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QUALITY ATTRIBUTES OF YAM (*Dioscorea rotundata*) FLOUR AS AFFECTED BY SOME PROCESSING PARAMETERS

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ABSTRACT

The effect of slice thickness and blanching time on some properties of yam (Dioscorea rotundata) flour was investigated. The properties determined include moisture content, crude protein, ash content, crude fibre and carbohydrate; bulk density, water and Oil absorption capacity; taste, texture, appearance and aroma respectively. The yam tubers were sliced at 6, 12, 18mm, labeled samples A, B, C and D (control sample) and blanched at 650C for 5, 7 and 9 mins. They were dried at 600C and milled into flour. The results obtained were subjected to statistical analysis using the design expert software 7.0. The results show that slice thickness and blanching time have significant effect ($p<0.05$) on the fat and ash content which ranged from 3.55 to 9.40% and 1.63 to 2.51% respectively. The slice thickness and blanching time did not have significant effect on moisture content, crude fibre, protein, carbohydrate, bulk density, water absorption capacity and oil absorption capacity of the flour; they ranged from 3.88 to 13.15%, 0.37 to 1.34%, 0.19 to 2.04%, 74.86 to 87.94%, 0.73 to 0.79g/ml, 2.00 to 6.67g/ml, 0.5 to 7.5g/ml respectively. Organoleptic assessment shows that yam flour with slice thickness 18mm and blanched for 5min, 7min and 9 minutes were preferred by panelists in terms of appearance, aroma, texture and taste with mean of 4.6, 4.4, 3.7 and 4.3 respectively. The statistical analysis based on desirability function shows that yam flour sliced at 6mm and 12mm, blanched for 7 minutes respectively yielded yam flour with better nutritional and functional properties.

Contribution/Originality: This study documents the effect of slice thickness and blanching time on the nutritional, functional and organoleptic properties of yam (Dioscorea rotundata) flour. The results revealed that processing parameters affected some of the quality attributes of yam flour.

1. INTRODUCTION

Yam belongs to the *Dioscorea* (spp.) and family *Dioscoreceae.* The economic important species grown are Water yam (*Dioscorea alata*), Bitter yam (*Dioscorea dementorum*), White yam (*Dioscorea rotundata*), Yellow yam (*Dioscorea cayenensis*), Aerial yam (*Dioscorea bulbifera*), and Lesser yam (*Dioscorea esculenta*) (Ike & Inoni, 2006). The white yam is the most preferred out of the other species; it is also the most widely grown because it has numerous varieties which are generally considered to be the best in terms of food quality, thus attracting the highest market value (Markson, Omosun, Madunagu, Amadioha, & Wokocha, 2010). In Nigeria, the largest yam producing states are Taraba, Niger and Benue while Nasarawa, Kogi, Ondo, Oyo and Delta states also have reasonable high levels of Yam production (Baah, 2009). Yam contains about 116-118 calories and has high amount of carbohydrate. All varieties of yam comprise of starch, water, small quantities of protein and other micro nutrients (Baah, 2009). The crop requires an optimum temperature between 25⁰C-35⁰C and rainfall of 1000-1500mm. it does well in deep, moderate porous to well drained, loamy soils with a pH range of 5.0-7.0 and high organic matter (Ogunlakin, Oke, Babarinde, & Olatunbosun, 2012; Purseglove, 1972).

In Nigeria, yam can be processed in diverse ways like boiling, frying, roasting and into flour. The processing of yam flour includes sorting, peeling, slicing, blanching, drying, milling, sieving and storing. Drying can be done either by sun drying or oven drying. Yams have high moisture content and this makes it vulnerable to microbial attacks and thus high perish ability of the tubers (Akinoso & Olatoye, 2013). In the absence of good storage facilities, yam tubers are liable to gradually deteriorate physiologically after harvest due to their high moisture content which predisposes them to spoilage. However, it can be processed into more stable products like yam flour. Processing yam tubers into flour prolongs their shelf life but if the process is not properly managed, it can lead to low quality or substandard flour which may not stand the test of time. This study therefore investigated some nutritional, functional and organoleptic properties of yam flour as affected by some processing parameters.

2. MATERIALS AND METHODS

2.1. Materials

Fresh yam tubers (*Dioscorea rotundata*) were obtained from a farmer in Gidan Kwano village, Minna, Niger state and transported to Federal University of Technology Minna, Niger State.

2.2. Methods

The fresh yam tubers were sorted, weighed and washed with clean water to remove adhering sand. They were then peeled manually with a sharp stainless knife and washed with clean water inside a bowl to prevent discoloration and labeled as samples A, B, C and D. Sample A was sliced to a thickness of 6mm and then divided into three portions labeled as samples A1, A2 and A3. Sample B was sliced to a thickness of 12mm and then divided into three portions labeled as samples B1, B2 and B3. Sample C was sliced to a thickness of 18mm and then divided into three portions labeled as sample C1, C2 and C3. Samples A1, B1 and C1 were blanched at 65⁰C for 5 minutes. Samples A2, B2 and C2 were blanched at 65⁰C for 7 minutes. The other samples A3, B3 and C3 were blanched at 65⁰C for 9 minutes. Sample D was used as the control sample. The samples were dried at 60⁰C in an Electric oven. The samples were then milled and sieved to produce fine flour and packaged for further analysis.

2.3. Determination of Nutritional Properties

The nutritional properties of the yam flour samples determined were moisture content, ash, fat, crude fibre, crude protein and carbohydrate as described by the AOAC (2005).

2.4. Determination of Functional Properties

The functional properties (bulk density, water absorption capacity and oil absorption capacity) of the yam flour samples were determined as described by Onwuka (2005).

2.5. Organoleptic Assessment

The yam flour was reconstituted into paste (*Amala*). Ten panelists were used to carry out the sensory evaluation test on the various samples of the Yam flour paste (Amala). At the evaluation sessions, each of the panelists conducted an independent assessment on appearance, texture, aroma and taste. The levels of perception were assessed using a 5-point hedonic scale and points were awarded as shown in Table 1.

Table-1. A 5-point scale showing levels of perception.

Points	Appearance	Texture	Aroma	Taste
5	Extremely Acceptable	Extremely smooth	Extremely acceptable	Extremely Pleasant
4	Very acceptable	Very smooth	Very acceptable	Very Pleasant
3	Acceptable	Smooth	Acceptable	Pleasant
2	Very acceptable	Very rough	Very unacceptable	Very unpleasant
1	Extremely unacceptable	Extremely rough	Extremely unacceptable	Extremely unpleasant

Source: Onwuka (2005).

2.6. Statistical Analysis

Data obtained was subjected to Analysis of Variance (ANOVA) and significant differences were reported at 95% confidence level using Design expert 7.0 version. The experimental design table is shown in Table 2.

Table-2. Experimental design.

Factor	1	2			Responses						
Run	A	B	MC	Fat	Crude fibre	Ash	Protein	CHO	Bulk density	WAC	OAC
	Mm	Min	%	%	%	%	%	%	g/ml	g/ml	g/ml
1	6	5									
2	12	5									
3	18	5									
4	6	7									
5	12	7									
6	18	7									
7	6	9									
8	12	9									
9	18	9									

Note:
A: Slice thickness.
B: Blanching time.

3. RESULTS AND DISCUSSION

The nutritional composition and functional properties of the yam flour are presented on Table 3.

Table-3. Nutritional composition and Functional properties of the yam flour.

Properties/Samples	M.C. %	Fat %	Crude fibre %	Ash %	Protein %	CHO %	BD (g/ml)	WAC (g/ml)	OAC (g/ml)
A1	13.15	9.4	0.37	1.78	0.45	74.86	0.75	2.00	3.50
B1	9.01	4.77	1.34	1.63	2.04	81.21	0.73	5.33	7.50
C1	5.32	4.54	0.52	2.16	0.32	87.15	0.78	3.67	0.50
A2	11.29	9.36	0.79	1.90	1.02	75.64	0.75	5.00	7.50
B2	7.43	6.36	0.77	1.64	1.18	82.63	0.75	3.33	5.50
C2	4.21	3.55	1.23	2.51	0.64	77.86	0.79	6.33	7.00
A3	9.56	6.33	0.48	1.71	0.19	81.74	0.76	6.67	5.00
B3	10.49	4.67	0.50	1.85	0.73	81.76	0.76	4.00	3.50
C3	3.88	3.63	1.28	2.22	1.05	87.94	0.77	5.33	7.50
D	13.03	3.30	0.15	1.83	0.67	81.02	0.75	3.33	1.50

The analysis of variance for the effect of slice thickness and blanching time on the proximate and functional properties of yam flour at 95% confidence level are presented in Table 4.

Table-4. Analysis of Variance for the effect of slice thickness and blanching time on the proximate properties of yam flour.

Qualities	Source	Sum of Squares	Df	Mean Square	F Value	p-value Prob> F	
Moisture Content	**Model**	**33.15151**	**4**	**8.287877**	**0.552028**	**0.7105**	**Not significant**
	A-Blanching Time	13.72339	2	6.861694	0.457035	0.6626	
	B-Slicing Thickness	19.42812	2	9.71406	0.647021	0.5709	
	Residual	60.05403	4	15.01351			
	Cor Total	93.20554	8				
Fat Content	Model	35.57685	4	8.894212	8.257403	0.0325	Significant
	A-Blanching Time	4.300512	2	2.150256	1.996302	0.2505	
	B-Slicing Thickness	31.27634	2	15.63817	14.5185	0.0147	
	Residual	4.308479	4	1.07712			
	Cor Total	39.88533	8				
Crude Fibre	Model	0.407778	4	0.101944	0.537237	0.7190	not significant
	A-Blanching Time	0.064306	2	0.032153	0.169442	0.8499	
	B-Slicing Thickness	0.343472	2	0.171736	0.905032	0.4740	
	Residual	0.759028	4	0.189757			
	Cor Total	1.166806	8				
Ash Content	Model	0.654123	4	0.163531	8.093609	0.0336	Significant
	A-Blanching Time	0.039114	2	0.019557	0.967921	0.4541	
	B-Slicing Thickness	0.61501	2	0.307505	15.2193	0.0135	
	Residual	0.08082	4	0.020205			
	Cor Total	0.734943	8				
Protein	Model	1.182184	4	0.295546	0.869478	0.5523	not significant
	A-Blanching Time	0.159332	2	0.079666	0.234372	0.8012	
	B-Slicing Thickness	1.022852	2	0.511426	1.504584	0.3257	
	Residual	1.359647	4	0.339912			
	Cor Total	2.541831	8				
Carbohydrate	Model	112.6392	4	28.1598	2.122495	0.2420	not significant
	A-Blanching Time	39.18322	2	19.59161	1.476683	0.3309	
	B-Slicing Thickness	73.45597	2	36.72798	2.768307	0.1759	
	Residual	53.06924	4	13.26731			
	Cor Total	165.7084	8				
Bulk Density	Model	0.002127	4	0.000532	4.545626	0.0858	not significant
	A-Blanching Time	0.000141	2	7.03E-05	0.601004	0.5913	
	B-Slicing Thickness	0.001987	2	0.000993	8.490248	0.0363	
	Residual	0.000468	4	0.000117			
	Cor Total	0.002595	8				
Water Absorption Capacity	Model	5.677311	4	1.419328	0.457236	0.7664	not significant
	A-Blanching Time	4.465689	2	2.232844	0.719311	0.5409	
	B-Slicing Thickness	1.211622	2	0.605811	0.195162	0.8301	
	Residual	12.41658	4	3.104144			
	Cor Total	18.09389	8				
Oil Absorption Capacity	Model	12.44444	4	3.111111	0.359551	0.8272	not significant
	A-Blanching Time	12.05556	2	6.027778	0.696629	0.5501	
	B-Slicing Thickness	0.388889	2	0.194444	0.022472	0.9779	
	Residual	34.61111	4	8.652778			
	Cor Total	47.05556	8				

The moisture content of yam flour ranged from 3.88 to 13.15% Table 3. The moisture content of samples sliced at 6mm thickness and blanched at 5min had the highest value of 13.15% indicating that the samples are likely to be affected by microorganism attack and a higher spoilage rate during storage (Baah, 2009) while samples sliced at 18 mm thickness and blanched at 9 min retained the lowest moisture content of 3.88% which is reflective of better keeping quality during storage. The range of moisture content recorded is slightly above those observed by Fashina, Adejori, and Akande (2016), while higher range of values were also observed by Adejumo, Okundare, Afolayan, and Balogun (2013). The value of moisture content decreased as slice thicknesses increased from 6mm to 18mm at 5 min and 7 min blanching time. Slice thickness and blanching time have significant ($p<0.05$) effect on the fat content of yam flour as shown in Table 4. The fat content of yam flour ranged from 3.55 to 9.40% Samples sliced at 6mm and blanched at 5min had the highest value of 9.40% fat content while samples sliced at 18mm and blanched for 7 min had the least value of 3.55% fat content. The fat content decreased with increase in slice thicknesses. This result agrees with Kone-Daouda, KoneMartial, DjeKouakou, Dabonne, and Kouame (2014) who deduced that high loss of fat content resulted from longer blanching time.

Slice thickness and blanching time had significant ($p<0.05$) effect on the ash content of yam flour (Table 4). The ash content increased with increase in slice thickness but decreased with increase in blanching time. Samples sliced at 12 mm thickness and blanched at 7min had the highest ash content of 2.51%, this could be as a result of more ash content generated due to increase in slice thickness of the yam while sample sliced at 18 mm and blanched at 7min had the lowest value of 1.60% ash content. Kone-Daouda et al. (2014) reported that decrease in ash contents may be due to leaching of minerals in boiling water and increase in blanching temperature and time will leads to decrease in ash content (Oluwalana, Oluwamukomi, Fagbemi, & Oluwafemi, 2011). The result obtained is within the range observed by Abioye (2012) and Fashina et al. (2016). Fibre content of samples sliced at 12 mm thickness and blanched at 5min had the highest ash content of 1.34% while samples sliced at 6 mm and blanched at 5min had the lowest value of 0.37%. The fibre content decreases as blanching time increased from 5min to 9min at 12mm and increases as blanching time decreased from 5min to 9min at 18mm. The low fibre contents of the yam flours agrees with the report of Abara, Tawo, Obi-Abang, and Obochi (2011) that white yams are low in fibre.

Protein content of yam flour samples sliced at 12mm thickness and blanched at 5min had the highest amount of protein content 2.04% while sample sliced at 6 mm and blanched at 9min had the lowest amount of protein content 0.19% Table 3. This is probably due to the denaturizing of protein caused by the effect of heat on the yam slice during blanching. This result is similar to the findings of Adejumo et al. (2013); Onwueme and Sinha (1991) who reported that blanching reduces the protein content of yam flour. The carbohydrate content of yam flour samples sliced at 18 mm thickness and blanched at 9min had the highest value of 87.94% while samples sliced at 6 mm and blanched at 5min had the lowest value of 74.86%. It increases as slice thickness increased at 5min blanching time. The optimum carbohydrate content was retained in all the slice thicknesses blanched at 9 min Table 3. This result agreed with the results of Leng, Gouado, and Ndjouenkeu (2011) who reported that yams are rich in starch and blanching at high temperatures induces starch gelatinization. Carbohydrate plays a vital role in the supply of energy to cells such as muscle, blood and brain (Alinnor & Akalezi, 2010).

The yam flour samples sliced at 6mm and blanched for 5min and 7min had the same value of 0.75gml with samples sliced at 12mm and blanched for 7min. The bulk density increased with increase in slice thickness. Samples sliced at 6mm and blanched for 9min had the highest value of 6.67g/ml; samples sliced at 6mm and blanched for 5min had the lowest value of 2.00g/ml while samples sliced at 12mm, 18mm and blanched for 5min and 9min had the same value of 5.33g/ml. Samples sliced at 6mm, 12mm and 18mm blanched for 7min, 5min and 9min respectively had the highest with same value of 7.5g/ml while those sliced at 18mm and blanched for 5min had the lowest value of 0.5g/ml of oil absorption capacity.

4. CONCLUSIONS

Based on the results obtained from the study, yam flour samples produced from slice thickness 6mm, 12mm and 18mm and blanched for 5min, 7min and 9minutes had higher values of fat and ash content and better quality compared to the control. Yam flour samples produced from slice thickness 12mm and blanched for 5min had the lowest values of bulk density which is suitable for infant food formulation while samples produced from slice thickness 18mm and blanched for 7min had the highest value which is suitable for thickener in food preparation. The drying of yam is influenced by slice thickness and blanching time of drying. Moderate blanching time and higher slice thickness affected the drying condition of the sliced yam. Also, samples sliced at 18mm and blanched for 5 mins, 7 mins and 9 minutes were generally acceptable during the organoleptic assessment.

Statistical analysis showed that slice thickness and blanching time had significant effect at 5% level of significance on fat content and ash content of the yam flour samples but did not have significant effect on moisture content, crude fibre, protein, carbohydrate, bulk density, water absorption capacity and oil absorption capacity.

From the study, it can therefore be concluded that slice thickness and blanching time have significant effect on some nutritional properties of yam flour but does not have effect on the functional properties of the yam flour.

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