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Effects of Pre-Treatments and Drying Methods on Proximate Composition of Cassava (*Manihot esculenta* Crantz) Flour

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ABSTRACT

The main purpose of this research was to determine the effect of different pre-treatments and drying methods on the proximate composition of cassava flour in Yola, Adamawa State. Cassava has been considered the 4th most important food security crop, but inevitably, postharvest physiological deterioration starts within 48-72 hours after harvest. The cassava tubers (*Manihot esculenta* Crantz) were obtained during the 2022 and 2023 seasons at the sub-station of National Root Crops Research Institute (NRCRI), Nyanya, Abuja and the variety used was "TME-419". The harvested tubers were subjected to different pre-treatments (48 hrs soaking in water, 2 and 4 minutes blanching) prior to three different drying methods (shade, sun, and oven). The time taken for the drying were 750C for 74 hours, 27.420C for 8 days, and 25.650C for 10 days for oven, sun, and shade drying, respectively, before milling into flour and the flour samples were analyzed for their proximate compositions. There was no significant difference (P>0.05) was observed among the pre-treatments and drying methods in 2022 and 2023. There were also no interaction effects (p>0.05) between the pre-treatments and drying methods in 2022 and 2023 except on protein content in 2023. The combination of 2 minutes of blanching and shade gave the highest mean value of 2.79%, followed by 2.72%, which was obtained from the combination of 4 minutes of blanching and oven drying, while the least of 2.28% was obtained from the combination of 2 minutes blanching and oven drying. Oven drying was found to be faster and more efficient in moisture removal than sun and shade drying methods. Therefore, any of the pretreatments used in this research should be adopted before drying for better quality and long shelf life of cassava flour.

Keywords: Cassava, Drying methods, Flour, Pre-treatments, Proximate

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INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a perennial shrub cultivated in tropical and sub-tropical climates. It is grown for its tuberous bulky roots, which contain about 80 percent carbohydrates (Erhabor et al. 2007). The root takes about 6-18 months to mature and is the world's fourth most important staple crop after rice, wheat, and maize and is, therefore, an essential component in the diet of over one billion people (FAO, 2018). Cassava is an important staple crop recognized as a 21st-century crop primarily for smallholder farmers (FAO, 2013; Droppemann et al. 2018). It is one of some 100 species of tree, shrub, and herbs of the genus Manihot believed to have been introduced from northern Argentina to the United States of America (FAO, 2013). Other studies opined cassava has several centers of origin, beginning from the southern edge of the Brazilian Amazon (Nassar , 1978; Olsen and Schaal, 1999; Allem, 2002). According to Liu et al. (2014), cassava production may be said to have originated in the northeastern part of Brazil/Paraguay to Mexico/Guatemala more than 4,000 years ago. It was believed to have been introduced to western Africa in 1588 through Portuguese merchants and was first cultivated in the Gulf of Guinea and the Congo Basin. The cultivation later spread to Madagascar and another eastern part of Africa. Towards the middle of the nineteenth century, cassava production and consumption became an essential staple food widely cultivated in Africa (Liu et al. 2014).

A critical advantage of cassava is that it has a wide range of uses, from consumption to industrial use, based on the level of final cassava processing. The cassava is boiled or steamed before eating but can also be processed into starch, tapioca, and dried chips. Further processing involves grinding and milling into flour. The principal users of cassava products are flour mills, biscuit factories and confectionaries, glue and adhesive producers, ethanol distillers, pharmaceutical industries, livestock and aquaculture farmers, and restaurants, among others (Fasuyi and Aletor, 2005). Rising oil prices, coupled with the need to address concerns about emissions from transportation fuels and the requirements of carbon emission, has led to the promulgation of a mandatory blending of biofuels (ethanol) with fossil fuels in Europe by 2020, which will require cassava chips as the alternative raw material feedstock (UNCTAD, 2009). Over 90% of cassava production is estimated to be processed into food (Nweke et al. 2002; Phillips et al. 2004). However, a significant industrial demand exists for cassava, primarily as a substitution for imported raw materials and semi-finished products. There is high demand for High Quality Cassava Flour (HQCF), primarily from 10% replacement in bread flour and for use in bouillon, noodles, and the adhesive industry (dextrins). Similarly, it is useful in the production of native and modified starches. It is also useful in the paint, pharmaceutical, and sweetener industries (FGN, 2011).

One massive challenge to cassava production and processing is its high moisture content of about 65%, making it highly perishable. According to IITA (1990), once tubers are harvested, they deteriorate within 40-48 hours due to some physiological changes and decay by rot organisms. However, small-scale holders can only use these methods, and do not apply to large-scale commercial production units. Processing cassava into dry forms is therefore necessary to reduce the moisture content and convert it into a more durable and stable produce with less volume, which makes it easier for transportation to reduce postharvest losses also to eliminate or reduce the level of hydrocyanic acid (HCN) and to improve the palatability of the food product (CSIR-FRI, 2009). The cassava roots need to be processed if these negative aspects are to be overcome, and experienced cassava producers are aware of different ways and methods of processing cassava (Nyirenda et al. 2011). Given these, this study was carried out with the objectives to determine the effects of pre-treatments and drying methods on proximate compositions of cassava flour.

MATERIALS AND METHODS

Experimental Site

The pre-treatments and subsequent drying were done in the Department of Biological Sciences, Abubakar Tafawa Balewa University, Bauchi. At the same time, the experiment was conducted in the Crop Production and Horticulture Department at Modibbo Adama University, Yola, Adamawa State. The proximate, functional, and sensory evaluations were conducted in the Food Science and Technology Department, Modibbo Adama University, Yola, Adamawa State.

Source of Cassava Root

Cassava variety (TME-419) was obtained from the National Root Crops Research Institute (NRCRI), Nyanya sub-station, for experimental purposes in the 2022 and 2023 growing seasons.

Sample collection

Cassava tubers at full maturity were harvested, and the undamaged and diseased tubers were selected for the experimental purpose.

Preparation of tuber for drying

The tubers were peeled and sliced into almost uniform sizes to maintain uniform drying. They were washed thoroughly with sodium hypochlorite to deactivate the microbial load on the surface of the tuber after peeling. The washed tubers were pre-treated (48 hrs soaking in H2O, 2 and 4 minutes blanching in boiling water). After drying, the dried cassava chips were ground into a flour mill.

Treatments and Experimental Design

The treatments were arranged in a Split Plot in Completely Randomize Design (CRD) with pre-treatments (48 hrs soaking in H2O, 2 min and 4 min blanching) were placed in the main plot while drying methods (oven drying, sun drying and shade drying) were placed in the sub-plot and replicated three times.

Proximate Analysis

The proximate analysis was determined according to the standard methods of the Association of Official Analytical Chemist AOAC (2007). The moisture content was determined as described by (AOAC). The samples were dried at 1050C for 3 hours using the preset oven. The (AOAC) method was employed for ash content. The crucible containing the pre-weighed samples was placed in a heated furnace at 6000C for 6 hours after they were cooled at ambient temperature in desiccators and weighed. The protein content (% nitrogen x 6.25) and fat content were (1g was extracted for ether extract determination using diethyl ether (640C solvent) as described by (AOAC). The carbohydrate was determined by subtracting from 100 the sum of the percentage moisture, ash, protein, fat and fibre from 100. Energy value was calculated using the Atwater factor method (9 x % lipid) + (4 x % protein) + (4 x % carbohydrate) as described by Osborne and Voogt (1978).

Data Analysis

The data obtained from the experiment were subjected to statistical analysis of variance (ANOVA). Means that were significantly different at ($p \leq 0.05$) were separated using Least Significant Difference (LSD).

RESULTS AND DISCUSSION

The result of the effects of pre-treatments and drying methods on moisture, ash, fibre, protein, lipid, CHO content and energy value are presented in Tables 1 and 2 in 2022 and 2023 respectively. The result showed no significant difference ($p>0.05$) among pre-treatments and drying methods on all the proximate parameters in both 2022 and 2023. There were also no interaction effects ($p>0.05$) between the pre-treatments and drying methods in 2022 and 2023 except on protein content in 2023 as presented in Table 3. The combination of 2 minutes of blanching and shade gave the highest mean value of 2.79%, followed by 2.72%, which was obtained from the combination of 4 minutes of blanching and oven drying, while the least of 2.28% was obtained from the combination of 2 minutes blanching and oven drying.

Studies on the effect of different pre-treatments and drying methods on proximate parameters of cassava flour, which include percentage of moisture, ash, fiber, lipid, protein carbohydrate, and calorific value were observed to be statistically not significant ($P>0.05$) in both 2023 and 2023. The moisture content of flour from the different pre-treatments and drying methods used was within the range of 10.81% - 14.88% Sanni et al. (2015). The moisture content of the flour produced indicates the quality of the flour. According to CSIR-FRI (2009), High-Quality Cassava Flour must be within the moisture content range of 9-12%. Also, Apea-Bah et al. (2011) reported similar findings for edible cassava flour. The moisture content of the flours suggests that the flours would have a longer shelf life. The moisture content of food is very important in nutrient density and shelf life of agricultural produce. The ash content of cassava flour from the different pre-treatments and drying methods used fell within the range of 2.02% - 3.03% Sanni et al. (2015). Different pre-treatments, such as blanching, have been applied in order to enhance the food drying process Arévalo-Pinedo and Xidieh Murr, 2007; Rodríguez et al. 2015; Ando et al. 2016; Wei et al. 2017). Pre-treatments have also been reported to promote different structural changes in the sample, which ease the water removal during drying. These structural changes have been described as the injury to the cell membrane and the weak adhesion of cell walls by Ando et al. (2016). According to Wei et al. (2017), the structure collapse during pre-treatment processes facilitated heat and moisture transfer during drying. Dietary fiber is necessary for healthy conditions, curing of nutritional disorders, and increasing food digestion (Ifon et al. 1979). The fiber content of cassava flour from the different pre-treatments and drying methods used was found within the range of 2.73% - 4.31%. There was no significant difference (P>0.05) found among the pre-treatments and drying methods throughout the experiment, and it conforms to the findings of (Ahmad et al. 2020). The protein content of cassava flour from the different pre-treatments and drying methods used was found within the range of 2.47% to 3.60%. Rodríguez et al. 2015 and Ando et al. 2016 reported that pre-treatments have been applied to enhance the food drying process. The lipid content of cassava flour from different pre-treatments, drying methods, and packaging materials fell within the range of 0.28% to 0.66%. The pre-treatments and drying methods were observed to be statistically not different (P>0.05) throughout the experiment in terms of lipid content. The CHO content of cassava flour from different pre-treatments and drying methods fell within the range of 75.42% to 81.07%. All the pre-treatments and drying methods were found to be statistically not different (P>0.05). After drying, the carbohydrate content of fruits, vegetables and tubers increases; low carbohydrate of fresh fruits, vegetables and tubers showed that they supply little or no energy when consumed except when supplanted with other foods (Rosello et al. 2007). The calorific value of cassava flour from different pre-treatments and drying methods were found to be within the range of 320.6 K/cal - 337.6 k/cal. High carbohydrate content leads to higher energy gain, and drying removes excess moisture content, thereby leading to a high CHO content and as well as energy value.

Table 1: Effects of Pre-Treatments and Drying Methods on Proximate Composition of Cassava Flour at in 2022

Treatments	Moisture (%)	Ash (%)	Fibre (%)	Protein (%)	Lipid (%)	CHO (%)	Calorific (kj/cal)
Pre-Treatments							
48 hrs Soaking in H_2O	14.51	2.07	3.48	3.35	0.66	75.93	322.9
2 min Blanching	12.97	3.03	3.69	3.30	0.55	76.48	330.5
4 min Blanching	13.67	2.76	3.58	3.32	0.52	76.16	322.6
P<F	0.058	0.093	0.828	0.961	0.680	0.862	0.328
LSD	1.203	0.904	0.934	0.504	0.443	2.770	14.36
Drying Methods							
Oven	14.88	2.32	3.27	3.22	0.53	75.79	320.6
Shade	13.41	2.67	4.31	3.60	0.59	75.42	327.6
Sun	12.86	2.84	3.18	3.15	0.61	77.36	327.7
P<F	0.390	0.412	0.085	0.244	0.819	0.498	0.598
LSD	3.193	0.839	1.113	0.590	0.302	3.689	17.09
Pre-treatments X Drying	NS	NS	NS	NS	NS	NS	NS

NS = Not Significant

Table 2: Effects of Pre-Treatments and Drying Methods on Proximate Composition of Cassava Flour at in 2023

Treatments	Moisture (%)	Ash (%)	Fibre (%)	Protein (%)	Lipid (%)	CHO (%)	Calorific (kj/cal)
Pre-Treatments							
48 hrs Soaking in H_2O	11.63	2.05	3.21	2.61	0.42	80.09	334.5
2 min Blanching	11.00	2.39	2.90	2.47	0.28	80.97	336.3
4 min Blanching	11.45	2.07	2.84	2.55	0.38	80.44	335.2
P<F	0.614	0.072	0.281	0.667	0.055	0.586	0.790
LSD	1.730	0.316	0.584	0.405	0.109	2.220	6.890
Drying Methods							
Oven	12.09	2.02	3.19	2.47	0.35	79.88	332.6
Shade	11.18	2.23	3.03	2.69	0.33	80.55	335.9
Sun	10.81	2.26	2.73	2.47	0.40	81.07	337.6
P<F	0.053	0.291	0.147	0.080	0.449	0.282	0.253
LSD	1.040	0.339	0.478	0.220	0.125	1.545	6.280
Pre-treatments X Drying	NS	NS	NS	*	NS	NS	NS

NS = Not Significant, * = Significant

Table 3: The Effects of Interaction of Pre-Treatments and Drying Methods on Protein Content (%) of Cassava Flour in 2023

Pre-Treatments	Drying	Oven	Shade	Sun
48 hrs Soaking in H_2O		2.41	2.91	2.50
2 min Blanching		2.28	2.79	2.34
4 min Blanching		2.72	2.37	2.35
P<F		0.023		
LSD		0.446		

CONCLUSION

Food drying is one of the methods that is used to preserve some perishable agricultural produce in order to ensure their availability almost all year round, reduce postharvest losses, and achieve food security. Therefore, in this study, 48 hrs soaking in water, 2 & 4 blanching used were capable of improving the proximate composition of cassava flour after drying. On the other hand, all the three drying methods were able to lower the moisture content within the acceptable limit, but shade and sun drying were more affordable and accessible than oven drying. However, oven achieved efficient drying within the shortest time as compared to sun and shade drying methods.

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CONFLICT OF INTERESTS

The authors declare that they have no conflicting interests.

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