was sliced and then blanched in hot water at 90ºC for 4 minutes. A filter bag was used to mop the excess water out of the sweet potato and then dried at 55ºC until it is completely dried. It was then milled and sieved to remove the chaff that might be present. The sweet potato flour was then packaged in air tight container.



Flow chart 1. Showing the method of processing the first half of the sweet potato tuber**.**

The second part processing method: The second half of the sweet potato was peeled and washed. It was then sliced and grated to obtain the pulp. The sweet potato was steeped in excess water for 8 hours inside the fridge. After 8 hours, the water from the sweet potato was decanted, it was then steeped again in fresh water for 8 hours in the fridge, and the water was decanted again and put in a filter bag to press out the water. The sample was dried at 55ºC, milled, sieved and the refined flour was then packaged.



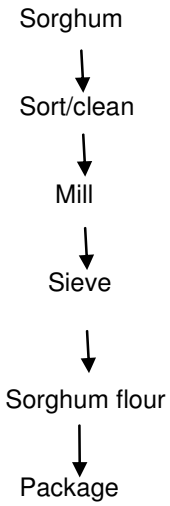
Flow chart 2. Showing the method of processing the second part of sweet potato tuber.

The methods of processing sorghum grains

The sorghum grains were equally shared into two parts.

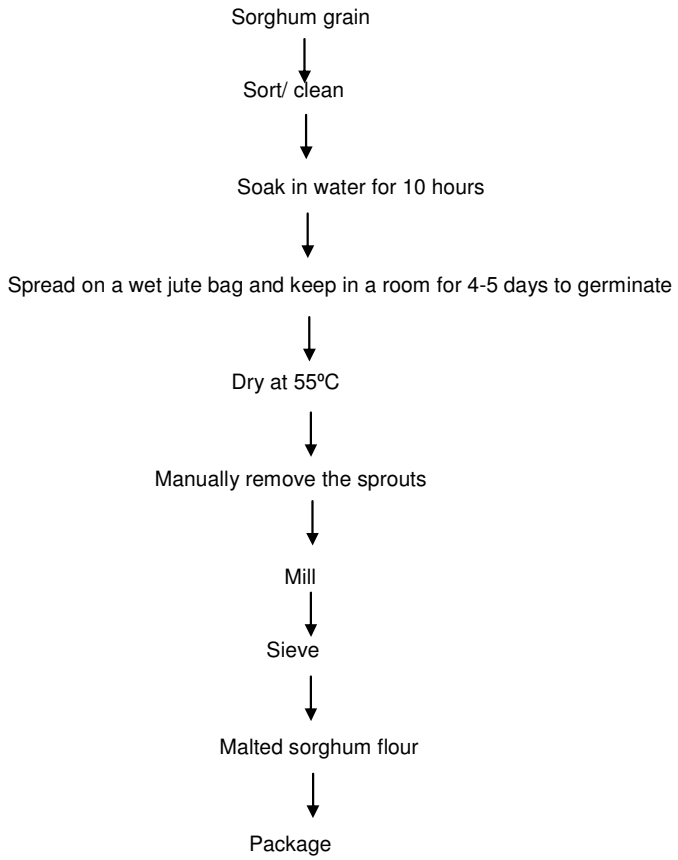
The first part processing method: the first half of the sorghum grains were cleaned and milled to obtain a

powdered sorghum (flour). It was then sieved to remove chaff and packaged.



Flow chart 3. Showing the method of processing the first part of sorghum grains

Second part processing method: The second half of the sorghum grains were cleaned and soaked in water for 10 hours. It was spread on a wet jute bag and kept in a room for 4-5 days to germinate, after 4 days; it was dried in an electric oven at 55ºC. The sprouts were removed manually and milled; it was then sieved to obtain malted sorghum flour and packaged.



Flow chart 4. Showing the method of processing the second part of sorghum grains

Proximate Analysis

Determination of fat content

The Apparatus and reagents used are soxhlet extractor, round bottom flask, beaker and a desiccator. The fat content is determined using the standard(Liao, Huang, Li, Huang, & Tang, 2020) method.

Principle: A dried, ground sample is extracted with diethyl ether which dissolves fats, oils, pigments and other fat soluble substances.

Procedure: A soxlet extractor with a reflux condenser and a 500ml round bottom flask was set up. About 300ml of petroleum ether was poured into the round bottom flask. The sample (2g) was weighed into labelled thimble and sealed with cotton wool, then fitted into the extraction tube of the soxhlet extractor. The soxhlets extractor after assembly was allowed to reflux for about 6 hours, after which the thimble was removed with care and the petroleum ether collected on top and drained into a container for re use. The flask is now free of ether, and was then removed and dried in desiccators and weighed.

Fat (%) content = $\frac{W2-W1}{W} x100$

Where

W= weight of sample used

$W_{1\ =}$ weight of empty extracting flask

$W_{2=}$ weight of flask and extracted oil

Determination of ash content

Apparatus and reagent: Fume cupboard, muffle furnace, crucibles, and desiccators. The ash contents of the samples were determined according to the standards of AOAC (2010).

Procedure: A preheated and cooled crucible was weighed. The sample was charred on a Bunsen flame inside a fume cupboard. The charred sample was placed in a muffle furnace set at 550ºC for 2 hours until a white or light grey ash is obtained. The sample was removed, cooled in desiccators and weighed.

Ash content= $\frac{W3-W1}{W2-W1} x100$

Where

$W_{1=}$ weight of empty crucible

$W_{2=}$ weight of crucible + weight of sample

W3= weight of crucible + weight of sample after ashing.

Determination of crude fiber

This was done according to AOAC (2010) method and the Apparatus and reagents used are Sulphuric acid, sodium hydroxide, alcohol.

Procedure

The sample was oven dried at 105ºC. Powdered dried sample (2g) was placed in a 500ml beaker and 200ml of boiling 1.25% H_2so_4 was added. The beaker was placed on a hot plate and boiled for 3minutes with occasional rotation of the beaker. The beaker was cooled and filtered by suction through a Buchner funnel. The beaker was rinsed with two 50ml positions of boiling water. The residue was carefully transferred into a beaker and 200ml of 1.25% NaOH was added. It was boiled for 30 minutes, cooled and filtered and washed twice with 50ml boiling water.

Finally, the sample was washed with 25ml 95% alcohol. The residue was oven dried for 2hours at 130ºC and cooled in a desiccators and weighed. The sample was heated for 30 minutes at 600ºC and cooled in a desiccator and weighed.

$$\text{Crude fibre} = \frac{\text{weight of residue}}{\text{weight of sample}} \text{x}100$$

Determination of moisture content

The Apparatus and reagents used are Desiccators, crucibles, and weighing balance. The moisture content of the sample was determined according to the standard of AOAC (2010).

Principle: The moisture and low volatile materials are removed by heating at 95-100°C under partial vacuum.

The crucibles were washed and dried in an oven at 100ºC for 1 hour. The weight was noted as w_1. 2g of each sample was separately weighed into the crucibles and their weights were taken and noted down as (w_2) before and during drying at 100ºC to constant weight (w_3).

Moisture content= $\frac{W2-W3}{W2-W1} x100$

Where

$W_{1\,=}$ weight of empty crucible

$W_{2\,=}$weight of crucible and sample before drying

$W_{3=}$ weight of sample after drying to a constant weight

Protein determination

The protein content of the samples was determined according to the standard methods of AOAC (2010) using kjeldahl's method. The sample was digested in concentrated sulphuric acid. The Apparatus and reagents used are Kjeldahl distillation unit, concentrated sulphuric acid, anhydrous sodium sulphate, boric acid solution, hydrochloric acid, boric acid indicator, volumetric flask, conical flask, sodium hydroxide.

Principle: In the presence of sulphuric acid, sodium sulphate and a catalyst, the amino nitrogen of many organic materials is converted to ammonium sulphate. The ammonia is distilled from an alkaline medium and absorbed in a standardized mineral acid.

Procedure

Digestion of the sample

2g of sample was weighed into Kjeldahl's flask and anhydrous sodium sulphate of 5g was added. 25ml of concentration H_2so_4 was added with few boiling chips. The content of the flask was heated in the fume chamber until clear solution is obtained. The solution was cooled and transferred into 250ml volumetric flask and made up to the level with distilled water.

The distillation unit was carried out using a well cleaned Kjedahl apparatus. 100ml conical flask containing 5ml of 2% boric and 2 drops of methyl red indicator was placed under the condenser. Pipette 5ml of the digest into the apparatus through the small funnel on the distillation unit. The digest was washed down with distilled water followed by addition of 5ml of 60% sodium hydroxide solution, it was distilled until the volume of the distillate (ammonium sulphate) reaches 100ml. The solution in the flask was then titrated with 0.04 Hcl until the first permanent pink colour appeared. The blank was titrated in the same way and the time value for the samples were obtained.

% nitrogen= $\frac{\text{vs.vb X Nacid X 0.04 X 100}}{\text{W}}$

Where

Vs = volume (ml) of acid required to titrate sample

Vb = volume (ml) of acid required to titrate the blank

Nacid = normality of acid (0.1N)

W= weight of sample in gram (g)

Note: most proteins contain about 16% nitrogen, so that 16mg nitrogen =100mg protein.

1mg Nitrogen = 6.25

Therefore protein (%) = N × 6.25 (conversion factor for protein)

2.3.6 Determination of carbohydrate

The carbohydrate content was determined as illustrated by AOAC (2010) as follows:

It was estimated as the remainder after accounting for all, crude fibre, protein and fats.

Total carbohydrate contents= 100-(% moisture +% ash + % protein +% crude fibre + % fat).

Where

Cp = crude protein

Cf = crude fibre

Ash = ash content

Fat = fat content

Moisture = moisture content

RESULTS AND DISCUSSION

The proximate compositions of two laboratory prepared

Table 1: Proximate composition (%) of samples

Sample	Protein	Fat	Ash	Moisture	Crude	Carbohydrate
WSF	13.1	3.7	0.9	10.6	1.7	70.0
MSF	10.7	3.2	1.11	9.9	1.7	73.4
GPF	6.7	1.1	0.7	10.3	2.6	78.6
BPF	5.6	2.3	1.3	10.2	2.4	78.2

KEY
WSF = whole sorghum flour
MSF = malted sorghum flour
GPF = grated potato flour
BPF = boiled potato flour

sorghum and sweet potato flour samples are presented in table 1 above.

The protein content of grated potato flour was found to be greater than that of the boiled potato flour. This is because in the process of boiling the potato, a certain amount of protein might have been denatured, hence the low level of protein.

The whole sorghum flour has high protein content compared to the malted sorghum flour; this means that the whole sorghum flour can be a better meal than the malted sorghum. It may even be used to treat protein deficiency diseases such as kwashiorkor. (Raghuvanshi *et al*., 2011) reported that the average *in vitro* protein digestibility of three cultivars of mung bean improved from 68.22 to 74.72% following dehulling and frying the grains.

The fat content of the boiled potato flour is greater than that of the grated potato flour. This is because grated potato flour was steeped in water and decanted two times in an interval of 10 hours in which a reasonable amount of fat might have been eliminated in the process.

The fat content of whole sorghum flour is greater than that of malted sorghum flour. This is also because malted sorghum flour was steeped in excess water for five (5) days and the water was then decanted and dried and as such, some amount of fat must have been lost along with the water.

The ash content of malted sorghum flour is greater than that of the whole sorghum flour; this means that the malted sorghum flour will supply more minerals to the body than the whole sorghum flour.

Similarly, the ash content of boiled potato flour is greater than that of the grated potato flour, which also means that the boiled potato flour will supply more minerals to the body that the grated potato flour.

The moisture content of whole sorghum flour is greater than that of the malted sorghum flour, thus, malted sorghum flour can be stored for longer periods without spoilage than whole sorghum flour and as such they have a longer shelf life.

The crude fibre content of both whole sorghum flour and malted sorghum flour is the same which means that both the whole sorghum flour and the malted sorghum flour will have almost the same effect in aiding digestion in the digestive system.

The grated potato flour has more crude fibre content than boiled potato flour. This means that the grated potato flour will have better digestion and lesser possibility of constipation than the boiled potato flour.

The carbohydrate content of malted sorghum flour is greater than that of the whole sorghum flour which implies that the malted sorghum flour will give higher calories of energy than the whole sorghum flour. This substantiates the findings of Ghavidel and Prakash (2007) that reported that germination and dehulling improved starch digestibility significantly. They also reported the relationship between methods of milling and processing and the particle size are related to the starch content of flour.

Also, the carbohydrate content of grated potato flour is slightly greater than that of boiled potato flour and so grated potato flour will supply a slightly higher amount of energy to the body system than boiled potato flour. This also agrees with the findings of (Kerr et al., 2000) that Home practices such as soaking, dehulling, fermentation, germination, and cooking effectively improve the nutritional value of legumes. Thus it can be said that soaking did not affect the nutritional quality of the sorghum.

Malted sorghum flour is an important ingredient in addressing the issue of dietary bulk of weaning foods required in meeting a growing infant's energy needs, this is a quality which whole sorghum flour does not possess. The protein and starch in sorghum grain are more slowly digested than those from other cereals, and slower rates of digestibility are particularly beneficial for people with diabetes.

CONCLUSION

This study showed that the grated sweet potato is low in fat and has less effect on crude fibre, moisture, protein and carbohydrate contents of sweet potato. It also shows

that the whole sorghum flour has less effect on the fat, crude fibre, moisture and protein contents of sorghum. In conclusion, the whole sorghum flour processing method has less effect on the nutritional properties of sorghum and the grated potato flour processing method has less effect on the nutritional properties of sweet potato.

RECOMMENDATION

The information obtained from the result of this research has contributed to our knowledge of methods of processing sweet potato and sorghum. Therefore, I recommend that the whole sorghum flour processing method should be adopted in processing sorghum in our various homes and the grated potato flour processing method should also be adopted to improve quality of life by enhancing a good diet.

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