SJIF Impact Factor: 6.711

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

ISSN: 2457-0400
Volume: 8.
Issue: 8
Page N. 95-103
Year: 2024

Review Article www.wjahr.com

THE EFFECT OF PRE-PROCESSING OPERATIONS ON THE PROXIMATE COMPOSITION OF SOME THERAPEUTIC TUBER FLOURS

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Article Received date: 07 June 2024 **Article Revised date:** 27 June 2024 **Article Accepted date:** 17 July 2024

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ABSTRACT
Some pre-processing operations such as (boiling, sprouting, frying and roasting) were carried out on white yam,(*Dioscorea spp*),water yam(*Dioscorea alata)*,aerial yam(*Dioscorea bulbifera*) and cocoyam (*Xanthosoma maffa*) flours to determine their effects on their proximate compositions. The comparative studies carried out in this work showed sprouted white yam to be significantly(p<0.05) different in protein content(3.50%) from all the other samples, followed closely by untreated cocoyam (2.84%).Boiled white yam and water yam were high in moisture content:(13.40%) and (12.99%) respectively. The fat content of fried white yam(13.02%) and aerial yam(11.18%) were outstanding from all the other samples while the crude fibre of untreated cocoyam (1.92%) was significantly(p<0.05) different from boiled white yam, aerial yam and cocoyam which had same value of (1.33%). Roasted aerial yam followed closely in crude fibre with (1.32%).Untreated aerial yam (5.49%), sprouted aerial yam(5.48) and roasted cocoyam (5.38%) were not significantly (p>0 05) different from each other in their ash contents. The carbohydrate content of boiled white yam (85.21%), roasted cocoyam (83.72%), boiled cocoyam (83.61%) and roasted water yam (83.46%) were significantly (p<0.05) different from all the other samples.

KEYWORDS: White yam, cocoyam, *Diocorea alata*, *Xanthosoma maffa/robustum* ,*Dioscorea bulbifera*, pre processing operations, proximate.

INTRODUCTION

Aerial yam (*Dioscorea bulbifera*) is native to Tropical Africa, Asia, pacific Island and Northern Australia. This bulbils bearing yam commonly known as cheeky yam, bitter yam or air potato, belongs to the order *Dioscorea*, family *Dioscoreaceae* and the genus is unpopular species among the edible yam species. It is cultivated in the South Eastern Asia, West Africa, South and Central America. *Dioscorea bulbifera* is a perennial vine with broad, alternate leaves, and two types of storage organs. The plant forms bulbils in the leaf axils of the twining stems, and tubers beneath the ground. These tubers are like small, oblong potatoes. Some varieties are edible and cultivated as a food crop, especially in West Africa.[1] The proximate composition varies among species and between cultivars. The nutritional and chemical composition of aerial yam is characterized by a high level of moisture and dry matter which varies as a result of environmental conditions within which it was cultivated,[2,3] reported the following on the proximate composition of white aerial yam flour : 4.92% crude protein,0.91% fat,1.17%crude fibre, 2.62% ash,7.12% moisture and 81.93% carbohydrate. Aerial yams are naturally high in dietary fibre, flavonoids and isoflavonoids and at such are good for treatment against constipation, stomach pains, diarrhea, stomach ulcers, tumors, antidiabetic, anticancer, oestrogenic heart properties and high blood pressure control.[4] They can be eaten as vegetable after chopping them into pieces and soaking for some hours.[5] However, *Dioscorea bulbifera* is known to posses some anti nutrients such as : Saponin, Phytate, Oxalate and Tannins.[6] However, detoxification methods for aerial yam includes soaking, blanching, boiling, peeling, grating, roasting, oven drying and fermentation processes.

Cocoyam (*Xanthosoma robustum*) also known as *Mafafa* or *Maffa* is a species of cocoyam belonging to the family *Araceae* and genius *Xanthosomae*. It is native to Northern and Southern America. The plant grows tall up to 4metres, stem hypogeous in young plants but epigeous and robust in adult plants. This neotropical specie of cocoyam commonly called "elephant ear" or "pata" as a result of the size and shape of the leave has 45 species and is therefore the most diverse genus of cocoyam.[7] This specie is also characterized by its floral thermogenicity; a pollination strategy in which a flower heats up to release odors as a means to attract pollinators and this is very common with the Araceae family of cocoyam.[8] According to the first nutritional report on *Xanthosoma robustum* reported by[9], an isolated *Xanthosoma robustum* starch is characterized by its low contents of protein, fat and ash but high starch content of 88.58% while the amylose content obtained was 35.43%.[8] Reported that digestion rates increase with longer amylose branches in food material and this is an important characteristic of this cocoyam. *Xanthosoma robustum* starch shows long chain of amylose and this contributes to its higher viscosity and gel stability.[9] The starchy corms are consumed as sources of starch by human.

Nutritionally, it contains 694.9g/kg moisture, 71.3g/kg protein, 55.3g/kg crude fibre, 2.20g/kg fat, 47.29g/kg ash and 129.2g/kg carbohydrate[10], on dry weight basis. It is reported by[11] that *Xanthosoma* species contains about 855mg of Phytate per 100mg and about 780mg per 100g of oxalate. Oxalate has been implicated in the acridity or irritation caused by cocoyam. it also tend to precipitate calcium and makes it unavailable for use by the body. Phytate has also been implicated as toxic substance in cocoyam. These anti nutritional factors can be reduced through simple pre-processing operations such as fermentation, blanching, peeling, grating, soaking, and oven drying.

Water yam (*Dioscorea alata*) is also referred to as greater yam, Asian greater yam and ten-month yam. It is more important as food in West Africa and the Caribbean than in Asia and the Americas where it originated, and has been competing with the most important native species. It was introduced to Africa some hundred years ago from Malaysia through agriculturists and by Portuguese and Spanish seafarers. It is next to *D. rotundata* in terms of volume of production and extent of utilization. *D alata* species is the highest yielding among the yam species and can store relatively longer than other species (5-6 months) after harvest.[12] *D. alata* tubers have variable shapes, the majority being cylindrical. Its tubers vary in number, from one to five. According to[13], *D. alata* is also known for its high nutritional content of 9.54% moisture, 5.59% ash, 7.52% fat, 7.85% crude protein, 12.12% crude fibre and 57.38% carbohydrate.

D. alata is suitable for producing weaning foods and other products that require low viscosity such as *amala*.[14] *D. alata* varieties has high total dietary fiber which makes it appropriate for management of pile, constipation and Diabetes.[15]

White yam (*Discorea rotundata*) are annual or perennial tuber-bearing and climbing plants belonging to the family of *Dioscoreaceae*. Some species of white yam originated from Africa before spreading to other parts traditionally. It contains 7.04% moisture,3.05% ash, 11.63crude fat,2.19% protein and 68.50% carbohydrate.[13] It contains some vitamins C, and an appreciable amount of potassium, a mineral that helps to control blood pressure.[16] White yam is also a good source of manganese, a trace mineral that helps with carbohydrate metabolism and also acts as a cofactor in a number of enzymes important in energy production and antioxidant defenses. It also contains traces of vitamin B-complex.[17]

MATERIAL AND METHODS

Study Site: The study was carried out in the Department of Food Technology, Akanu Ibiam Federal Polytechnic Unwana, Afikpo in Ebonyi State, and the analyses were done at the Department of Food Technology, Akanu Ibiam Federal Polytechnic Unwana and Biochemical Department laboratory of the National Root Crops Research Institute (NRCRI) Umudike in Umuahia, Abia state.

The sample collection, preparation and investigations were conducted within two (2) months.

Raw Materials

White yam (Dioscorea rotundata), Aerial yam (*Dioscorea bulbifera*), cocoyam (*Xanthosoma robustum*) and water yam (*Dioscorea alata*) were purchased in large quantity from Eke market in Afikpo in Ebonyi State.

Sample Preparation

Samples were prepared at the processing laboratory of the department of Food Technology, Akanu Ibiam Federal Polytechnic Unwana, Afikpo in Ebonyi State and the analytical grade chemicals and Enzymes used in the bench work for the analysis of this research were from the Laboratory of Food Technology, Akanu Ibiam Federal Polytechnic Unwana and Biochemical Department of the National Root Crops Research Institute (NRCRI) Umudike in Umuahia, Abia state.

Raw materials preparations

The selected tuber crops; water yam, aerial yam and cocoyam were sorted (to remove bad or spoilt ones), washed with the back, peeled and washed again. They were then sliced into 2-3cm thickness, labeled and subjected to four different treatments: boiling, frying, sprouting and roasting.500g of each of the samples were boiled 100^0C for 15 minutes for cocoyam and water yam and 100^oC for 20 minutes for white yam and aerial yam. 500g of each of the samples were deep fried at 160^0C till done and oil was drained off. Another 500g of each of the samples were sprouting for 7-21 days at 36^{0}C/room temperature. 500g of each of the samples were oven roasted at 180^{0}C for 20 minutes for all and 30 minutes for aerial yam. A set (500g) was left untreated which served as the control samples The samples were oven dried until a constant weight was achieved for each of the samples showing maximum drying. They were dry milled into fine flours and their proximate compositions were analyzed in triplicate forms according to the method described by.[18]

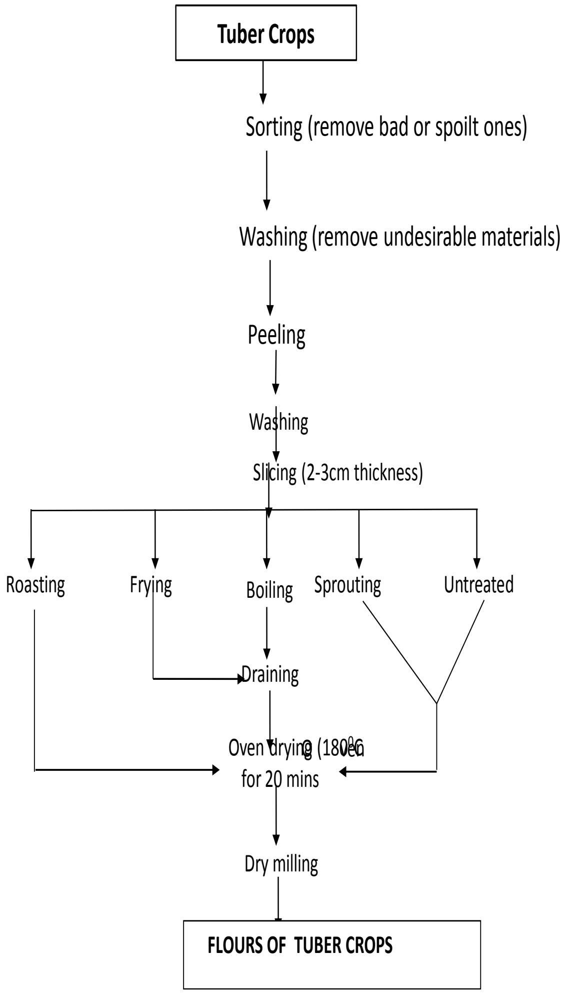

Figure 1: Showing the production of the tuber flours with the different pre processing methods.

Source.[19] with some modifications.

The different plates showing the selected tubers and some pre processing treatment given to them

Plate 1: Cocoyam *(Xanthosoma robustum).*

Plate 2: Sprouted cocoyam (*Xanthosoma robustum*).

Plate 3: Sprouted white yam (*Dioscorea rotundata*).

Plate 4: Cross-section dissected/undissected white yam *(Dioscorea rotundata)*.

Plate 5: Water yam *(Dioscoreaa alata)*.

Plate 6: Sprouted wateryam *(Dioscorea alata)*.

Plate 7: Aerial yam *(Dioscorea bulbifera)*.

Plate 8: Sprouted aerial yam *(Dioscorea bulbifera)*.

Table 1: Showing the effect of pre-processing operations on the proximate compositions (%) of some therapeutic selected tuber flours.

Treatments	Samples	Protein content (%)	Moisture content (%)	Fat content (%)	Crude fibre content (%)	Ash content (%)	Carbohydrate content (%)
Fried	White yam	$1.19^{i} \pm 0.02$	$8.85^{m} \pm 0.05$	$13.02^{a} \pm 0.04$	$0.44^{fg} \pm 0.02$	$3.00^{j} \pm 0.02$	$73.50^{m} \pm 0.06$
Boiled		$0.47^{n} \pm 0.04$	$13.40^{a} \pm 0.12$	$3.33^{d} \pm 0.07$	$1.33^{b} \pm 0.03$	$2.90^{j} \pm 0.02$	$85.21^{a} \pm 0.09$
Sprouted		$3.50^{a} \pm 0.04$	$11.78^{d} \pm 0.08$	$0.90^{j} \pm 0.03$	$0.53^{e} \pm 0.02$	$3.80^{i} \pm 0.02$	$79.74^{h} \pm 0.04$
Roasted		$1.62^{f}\pm0.02$	$9.73^{j}\pm0.05$	$0.34^{j} \pm 0.03$	$0.62^{d} \pm 0.02$	$0.62^{m} \pm 0.03$	$80.19^{g} \pm 0.27$
Untreated		$1.75^{e} \pm 0.02$	$10.65^{e} \pm 0.01$	$0.61^{k} \pm 0.04$	$0.73^{c} \pm 0.05$	$4.10^{i} \pm 0.04$	$82.15^{d} \pm 0.01$
Fried	Aerial yam	$0.88^{k} \pm 0.05$	$10.73^{e} \pm 0.08$	$11.18^{b} \pm 0.01$	$0.36^{hi}\pm0.02$	$2.64^{j} \pm 0.02$	$74.21^{i} \pm 0.04$
Boiled		$0.83^{kl} \pm 0.03$	$9.94^{hi} \pm 0.01$	$2.33^{g} \pm 0.04$	$1.33^{b} \pm 0.03$	$5.00^{de} \pm 0.01$	$80.32^{fg} \pm 0.05$
Sprouted		$1.31^{h} \pm 0.02$	$9.69^{j} \pm 0.03$	$1.29^{i} \pm 0.04$	$0.28^{jk} \pm 0.03$	$5.48^{a} \pm 0.06$	$81.95^{d} \pm 0.03$
Roasted		$1.04^{j} \pm 0.03$	$10.54^{f} \pm 0.04$	$1.98^{h} \pm 0.03$	$1.32^{b} \pm 0.01$	$4.80^{f} \pm 0.06$	$80.57^{f} \pm 0.05$
Untreated		$2.50^{d} \pm 0.03$	$8.55^{n} \pm 0.04$	$2.65^{f} \pm 0.01$	$0.25^{k} \pm 0.04$	$5.49^{a} \pm 0.03$	$80.56^{f}\pm0.07$
Fried	Cocoyam	$1.52^{g} \pm 0.04$	$9.58^{k} \pm 0.04$	$8.87^{c} \pm 0.02$	$0.42^{g} \pm 0.02$	$4.34^{h} \pm 0.04$	$75.27^{k} \pm 0.05$
Boiled		$0.42^{n} \pm 0.02$	$9.70^{j} \pm 0.02$	$0.33^{j} \pm 0.01$	$1.33^{b} \pm 0.02$	$4.50^{g} \pm 0.08$	$83.61^{b} \pm 0.05$
Sprouted		$2.66^{c} \pm 0.05$	$9.88^{i} \pm 0.02$	$0.68^{k} \pm 0.03$	$0.39^{gh} \pm 0.03$	$5.14^{cd} \pm 0.04$	$81.25^{e} \pm 0.14$
Roasted		$0.63^{m} \pm 0.03$	$9.26^{l} \pm 0.04$	$1.00^{j} \pm 0.02$	$0.32^{ij} \pm 0.02$	$5.38^{ab} \pm 0.36$	$83.72^{b} \pm 0.08$
Untreated		$2.84^{b} \pm 0.04$	$10.00^{h} \pm 0.06$	$0.68^{k} \pm 0.03$	$1.92^{a} \pm 0.05$	$4.05^{i} \pm 0.06$	$78.95^{i} \pm 0.03$
Fried	Water yam	$0.80^{f} \pm 0.04$	$10.53^{f} \pm 0.05$	$8.33^{d} \pm 0.50$	$0.35^{hi} \pm 0.04$	$2.65^{j} \pm 0.06$	$77.39^{j} \pm 0.57$
Boiled		$1.31^{h} \pm 0.06$	$12.99^{b} \pm 0.04$	$0.33^{j} \pm 0.01$	$0.29^{jk} \pm 0.05$	$2.90^{j} \pm 0.04$	$80.08^{g} \pm 0.17$
Sprouted		$1.53^{g} \pm 0.02$	$10.42^{g} \pm 0.05$	$0.41^{i} \pm 0.03$	$0.61^{d} \pm 0.03$	$4.94^{ef} \pm 0.06$	$82.09^{d} \pm 0.13$
Roasted		$0.88^{k} \pm 0.04$	$11.78^{d} \pm 0.05$	$0.33^{l} \pm 0.02$	$0.48^{f} \pm 0.02$	$5.24^{bc} \pm 0.04$	$83.46^{b} \pm 0.22$
Untreated		$1.67^{f} \pm 0.00$	$11.90^{c} \pm 0.02$	$0.38^{l} \pm 0.02$	$0.33^{ij} \pm 0.02$	$2.63^{j} \pm 0.03$	$83.07^{c} \pm 0.05$

Values are mean ± standard deviation of duplicate determinations. Mean on the same column with the same superscript are not significantly different at p>0.05%.

Protein (%)
Sprouted white yam was significantly (p<0.05) higher than all the other samples with protein content of (3.50%). The range of the protein content of the samples were from (0.42 - 3.50%) and these were within the range (2.21-3.37%) reported by.[20] on two edible wild yam flours varieties from Abakiliki, Nigeria. Untreated and sprouted cocoyam had a protein content of (2.84%) and (2.66%) respectively while untreated aerial yam protein content was significantly higher (p<0.05) than its treated counterparts at (2.50%). The least protein content among the samples were seen in boiled white yam (0.47%) and boiled cocoyam (0.42%). Foods with high protein content as represented by sprouted white yam may be regarded as food of good nutritional quality to help prevent protein malnutrition.

Moisture Content (%)
The moisture content of the samples ranged from (8.55 - 13.40%). Boiled white yam had a moisture content of (13.40%) and was significantly (p<0.05) different from all the other samples. This was followed closely by the moisture content of roasted water yam (12.99%). These moisture content were within the range (7.04 - 9.54%) of the report given by[13] on *Dioscorea alata*, *Dioscorea rotundata* and *Dioscorea bulbifera* Moisture content is

an important parameter used to define the maximum or minimum amount of water present in a food material, to calculate the cost of the food material, to examine the quality of the food material as well its stability and shelf life.[21] It is the primary parameter for food spoilage to occur.[22]

Fat (%)
The samples showed fat content in the range of (0.33 - 13.02%). The highest fat content in this work (13.02%) seen in fried white yam was higher than the range (0.8-1.1%) reported by[23] on yam chips, flakes and flours but lower to that reported (23.03%) by[24] on vegetable oil fried cocoyam (C*olocasia esculenta*). High fat content in tuber flours is of advantage mostly in food processes because one gram of fat or oil can produce 9kcal of energy while protein and carbohydrate produce only 4kcal energy in the body.[25]

Fat content of fried aerial yam (11.18%) was also significantly ($p<0.05$) high than other samples apart from fried white yam. Deep frying is defined as a method of cooking and dehydration process which consist of immersing the food material in an oil bath at the temperature range of 150-190^{0}C.[26] This can increase the fat content of food sample since oil is the medium used. This could be the reason why fried white yam samples were significantly higher ($p<0.05$) than the other samples.

Crude fibre (%)
The samples had crude fibre content in the range of (0.25 -1.92%). These were lower compared to what[27] reported on raw cocoyam (1.99%) and yam flours (7.09%) but were close (1.20% — 1.40%) to what[11] reported for cocoyam flours. Untreated sample of cocoyam with crude fibre content of (1.92%) was significantly ($p<0.05$) higher than the other samples. This is consistent with the work of[1] on some tuber crops. They reported some tuber crops such as cocoyam to have high soluble fibre content. The crude fibre of boiled white yam (1.33%), boiled aerial yam (1.33%), boiled cocoyam (1.33%) and roasted aerial yam (1.32%) were not significantly($p>0.05$) different from each other. However, untreated aerial yam was significantly lower ($p<0.05$) than all the samples with crude fibre content of (0.25%). Crude fibre, an important component in food provides roughages or bulk, aids digestion, soften stool and prevents colon cancer.[10]

Foods with high crude fibre are said to improve glycemic response, reduce postprandial blood sugar levels, help treat diabetes, control weight and reduce incidence of obesity.[28,29]

Ash content (%)
The ash content of the samples range from (0.62-5.49%) and these were lower than what[10], reported on yellow yam (19.64%), aerial yam (30.66%) and cocoyam (47.29%) but was within the range of what was reported by[24] for the ash content for untreated cocoyam (2.14%) and vegetable fried cocoyam(1.07%) (*Colocasia esculenta*). Ash content of the untreated sample (5.49%) and sprouted aerial yam (5.48%) were significantly ($p<0.05$) different from the other samples. According to[21], ashing is used for the nutritional evaluation of a food material. The ash content of roasted cocoyam (5.38%), roasted water yam (5.24%) and sprouted cocoyam (5.14%) were not significantly ($p>0.05$) different from each other. Roasted white yam was significantly lower ($p<0.05$) (0.62%) than all the samples in ash content. Ash content is a measure of the mineral status of a food sample. It may also be regarded as a measure of quality or grade of the flour sample of the food material and often a useful criterion in identifying the authenticity of a food or product.[21]

Carbohydrate (%)
The carbohydrate content of the samples range from (73.50-85.21%) and this was within the range (79.6-81.8%) of what[23] reported on yam chips, flakes. The carbohydrate content of boiled sample of white yam was significantly ($p<0.05$) higher (85.21%) than the other samples.[30] Reported that carbohydrate content of boiled yam chips was higher than the fried ones. Boiling as a heat treatment caused water to be absorbed in the amorphous space of starch. The penetration of water thus increased the randomness in the starch granule structure and causes swelling.[18] This could as well cause the high carbohydrate content seen in boiled cocoyam samples (83.76%).

However, the carbohydrate content of fried white yam was significantly ($p<0.05$) lower (73.50%) when compared to the other samples. High carbohydrate content of these flours suggest that they can be used in managing protein- energy malnutrition since there is enough quantity of carbohydrate to derive energy from in order to spare protein in order for protein to be used for its primary function of building the body and repairing worn out tissues rather than a source of energy. Tuber plants are good sources of carbohydrate which could be used as strategic national food reserves.[22]

CONCLUSION
Some therapeutic tuber flours from:aerial yam, cocoyam (*Xanthosoma robustum*),water yam and white yam flours were analysed for their proximate composition after they have been subjected to four pre-processing operations. Sprouted white yam was high in protein content(3.50%) compared all the other samples, followed closely by untreated cocoyam (2.84%).Boiled white yam and water yam were high in moisture content: (13.40%) and (12.99%) respectively. The fat content of fried white yam(13.02%) and aerial yam(11.18%) were outstanding from all the other samples while the crude fibre of untreated cocoyam (1.92%) was different from boiled white yam, aerial yam and cocoyam which had same value of (1.33%). Roasted aerial yam followed closely in crude fibre with (1.32%).Untreated aerial yam (5.49%),

sprouted aerial yam(5.48) and roasted cocoyam (5.38%) were not different from each other in their ash contents. The carbohydrate content of boiled white yam (85.21%), roasted cocoyam (83.72%), boiled cocoyam (83.61%) and roasted water yam (83.46%) were different from all the other samples. Boiling and sprouting stood out among the pre-processing operations used in this work.

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