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Quality Attributes of Yam Flour (Elubo) As Affected By Blanching Water Temperature and Soaking Time

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----------Abstract----------
Yam is a tuber crop which belongs to the family Dioscorea spp. It is a semi perishable class of food diet due to its high moisture content. Yam flour (elubo) is a fine powder made from the processing of yam tuber. The process of obtaining yam flour from yam tuber involves sorting, peeling slicing, blanching, drying and milling. The objective of this work is to determine the effect of blanching water temperature and soaking time on some quality attributes of yam flour. Fresh yam tubers (Dioscorea rotundata) without rot and decay was selected peeled, cut into cubes of 25mm ± 2mm thickness, blanched, soaked, dewatered and oven dried. The dried samples were milled, sieved and packaged for analysis. The experiment was carried out at three blanching temperatures (40, 50 and 60^oC) and three soaking time (12, 24, 48 hours) at three replicates (3x3x3=27replicates). The unbalanched and unsoaked samples were used as control. All the samples were stored separately for further analysis. The physical and proximate qualities of yam flour samples were determined using standard methods. Data collected was analyzed statistically to determine the Analysis of Variance (ANOVA) and the means separated. The result shows that the blanching water temperature and soaking time has significant effects ($p \leq 0.05$) on the moisture content, protein, carbohydrate, loose bulk density, packed bulk density, swelling capacity, foaming capacity and water absorption capacity of yam flour. However these processing parameters have no significant effect ($p \leq 0.05$) on the fat and ash contents of yam flour. The blanching and soaking of fresh yam cubes before the yam flour production resulted in significantly higher protein content, carbohydrate content, swelling capacity, foaming capacity, and bulk density (loose and packed) compared to the control sample. The yam flour produced from blanched and soaked yam cubes has better quality attributes than the unblanched and unsoaked samples. It is therefore recommended that the best combination of processing parameter for best quality yam flour is 40^oC blanching water temperature and 12h soaking time.

Keywords: *yam, yam flour, blanching temperature, soaking time, quality attributes*

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1. Introduction

Yam belongs to the family Dioscorea spp. It is a semi-perishable class of food due to its relative high moisture content (Jimoh and Olatidoye, 2009). It is a tuber crop that is grown widely in many parts of the world. It is majorly grown in sub-Saharan Africa, with the production of more than 95% of the global yam cultivation. It is the second most important root/tuber crop in Africa after cassava (FAO 1996, 1997). The species of yam majorly grown include; Dioscorea alata (water yam), Dioscorea bulbifera (potato yam), Dioscorea cayenensis (yellow yam), Dioscorea dumetorum (bitter yam), Dioscorea esculenta (lesser yam), Dioscorea opposita (Chinese yam), Dioscorea rotundata (white yam), and Dioscorea trifida (cush-cush yam). Among these species, the commonly grown ones are Dioscorea rotundata and Dioscorea cayenensis.

Yam provides around 110 calories per 100 grams of products. It contains mainly carbohydrates with little amount of proteins, lipids and vitamins (Babalola and Oyenuga, 2001). Yam is high in moisture, dry matter, starch, dietary fiber, vitamins C and B_6, but low in saturated fat, sodium and vitamin A contents. Yams contain about 5-10 mg/100g of vitamin C, and the limiting essential amino acids are isoleucine and also containing sulphur. They also contain a steroid sapogenin compound called diosgenin, which can be extracted and used as base for drugs such as cortisone and hormonal drugs. Some species contain alkaloids (e.g. dioscorine $C_{13}H_{19}O_2N$) and steroid derivatives. It should be noted that the method of preparation affects the final nutritional status of yam-based foods. These data are useful in designing new product formulations as well as efficient food process operations (FAO, 1996).

The traditional storage structures used for yam storage include leaving the tubers in the ground until required, the yam barn, and underground structures (FAO, 1997). In the absence of good storage facilities, yam tubers are prone to gradual physiological deterioration after harvesting (Jimoh and Olatidoye, 2009). Yam is a source of carbohydrate and has a lower glycaemic index which makes it a sustainable source of energy and gives better protection against obesity and

diabetes (Brand-Miller *et al.* 2003*).* Fresh yams are difficult to store and are subject to post harvest losses during storage (Otunsanya and Jeger, 1996; Afoakwa and Dedeh, 2001). These losses serve as an impetus for processing this staple food into a product of longer shelf life.

Yam flour is a fine powder made from the processing of yam tuber. The process involved in yam flour production includes harvesting, sorting, peeling, slicing, blanching, drying and milling. This is the age-old traditional method of processing yam into dry yam *(gbodo)*, and subsequently yam flour *(elubo)*. The quality of *gbodo* and *elubo* varies from processor to processor and from location to location (Akissoe *et al.,* 2003, Hounghonigan *et al.,* 2003; Mestress *et al.,* 2004).Yam flour is the major ingredient in the making of *Amala* in Nigeria when reconstituted. Local consumers of yam flour *(elubo)* have preference for the product made from a particular part of South-West Nigeria due to a more preferred and better nutritional value (Bricas *et al.* 1997).

Yam flour *(elubo)* is made from yam tuber peeled and sliced to the thickness of about 10mm depending on the type of drying method to be used. The sliced yam are parboiled and allowed to cool in cooking water in what is known as blanching. The parboiled slice is dried and then milled into flour to produce a uniform texture. The quality of the yam flour produced is dependent on the parameters taken into consideration during its processing operation. These parameters include blanching temperature, blanching time and slice thickness. Yam flour can be easily stored for a long period (12 - 18 months) if the flour is free from moisture. In recent years, much attention has been drawn to the quality of dehydrated food products. Drying methods and the physicochemical changes that occur in tissues during drying affect the quality of the dehydrated products. More specifically, the method used for drying affects properties such as colour, texture, density, porosity and sorption characteristics of materials (Krokida *et al.,* 1998). Traditionally in Africa, yam slices are usually sun dried. Sun-drying represents a low cost processing method of preserving agricultural produce in the tropics. Open sun drying, however, has some limitations. These include the inability to control the drying process and parameters, weather uncertainties, high labour costs, the requirement of a large drying area, insect infestation, and contamination with dust and other undesirable materials (Sankat and Mujaffar, 2004). A controlled environment is therefore recommended to improve the quality of the product. Hot air drying is one of the most frequently used operations for food dehydration. It is a method in which heated air is blown over food materials with the aid of fan(s) to remove most of the moisture from the food material. The drying of wet materials induces a number of physicochemical changes in the product, often reflected by colour. By choosing suitable drying methods and the appropriate conditions, the final product quality can be controlled.

The effect of drying methods (oven-drying) on the rheological properties and colour of *amala*, a thick paste from yam flour, was investigated using two varieties of yam *(Dioscorea rotundata and Dioscorea alata).* The yam flour produced was later reconstituted to produce *amala* of different pasting characteristics, textural qualities and colour (Akissoe *et al.,* 2003, Akissoe *et al.,* 2001). Yam flour paste (*amala)* of higher paste viscosity, and firmer gels were produced from *Dioscorea rotundata* than yam flour paste produced from *Dioscorea alata*. A higher water binding capacity (156.7%) was observed in yam flour paste produced from *Dioscorea alata* as compared with that of *Dioscorea rotundata*, while no significant difference was observed in the solubility index and swelling power of the two varieties. Blanching, a unit operation in yam flour processing, has a significant effect on the pasting characteristics of the reconstituted flour. It reduces the peak viscosity, holding strength, final viscosity, set back and elasticity but it has little or no significant effect on the adhesiveness, smoothness and cohesiveness of the paste. Oven drying had no effect on the pasting characteristics or physicochemical properties. However, yam flour produced using sun drying method had a more elastic paste and a higher brown-index (Abulude and Ojediran 2006). The quality attributes of yam flour does not only include the colour, texture and taste, but also its nutritional quality attributes. In Lagos, Kwara, Ibadan and Akure among other states in Nigeria, there have been records of some whole family death after the consumption of yam flour dough *(Amala)* (Adeleke, 2009). Attempts to improve or maintain the chemical and sensory qualities of yam flour before their utilization have been reported by various authors (Sanni *et al*., 2006, Hounghonigan *et al.,* 2003; Mestress *et al.,* 2004, Jimoh and Olatidoye, 2009). The aim of this work is to study the effect of blanching temperature and soaking time on some selected quality attributes of yam flour *(elubo).*

2. Materials and methods

Fresh yam tubers (*Dioscorea rotundata*) without rot and decay was selected peeled, cut into cubes of 25mm ± 2mm thickness, blanched, soaked, dewatered and oven dried. The dried samples were milled, sieved and packaged for analysis. The experiment was carried out at three blanching temperatures (40, 50 and 60^0C) and three soaking time (12, 24, 48 hours) at three replicates (3x3x3=27replicates). The unbalanced and unsoaked samples were used as control. All the samples were stored separately for further analysis. The proximate and physical analysis of the yam flour sample was determined as prescribed by Association of Official Analytical Chemist (AOAC), 1990 and IFST, 1992. The physical and proximate qualities of yam flour samples were determined using standard methods. Data collected were analyzed statistically to determine the Analysis of Variance (ANOVA) and the means separated.+

3. Results

The results of the mean effect of blanching water temperature and soaking time on the selected quality attributes of yam flour with their separated means values are as presented in Table 1. The analysis of variance of the effect of blanching water temperature and soaking time on the selected quality attributes of yam flour are also presented in Table 2.

Table 1: The mean[1,2] effect of blanching temperature and soaking time on the quality attributes of yam flour

Temperature	40°C			50°C			60°C			
Time	12h	24h	48h	12h	24h	48h	12h	24h	48h	Control
Moisture content (%)	9.27^a	9.40^b	9.33^b	9.47^{bc}	9.67^c	9.60^c	9.23^b	9.37^b	9.53^c	8.83^a
Protein content (%)	2.53^a	2.57^a	2.50^a	2.50^a	2.43^a	2.43^a	2.53^a	2.43^a	2.50^a	3.07^b
Ether extract (%)	0.57^a	0.57^a	0.53^a	0.57^a	0.53^a	0.47^a	0.60^a	0.53^a	0.47^a	0.57^a
Ash content (%)	2.20^a	2.13^a	2.13^a	2.27^a	2.10^a	2.07^a	2.23^a	2.13^a	2.10^a	2.20^a
Crude fiber (%)	1.37^a	1.30^a	1.30^a	1.37^a	1.23^a	1.23^a	1.37^a	1.23^a	1.23^a	1.37^a
Carbohydrate (%)	84.07^a	84.03^a	84.27b	83.83^a	84.03^a	84.43^b	83.97^a	84.07^a	84.17^a	83.83^a
Bulk density (loose)	.421^a	0.42^a	0.413^a	0.42^a	0.41^a	0.41^a	0.42^a	0.41^a	0.41^a	0.43^b
Bulk density (packed)	0.73^a	0.723^a	0.72^a	0.73^a	0.72^a	0.72^a	0.73^a	0.72^a	0.72^a	0.75^b
Swelling capacity	1.30^b	1.40^c	1.40^c	1.30^b	1.43^c	1.47^c	1.30^b	1.47^c	1.50^c	1.20^b
Foaming capacity	32.20^a	32.20^a	32.20^a	32.93^b	33.20^b	33.33^b	32.87^b	33.43^b	33.57^b	42.47^c
Water absorption capacity	135^a	135^a	135^a	145^b	145^b	145^b	145^b	145^b	145^b	150^c

[1] means of three replicate [2] superscript means with the same letters for a particular measurement are not significantly different ($p \leq 0.05$).

Table 2: The analysis of variance of the effect of blanching water temperature and soaking time on the quality attributes of yam flour.

		Sum of Squares	Df	Mean Square	F	Sig.
MC	Between Groups	1.50	9	0.17	31.20	0.00
	Within Groups	0.12	20	0.01		
	Total	1.61	29			
Protein	Between Groups	0.95	9	0.11	14.37	0.00
	Within Groups	0.15	20	0.01		
	Total	1.10	29			
Fat	Between Groups	0.05	9	0.01	2.18	0.07
	Within Groups	0.05	20	0.00		
	Total	0.11	29			
Ash	Between Groups	0.11	9	0.01	1.40	0.25
	Within Groups	0.18	20	0.01		

	Total	0.29	29			
Crude fibre	Between Groups	0.11	9	0.01	2.76	0.03
	Within Groups	0.09	20	0.00		
	Total	0.20	29			
Carbohydrate	Between Groups	0.92	9	0.10	6.39	0.00
	Within Groups	0.32	20	0.02		
	Total	1.24	29			
Bulk density loose	Between Groups	0.00	9	0.00	8.95	0.00
	Within Groups	0.00	20	0.00		
	Total	0.00	29			
Bulk density packed	Between Groups	0.02	9	0.00	23.32	0.00
	Within Groups	0.00	20	0.00		
	Total	0.00	29			
Swelling capacity	Between Groups	0.25	9	0.03	27.91	0.00
	Within Groups	0.02	20	0.00		
	Total	0.27	29			
Foaming capacity	Between Groups	255.67	9	28.41	1026.39	0.00
	Within Groups	0.55	20	0.03		
	Total	256.22	29			
WAC	Between Groups	787.50	9	87.50	875.00	0.00
	Within Groups	2.00	20	0.10		
	Total	789.50	29			

Where:
MC = Moisture content; WAC = water absorption capacity

The analysis of variance (Table 2) shows that the blanching water temperature and soaking time has significant effect ($p< 0.05$) on the final moisture content of yam flour. The yam flour produced without blanching and soaking had the lowest moisture content of 8.83% while the sample which was soaked for 24h at 50^{o}C had the highest value, the moisture content of samples however soaked for 48h at 50^{o}C and 60^{o}C as well as samples soaked for 12h and 24h at 50^{o}C were not significantly different ($p< 0.05$) from each other. The yam flour produced without blanching and soaking had the highest protein content of 3.07% while the samples which were soaked for 24h at 50^{o}C and 60^{o}C and 48h at 50^{o}C had the lowest value of 2.43% (Table 1). The blanching water temperature and soaking time has significant effect ($p < 0.05$) on the final protein content of yam flour. The analysis of variance (Table 2) shows that the blanching water temperature and soaking time has no significant effect ($p < 0.05$) on the final fat content of yam flour. The yam flour soaked for 48h at 50 and 60^{o}C had the lowest fat content value of 0.47 % while the yam soaked for 12h at 60^{o}C had the highest value of 0.60 %.

The yam flour soaked for 48h at 50^{o}C has the lowest value at 2.07% while the yam flour sample soaked for 12h at 50^{o}C had the highest value of 2.27%. The blanching water temperature and soaking time has no significant effect ($p < 0.05$) on the final ash content of yam flour. The analysis of variance shows that the blanching water temperature and soaking time has significant effect ($p < 0.05$) on the final crude fibre content of the yam flour. The yam flour soaked for 24h at 50 and 60^{o}C, 48h at 50 and 60^{o}C had the lowest value of 1.23% while the unblanched and unsoaked yam flour had the highest value of 1.37%. The analysis of variance shows that the blanching water temperature and soaking time has significant effect ($p < 0.05$) on the final carbohydrate content of the yam flour. The unblanched and unsoaked yam flour sample had the lowest carbohydrate content of 83.83% while the yam flour soaked for 48h at 50^{o}C had the highest carbohydrate of 84.43%. There was no significant difference for all the parameters considered.

The blanching water temperature and soaking time had significant effect ($p < 0.05$) on the bulk density (loose) of the yam flour. The unblanched and unsoaked samples had the highest bulk density of 0.43g/ml while the samples soaked for 48h at 60^{o}C had the lowest value of 0.41g/ml. The blanching water temperature and soaking time has significant effect ($p < 0.05$) on the final bulk density (packed) of yam flour. Yam flour soaked for 48h at 60^{o}C had the lowest bulk density of 0.7203g/ml, while the unblanched and unsoaked samples have the highest bulk density of 0.75g/ml (Table 1).

The analysis of variance shows that the blanching water temperature and soaking time has significant effect ($p < 0.05$) on the swelling capacity of the yam flour. The unblanched and unsoaked samples had the lowest swelling capacity of 1.20 %, while the samples soaked for 48h at 60^{o}C has the highest value of 1.50 %. However, there were no significant differences ($p < 0.05$) in the swelling capacities of yam flour at all other processing parameter variables considered (Table 1). The analysis of variance shows that the blanching water temperature and soaking time has significant effect ($p < 0.05$) on the foaming capacity of the yam flour. The unblanched and unsoaked samples has the highest foaming capacity value of 42.47 % while the samples soaked for 12h, 24h and 48h at 40^{o}C has the lowest value of 32.20 %. However, there was no significant differences ($p < 0.05$) in the foaming capacities of all the other yam flour samples produced at all the other processing parameter variables (Table 1). The analysis of variance shows that the blanching water temperature and soaking time has significant effect ($p < 0.05$) on the water absorption capacity of the yam flour. Yam flour soaked for 12h at 40, 50 and 60^{o}C has the lowest water absorption capacity value of 135%, while the unblanched and unsoaked samples have the highest value of 150 %, which was not significantly different from all the other samples.

3.2 Discussion

The result shows that blanching water temperature and soaking time has no significant effect ($p \leq 0.05$) on the fat and ash contents of yam flour. The blanching water temperature and soaking time however has significant effect on the moisture, protein, carbohydrate, loose bulk density, packed bulk density, swelling capacity, foaming capacity and water absorption capacity of yam flour samples. These results are similar with previous reports Jimoh and Olatidoye, 2009 Sanni *et al*., 2006, Mestress *et al.,* 2004 and Hounghonigan *et al.*, 2003.

The effect of blanching water temperature and soaking time on the protein content was probably due to the denaturizing of protein caused by the effect of heat on the yam cube samples during blanching. This is an indication that protein content value of yam flour can be influenced by using appropriate set of processing parameters. This shows the protein content will decrease irrespective of the blanching water temperature and soaking time. The low value in foaming capacity of the blanched and soaked yam flour samples probably was due to the fermentation that occurred during soaking which has reduced its acidic content compared to the high value recorded in the control sample. The weak gelatinization of starch granules of the control yam flour sample could be responsible for the low value of swelling capacity compared to the high value recorded in the blanched and soaked yam flour. The swelling capacity increases with soaking time.

The bulk density (packed and loose) was low in the blanched and soaked yam flour sample probably due to the starch particles becoming loose during soaking while it was high in the control. The bulk density (packed and loose) reduces with increase in soaking time. The best combination of processing parameter for best quality yam flour is 40^{0}C blanching water temperature and 12h soaking time because it has a low moisture, protein, crude fibre, moderate carbohydrate contents, water absorption capacity, low foaming capacity, high bulk density (loose and packed) and foaming capacity.

4. Conclusion

It is concluded that fresh yam should be blanched and soaked before being dried for yam flour production because these processing parameters resulted in significantly higher protein content, carbohydrate content, swelling capacity, foaming capacity and bulk density (loose and packed) compared to the control sample. The yam flour produced from blanched and soaked yam cubes has better quality attributes than the unblanched and unsoaked samples. It is therefore recommended that the best combination of processing parameter for best quality yam flour is 40^{o}C blanching water temperature and 12h soaking time.

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