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PROXIMATE COMPOSITION OF TANNIA (*Xanthosoma sagittifolium*) FLOUR AS INFLUENCED BY PRETREATMENT AND DRYING TEMPERATURE

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ABSTRACT

Drying is an important operation in processing fresh tannia cormel into flour with better storability. Product characteristics and drying variables could affect the final product's quality and consumers' acceptability. This study was therefore designed to investigate the effects of blanching time (5, 10, and 15 minutes) and drying temperature (60, 70 and 80°C) on selected proximate composition of oven-dried tannia flour. Response Surface Method (RSM) of 2 factors, 3 levels Historical Data Design (HDD) second-order polynomial model was adopted for the experimental design. Flour was produced from fresh and pretreated tannia cormels and proximate analysis of the flour samples was carried out using standard methods. Data obtained were statistically analyzed at 5% level of significance. Moisture content (wet basis), carbohydrate, protein, ash, crude fibre and fat content of the flour samples were within the ranges 4.43-12.74, 77.34-84.71, 2.22-4.22, 2.47-4.69, 0.34-2.50 and 0.63-3.72%, respectively. Samples dried at 60°C and blanched for 12.74 minutes had the best quality attributes with the optimum response values of 83.19% carbohydrate, 3.56% protein, 3.80% ash, 0.98% crude fibre and 1.96% fat with 7.01% moisture content. Extended blanching period is recommended to obtain high-quality flour with improved storage stability. Proper combination of drying temperature and blanching period that will result in desired proximate composition of tannia flour can be achieved based on the findings of this study.

Keywords: *Proximate composition, Quality attributes, Blanching time, Drying temperature, Tannia flour.*

INTRODUCTION

Tannia (*Xanthosoma sagittifolium* (L.) Schott) belongs to *Araceae* family, and it is primarily cultivated for its edible corms and cormels although its leaves are also useful as vegetables and for medicinal purposes (Ugwu, 2009; Oyefeso and Raji, 2017). Tannia contains many nutrients such as carbohydrate, protein, vitamins C and E, riboflavin, thiamine, niacin, copper, fibre and essential amino acids in varying proportions depending on the varieties and agronomic practices (Lewu *et al.,* 2009; Awolu *et al*., 2017). It serves as staple food in Nigeria and some other developing nations (Raji and Oyefeso, 2017). It is used as soup or sauce thickener in Eastern Nigeria. The corms and cormels are usually eaten after boiling, roasting, or frying and they can also be processed into flour (Obadina *et al.*, 2016). Tannia flour can be made into pudding or baked into snacks. It can also be mixed with children's food or pellets for feeding livestock as concentrates. Starch from the corms and cormels is also useful as an ingredient for baby foods because the starch granules are small and easily digestible (Falade and Okafor, 2014).

In its raw form, tannia has some anti-nutritional constituents such as calcium oxalate raphides, trypsin inhibitors, α-amylase inhibitors and sapotoxins (Owusu-Darko *et al.*, 2014). However, the presence of some of these anti-nutritional factors can be reduced by processing operations such as peeling, grating, fermentation, drying, cooking, soaking or steeping the cormels in cold water overnight etc (Owusu-Darko *et al.*, 2014; Raji and Oyefeso, 2017). Tannia cormels are usually costly and in low supply during the off-season periods because the cormels deteriorate rapidly after harvest due to inadequate post-harvest processing and storage technologies (Amandikwa, 2012). Processing of tannia into some of its products with improved storage stability such as chips, flakes and flour will extend its shelf life and thereby, make it available throughout the year.

Drying is an important unit operation in the production of tannia flour (Oyefeso and Raji, 2020). Other unit operations involved include washing, peeling, size reduction (cutting into required sizes and shapes), blanching, fermentation, milling, packaging etc. It is perhaps the oldest method of preserving food and agricultural materials which entails transfer of heat and mass (Maxwell and Zantoph, 2002). It helps to reduce the moisture content of a product to a pre-determined level with the attendant benefits of extending its shelf life, reducing the activities of deteriorating microorganisms, improving product quality, facilitating production of new products with unique characteristics and reducing storage losses (Sahay and Singy, 1994; Mujumdar, 1997; Oyefeso and Raji, 2020).

Agricultural and food materials can be dried using various methods such as sun (open air), solar, oven, drum, tray or cabinet, microwave or flash drying (Zantoph and Schuster, 2004). Choice of appropriate drying parameters such as thermodynamic properties of the drying air, product characteristics, and pre-drying treatments can have significant effects on the quality attributes and acceptability of the final products. This study therefore, investigated the effects of blanching time and drying temperature on the proximate composition of tannia (*Xanthosoma sagittifolium*).

MATERIALS AND METHODS

White-fleshed tannia cormels used for the study were purchased from *Gbonje* market, Okeho, Oyo State, Nigeria. The chemicals and reagents of analytical grade used were sourced from the Central Laboratory of Oyo State College of Agriculture and Technology, Igboora, Oyo State, Nigeria.

Sample preparation

Fresh tannia cormels used for the study were washed with clean water, peeled and cut into 3 mm thickness using a sharp steel stainless knife. Sliced cormels were washed again to remove mucilage from the freshly cut surfaces. The tannia slices were blanched in hot water at 60ºC for 5, 10 and 15 minutes. Pre-treated (blanched) cormels were oven dried at 60, 70 and 80ºC temperature levels. The samples were subjected to drying until they could be broken sharply between hands (Amandikwa, 2012). Sun-dried, unblanched cormel was used as the control. Each dried sample was milled separately using a burr mill and sieved using a sieve of 500µm mesh size to obtain the flour (Amandikwa, 2012). The flour obtained was packed in air-tight polythene bags and labeled properly for further analysis.

Determination of proximate composition

Moisture content of the flour was determined according to AOAC official method 925.09 (AOAC, 2000). It involved drying a sample of known weight in an oven at 105°C until a constant weight was observed. The moisture content was calculated using Equation 1 (Oyefeso and Raji, 2019).

$$MC_{wb} = \frac{M_{ws} - M_{ds}}{M_{ws}} \qquad (1)$$

Where: MC_{wb} is the moisture content of the cormel (%, wet basis), M_{ws} is the mass of wet or fresh cormel (g), and M_{ds} is the mass of oven-dried sample (g).

The protein, ash, fibre, and crude fat contents of the flour were determined according to AOAC official methods 925.09 (AOAC, 2000). Carbohydrate content was determined by difference method.

Statistical analysis

All the data obtained were analyzed statistically using Response Surface Method (RSM). The experimental design adopted was 2 factors, 3 levels Historical Data Design (HDD) of second order polynomial model. Data obtained were statistically analyzed at 5% level of significance. The optimum values for both independent and response parameters were derived. The relationship between these parameters were also analyzed and established.

RESULTS AND DISCUSSION

The results of the proximate composition of the flour samples are presented in Table 1. The relationship between the proximate composition of tannia flour (as the dependent variable), and drying temperature and blanching period (as the independent variables) was established using RSM.

Table 1. Proximate composition of tannia flour

Drying Temperature (°C)	Blanching time (minutes)	Moisture content (%)	Carbohydrate (%)	Protein (%)	Ash (%)	Crude fibre (%)	Fat (%)
Fresh cormel	Nil	12.54±0.117^{a}	77.44±0.056^{f}	2.34±0.135^{k}	2.68±0.123^{f}	0.83±0.031^{de}	3.63±0.054^{b}
60	5	4.90±0.269^{h}	84.57±0.080^{a}	3.95±0.158^{a}	3.30±0.088^{a}	0.61±0.039^{gh}	2.96±0.058^{c}
	10	7.80±0.209^{i}	82.98±0.077^{b}	3.28±0.040^{bc}	3.13±0.007^{de}	0.73±0.058^{fg}	1.90±0.089^{gh}
	15	6.91±0.226^{b}	82.65±0.075b^{c}	3.51±0.033^{b}	4.34±0.116^{e}	0.90±0.089^{de}	2.09±0.014^{ef}
70	5	10.80±0.055^{bc}	80.20±0.086^{ab}	2.95±0.034^{bc}	3.12±0.146^{cd}	0.76±0.042^{h}	1.76±0.121^{d}
	10	9.90±0.242^{ef}	81.36±0.243^{cd}	3.07±0.025^{bc}	3.95±0.060^{e}	0.85±0.059^{a}	1.11±0.047^{e}
	15	9.50±0.138^{de}	78.44±0.082^{e}	3.04±0.113^{gh}	4.41±0.161^{c}	0.94±0.012^{c}	0.91±0.160^{gh}
80	5	11.40±0.225^{ab}	83.64±0.134^{g}	3.40±0.239^{ef}	3.65±0.027^{e}	0.54±0.114^{ef}	2.71±0.113^{h}
	10	10.30±0.229^{ef}	81.64±0.251^{cd}	3.37±0.055^{cd}	3.12±0.215^{bc}	2.34±0.093^{de}	2.22±0.059^{i}
	15	10.80±0.053^{g}	79.35±0.082^{g}	2.27±0.026^{de}	3.85±0.053^{a}	1.19±0.989^{d}	1.89±0.184^{j}

Note: Values with the same superscripts along the same rows and columns are not significantly different at $p \leq 0.05$

The results of analysis of variance (ANOVA) for models depicting the influence of variation of drying temperature and blanching period on the proximate composition are presented in Table 2. Responses showing the effects of drying temperature and blanching period on the moisture content, carbohydrate, protein, ash, crude fibre, and fat contents of the flour are presented in Figures 1 to 6, respectively while the regression models between response variables (moisture, carbohydrate, protein, ash, crude fibre and fat contents) and the independent parameters (drying temperature and blanching time) are shown in Equations 2 to 7, respectively

$$M = -82.78 + 2.28A + 1.14B - 0.0131AB - 0.0138A^2 - 0.01134B^2 \text{ } (R^2 = 0.89) \quad (2)$$

$$C_o = 81.23 - 0.69A - 0.40B - 0.35AB + 2.47A^2 - 0.48B^2 \text{ } (R^2 = 0.90) \quad (3)$$

$$P = 16.46 - 0.381A + 0.235B - 0.00345AB + 0.00276A^2 - 0.00213B^2 \text{ } (R^2 = 0.66) \quad (4)$$

$$A_o = -11.34 + 0.406A + 0.0757B - 0.0042AB - 0.00262A^2 + 0.0151B^2 \text{ } (R^2 = 0.78) \quad (5)$$

$$C = 7.87 - 0.270A + 0.298B + 0.0018AB + 0.00201A^2 - 0.0193B^2 \text{ } (R^2 = 0.57) \quad (6)$$

$$F = 54.18 - 1.45A - 0.35B + 0.00025AB + 0.0104A^2 + 0.0124B^2 \text{ } (R^2 = 0.97) \quad (7)$$

Where: M is moisture content (%), C_o is the carbohydrate content (%), P is the protein content (%), A_o is the ash content (%), C is the crude fibre content (%), F is the fat content (%), A is drying temperature (°C), and B is blanching time (minutes).

Table 2. Analysis of variance for proximate composition of tannia flour

Composition	Source	Sum of Squares	df	Mean Square	F-value	p-value
Moisture Content	Model	33.37	5	6.67	4.95	0.1091
	A	27.69	1	27.69	20.54	0.0201
	B	0.00202	1	0.002017	0.001496	0.9716
	AB	1.7	1	1.7	1.26	0.3428
	A^2	3.82	1	3.82	2.83	0.191
	B^2	0.16	1	0.16	0.12	0.7542
	Residual	4.04	3	1.35		
	Cor Total	37.42	8			
Carbohydrate	Model	29.68	5	5.94	5.3	0.1
	A	2.24	1	2.24	2	0.252
	B	0.98	1	0.98	0.88	0.417
	AB	1.16	1	1.16	1.04	0.382
	A^2	12.22	1	12.22	10.91	0.045
	B^2	1.78	1	1.78	1.59	0.296
	Residual	3.36	3	1.12		
	Cor Total	33.04	8			
Protein	Model	1.12	5	0.22	1.17	0.4801
	A	0.48	1	0.48	2.5	0.2123
	B	0.37	1	0.37	1.89	0.2628
	AB	0.12	1	0.12	0.62	0.4896

	A^2	0.15	1	0.15	0.79	0.4388
	B^2	0.00569	1	0.005689	0.029	0.8746
	Residual	0.58	3	0.19		
	Cor Total	1.7	8			
Ash	Model	1.67	5	0.33	2.14	0.2821
	A	0.00375	1	0.004	0.024	0.8867
	B	1.07	1	1.07	6.84	0.0794
	AB	0.18	1	0.18	1.13	0.3657
	A^2	0.14	1	0.14	0.88	0.418
	B^2	0.29	1	0.29	1.83	0.2686
	Residual	0.47	3	0.16		
	Cor Total	2.14	8			
Crude Fibre	Model	1.35	5	0.27	0.8	0.6153
	A	0.56	1	0.56	1.66	0.2885
	B	0.21	1	0.21	0.62	0.4885
	AB	0.032	1	0.032	0.096	0.7769
	A^2	0.081	1	0.081	0.24	0.657
	B^2	0.47	1	0.47	1.39	0.324
	Residual	1.01	3	0.34		
	Cor Total	2.36	8			
Fat	Model	3.41	5	0.68	19.28	0.0173
	A	0.00282	1	0.003	0.08	0.7963
	B	1.08	1	1.08	30.36	0.0118
	AB	0.00063	1	0.000625	0.018	0.9027
	A^2	2.14	1	2.14	60.5	0.0044
	B^2	0.19	1	0.19	5.43	0.1022
	Residual	0.11	3	0.035		
	Cor Total	3.52	8			

Note: A is drying temperature (°C), and B is blanching time (minutes)

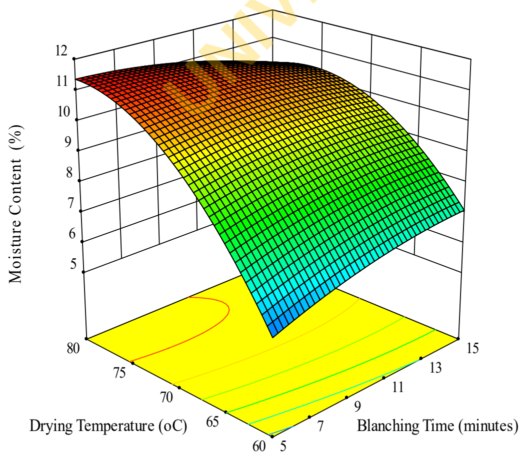

Figure 1. Response of moisture content to changes in blanching time and drying temperature

The moisture content of the flour samples had a minimum value of 4.43% when blanched for 5 minutes and oven dried at 60°C while a maximum value of 12.74% was obtained when sun dried without blanching. This is similar to values obtained by Sowola (2002) for cocoyam flour. Moisture content of the flour increased (non-linearly) as blanching period and drying temperature increased (Figure 1). Lower blanching period and drying temperature are therefore, recommended so as to obtain lower moisture content which indicate lower enzymatic reactions, reduced microbial deterioration and better storage stability of tannia flour.

The maximum carbohydrate content (84.71%) was obtained for the flour sample blanched for 5 minutes and oven-dried at 60°C while the untreated sun-dried sample had the lowest value of 77.34%. The carbohydrate contents reported in this study are slightly higher than those reported by Obadina *et al.* (2016). Carbohydrate content of the flour decreased non-linearly with increasing blanching period while it decreased and then increased with increasing drying temperature (Figure 2). The high carbohydrate content reported in this study is in agreement with the report of Enwere (1998) which stated carbohydrates predominate all the other solid nutrients in roots and tuber crop. This study indicates that tannia cormel is a good source of energy and could therefore, be recommended as an alternative source of carbohydrate in human and animal diets.

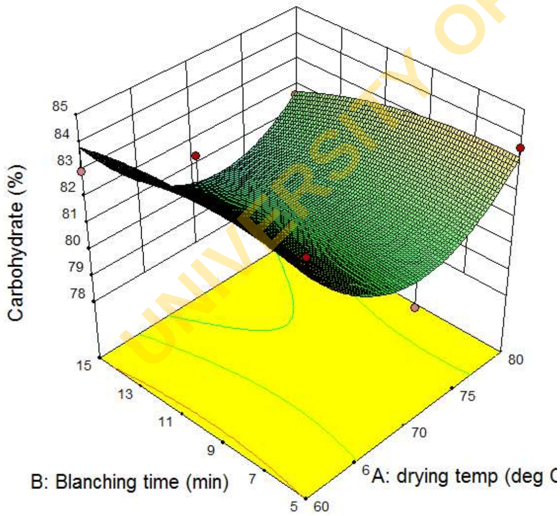

Figure 2. Response of carbohydrate content to changes in blanching time and drying temperature

The minimum and maximum protein contents of the flour were 2.22 and 4.22% when blanched for 15 and 5 minutes before being oven-dried at 80 and 60°C, respectively. These results indicate that tannia is a poor source of protein and protein supplements would therefore, be required in tannia diets to make it a complete meal. The protein content of tannia flour followed a decreasing trend with increasing blanching period and drying temperature as shown in Figure 3.

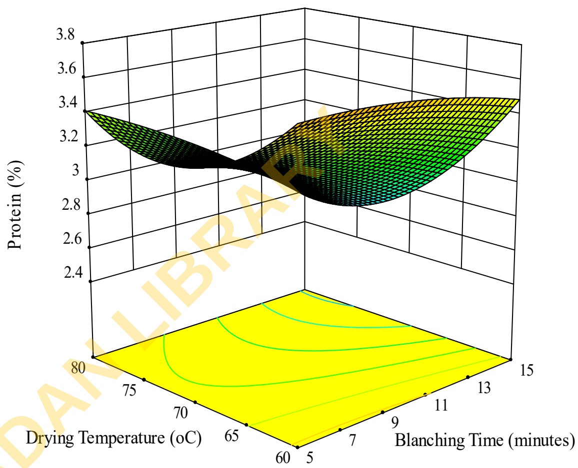

Figure 3. Response of protein content to changes in blanching time and drying temperature

The protein content reported in this study is slightly lower than those reported for taro by Ogunlakin *et al.* (2012) and Obadina *et al.* (2016). This could be as a result of the differences in the species and other environmental factors under which the crops were grown (Amandikwa, 2012).

The ash content which gives an estimate of the minerals present in the flour was within the range 2.47-4.69%. The minimum and maximum ash contents were obtained for unblanched sun-dried samples (control) and samples blanched for 15 minutes and oven-dried at 70°C, respectively. The ash content increased and then decreased with increasing drying temperature while it increased continuously with increasing blanching time (Figure 4).

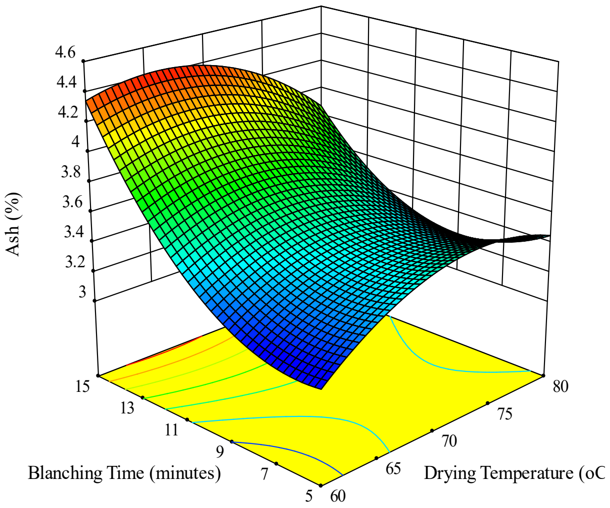

Figure 4. Response of ash content to changes in blanching time and drying temperature

The ash content within the range 1.56-2.98% reported by Sefa-Dedeh and Agyir-Sackey (2004) for some cocoyam varieties is lower than the values reported in this study. The crude fiber content which is an indication of the amount of undigestible sugars in the flour was within the range 0.34-2.50%. The minimum and maximum crude fiber contents were obtained for samples which were oven-dried at 80°C after being blanched for 5 and 10 minutes, respectively. Crude fibre content of the flour increased with increasing drying temperature while it increased and then decreased with increasing blanching period (Figure 5).

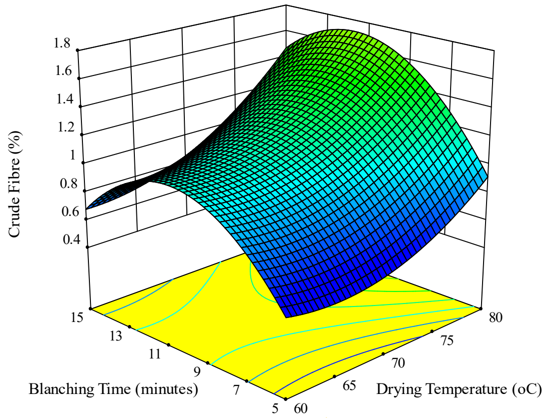

Figure 5. Response of crude fibre content to changes in blanching time and drying temperature

The minimum and maximum fat contents were 0.63 and 3.72% for samples which were blanched for 15 minutes before being oven-dried at 70 °C and unblanched sun-dried samples (control), respectively. The low-fat content has an attendant advantage of improved shelf life of the flour due to the lowered chance of rancid flavour development. Fat content decreased and then increased with increasing drying temperature (Figure 6).

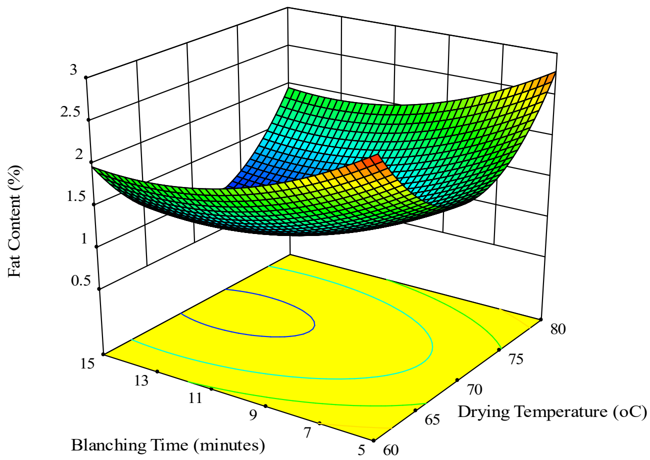

Figure 6. Response of fat content to changes in blanching time and drying temperature

However, it decreased as the blanching period increased. Longer blanching period is therefore, recommended for lower fat content and subsequent reduction of rancidity of the flour in storage.

Moisture content, protein, crude fibre and ash contents of tannia flour were found not to be significantly affected by variation in drying temperature and blanching time according to the F-values of their models (Table 2). The optimum values obtained for moisture, carbohydrate, protein, ash and crude fibre contents were 7.01, 83.19, 3.56, 3.80 and 0.98% respectively with desirability of 0.55 at drying temperature and blanching time of 60ºC and 12.74 minutes. However, the fat content of tannia flour responded significantly ($p \leq 0.05$) to variation in drying temperature and blanching time as shown in Table 2. The optimum value obtained for fat content was 1.96% with desirability of 0.55. Blanching as a form of pretreatment reduced the moisture and fat contents of tannia flour which are important parameters in food storage, thereby resulting in products of high quality in terms of storage stability.

CONCLUSIONS

This study showed that variations in blanching period and drying temperature affect the proximate composition of tannia cormel flour. Extended blanching period is recommended to obtain high quality flour with improved storage stability. Oven-drying of blanched tannia cormels at 60ºC was considered at the optimum condition for good quality retention. Proper combination of drying temperature and blanching period that will result in desired proximate composition of tannia flour can be achieved based on the findings of this study.

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