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EFFECTS OF PROCESSING TECHNIQUES ON PROXIMATE COMPOSITION OF FLOUR OBTAINED FROM TWO CASSAVA (*MANIHOT ESCULENTA CRANTZ*) VARIETIES

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Abstract

This study focused on determining effects of processing methods on proximate composition of cassava flour obtained from two cassava varieties (Tropical manihot specie(TMS) 419, TMS 30555) The cassava samples were subjected to four processing methods; blanching processing technique (BPT), direct processing technique (DPT), fermentation with daily change of water (FMCΔH2O) and fermentation without daily change of water (FMCΔH2O,). Sun and oven drying methods were subsequently employed. It was a 4 $\times$ 2 $\times$ 2 factorial experiment fitted into RCBD research design. Flour samples obtained with the use of the various processing methods were subjected to laboratory analysis to determine their proximate composition. Results of the laboratory analysis were computed and presented in simple percentages. Result obtained shows that percentage Ash level of cassava flour from the sampled cassava varieties differed with changes in the processing methods employed, with DPT and (FMCΔH2O,) recording highest ash value of 2.90 and 2.36% respectively. Though, moisture level gotten across the processing methods were within limit for safe moisture level for cassava flour BPT and DPT recorded a more acceptable moisture limit needed for prolonged storage of the flour . Fermentation without daily change of water (FMCΔH2O) and Blanching method of processing (BPT) enhanced % dry matter (DM), protein and crude fiber levels. Both processing methods, varietal influence affected the proximate composition of the cassava flour sampled, to the extent that no single processing method had same effect across proximate values of tested cassava flour samples. With regards to drying methods of processing, higher % protein value were obtained in sun dried cassava flour samples than the oven dried samples. Whereas % ash content for oven dried samples were relatively higher than that obtained from sun dried samples, but variability in % carbohydrate were within range for cassava tuber on dry matter basis across samples and across processing methods employed.

Keywords: *Cassava,Composition,Fermentation,Processing, ProximatE*

Introduction

Cassava (*Manihot esculenta Crantz*) is a perennial woody shrub grown and consumed across the tropical and sub-tropical regions of the world. Cultivars for cultivation are largely obtained from stem cuttings that grows and produce roots that mature within 10-12 months, depending on variety. Though cassava leaves are edible and are consumed as vegetables in the tropics, the starchy edible root known for its high calorie and energy content is no doubt, the most economic portion of the plant. It is a cheap source of carbohydrate (80-90%) on dry weight basis (Balogopalam, et al., 1998) and contains variable amounts of sucrose, glucose, fructose and maltose (Tewe & Lutaladio, 2004).It is an important food crop in the tropics and a major source of carbohydrate in Nigeria. It is a root crop rich in starch, known for very high calorie value and a root crop that is widely grown and consumed as a staple food in the humid tropics. According to FAO (2002), cassava is the third most

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important source of calories in the tropics, after rice and corn. Cassava is cultivated with use of stem cuttings, however most cultivars use for cultivation in Nigeria were developed through breeding programs conducted at the National Root Crops Research Institute Umudike (NRCRI) in collaboration with the International Institute for Tropical Agriculture (IITA) Ibadan Nigeria. Cassava varieties (cultivars) so developed are given acquisition numbers (Rn/8083, TMS 8233, 50395, 8082, TMS 30572, TMS 30555, TMS 4 (2) 1425) etc. for purposes of identification and differentiation. Cassava varieties differ in morphological traits, taste, cyanide content average yield and disease resistance (Mic,2007; Gbadegesin , Olaiya, Beeching , 2013). Cassava has been instrumental in the alleviation of food crisis in Africa**, (**Hahn & Keyser, 2005**)** and have been recognized as Africa's food security crop**.** Countries known for cassava production in Africa are Nigeria. Benin Republic, Kenya, Zambia, Tanzania, Uganda, Zimbabwe, Congo and Mozambique (Hahn & Keyser, 2005). Cassava production in Africa was estimated to about one hundred and fourteen million tones **(**FAO, 2002**)** in 2015**.** However, cassava roots have its uniqueness that it can be processed into a diversity of food and industrial products, to extend its shelf life and ensure food security. Processing of cassava tuber into varied local products is quite laborious and takes a lot of time, but does help to address the short post-harvest life of the crop (Nweke, 2005). Globally, changes in consumer trends have been geared towards convenience in processing and/or accessing processed food products. The processing of cassava into various food products involves the application of different techniques, each of which affects the chemical composition and the organoleptic characteristics of the products. Chemical composition simply refers to the arrangement, type and ratio of atoms in molecules of chemical substances. The chemical composition of a food product determines the ratio of elements, size of the compound, intermolecular forces, colour and the texture of the product. Generally, chemical composition of a food substance is studied through the use of laboratory tests. To determine the chemical or proximate composition of cassava, harvested tubers are sliced dried and ground into flour. To produce good quality cassava flour, the cassava tuber to be used must be matured and of good quality. Tapioca, farina, garri, fufu, starch etc. are some of the product often gotten from processing of cassava tuber locally. Food processing involves the altering of food from its raw form into a new form. Food processing is very helpful as it extends the shelf life of food products, prevents spoilage and also makes the food accessible to more people, thereby increasing food availability. Apart from the fact that the cassava roots contain 70% moisture, they are bulky and difficult to transport in large quantities which makes it difficult and expensive to market it fresh. Fresh cassava roots could be toxic when eaten as it contains high level of hydrogen cyanide poisonous to man. Cyanogenic glucoside is a major phyto- chemical found in virtually all parts of the plant with the root peels having highest concentration of (Montagnac et.al., 2009). Generally the amount of cyanogenic glucoside in cassava varies depending on variety, climate and environmental conditions, but sweet cassava variety contains a relatively lower Cyanogenic glucose than the bitter variety (Falade & Akingbala, 2010). Hydrolysis of cyanogenic glucoside liberates hydrocyanide compound known to be toxic on consumption, even at very low concentration (FAO, 1971) particularly if consumed above the permissible or threshold limit of ≤10mg/equivalent/kg dry matter (FAO/WHO, 1991).Post-harvest processing of cassava affects, nutritional value of the roots, through modification and loss of nutrients of high value. (Montagnac et al., 2009), help to reduce hydro cyanide content of the roots, and break bulkiness of harvested roots. Again processing helps to prolong shelf-life of products through reduction in moisture content, improved palatability, nutritive value of products and at the same time, provides a variety of food products needed by consumers (Isirima, 2018). Though post-harvest processing of cassava affects, nutritional value of the roots, through modification and loss of nutrients of high value. (Montagnac, et al., 2009) it is also known to reduce hydro cyanide content of the roots, and break bulkiness of harvested roots. Again processing helps to prolong shelf-life of products through reduction in moisture content, improved palatability and nutritive value of products and at the same time, provides a variety of food products

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needed by consumers (Isirima , 2018). Studies shows that processing of food products is associated with either loss or improvement in certain nutrient and chemical characteristics of the products. This depends to a large extent on the processing methods applied. For instance, the application of heat is known to reduce hydrogen cyanide content of cassava tuber (Ministry of Agriculture, 2005**).** Processing of cassava roots into finished products is a sure way to prolong shelf-life and reduce cyanide level. It also helps to ease transportation and enhance marketability of products. Cassava processing is an activity that have been in existence and as such not new but producing good quality cassava flour which can be turned into nutritious and acceptable fufu is of great concern to rural farmers in Nigeria. The traditional method of processing cassava roots into paste for fufu preparation has been through retting or fermentation of cassava roots (peeled and unpeeled). This method is associated with resentful aroma that remains on the consumer's palm for a long period of time after consumption. Different processing methods have been employed in producing cassava flour for subsequent preparation into fufu. These techniques have their effects on the physico - chemical characteristics of flour obtained and are known to contain nutrient value below recommended levels, whereas other processing methods contain cyanide above thresh hold limit. Thus, the aim study is to determine the most preferable method of producing high quality cassava flour suitable for fufu preparation.

Research Methodology

Description of the research design, research population, sampling techniques and method of data collection is as indicate here-in. A randomized complete block design involving a laboratory experiment was adopted in the study. Processing of the cassava tuber into flour was carried out at the Agricultural Science Laboratory, Federal College of Education (Technical), Omoku .Samples of Tropical *Manihot esculenta* (TME) 419 and Tropical Manihot specie (TMS) 30555, cassava varieties obtained from the Green River Project of the Nigerian Agip Oil Company Limited, were peeled, weighed, sliced into uniform thin chips and subsequently sundried or oven dried where applicable. The dried chips were taken to a mill for milling, sieved with a sieve to remove unwanted particles, weighed and packaged, for the study. The experiment was a 3 factor, factorial experiment consisting of 3 treatments; namely four processing methods, two cassava varieties and 2 drying methods (4 x 2 x 2) fitted into randomized complete block design (RCBD). Processing methods employed in this study is as shown below:

Method 1: Direct Method: Cassava tuber -> peel -> wash -> slice -> dry -> grind -> sieve -> fine flour

Method 2: Blanching Method: Cassava tuber -> peel -> wash -> slice -> blanch -> dry-> grind -> sieve-> fine flour.

Method 3: Retting method (fermentation without daily change of water): Cassava tuber -> peel -> wash -> slice -> ret -> dry -> grind -> sieve -> fine flour

Method 4: Fermentation with daily change of water: Cassava tuber -> peel -> wash -> slice -> ferment -> dry -> grind -> sieve -> fine flour.

Preparation of Cassava Flour for Fufu

For the purpose of this study. 38.44g of flour sample was poured into 100l of boiling water in a stainless steel pot and stirred vigorously and thoroughly with a wooden stirrer until it turned into a thick and moderately strong dough ("fufu" paste). The paste was removed and transferred into a clean stainless steel plate. This procedure was followed for all samples under investigation.

Proximate Analysis : Proximate analysis was used to determine chemical composition of each flour. The analysis is according to Eltayeb et al., (2012) and includes the determination of moisture content, carbohydrate, ash, crude fiber, crude protein and fat content. **Moisture Content Determination:** Moisture meter was used.

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The device mechanism is based on drying of the sample at 100^0C for 10 minutes. The moisture analyzer was connected to switch, when the switch lid was closed. At 10 minutes, the device indicated the end of the analysis by displaying the moisture content in percentage on its screen.

Carbohydrate Determination : Total carbohydrate content of each samples were determined by difference.These were done by subtracting the percentage of moisture, ash, protein and fat obtained from 100%. **(**Bryant, Pradhu, Floer, Wang, Spagna, Schreiber and Ptashine; 2008).carbohydrate = 100% - (Moisture + ash + % protein + fat)

Ash Content Determination: Ash content determination was based on principle of complete incineration of organic component of food and the left behind component is inorganic of ash.

The crucibles and their contents were then transferred, using a pair of cleaned tongs into a muffle furnace of 600^0C for 1 hour or until fully ash. The crucibles and their content (residue) were placed in the desiccators for cooling and weighed. **Calculation:** $\frac{\text{\% ash weightof residue}}{\text{Weight of sample}} \times \frac{100}{1}$

Crude Fiber Determination : 100g of each samples were weighed into a 250ml conical flask, 50ml of 0.3m H_2SO_4 was added and the mixture reflux for half an hour using reflux condenser. 0.5m NaOH was added after 30 minutes and refluxing was carried out for another 30 minutes. Content in the flask was filtered using filter paper. Residue was rinsed with hot water and this followed with addition of 50ml acetone to remove any fat present. Fiber was then scrap into crucible using a jet of acetone from the filter paper into a cleaned, weighed crucible. Acetone was evaporated by heating crucible over a boiling water bath. The sample was dried in a conventional oven for 1 hour at 140^0C. The fiber was further ash in furnace at 600^0C to 650^0C for 3 hours. Sample was cooled in desiccators and weighed after cooling. Same procedure was repeated for other samples.

Protein Determination : Protein content in flour samples is determined usually by the conventional Kedjhal method. However, various modifications are available and one of them is Nessier's reagent method where 5g of the sample was weighed and transferred into a digestion flask. 5ml of the concentrated H_2SO_4 was added. Colour developed was measured using spectrophotometer at about 460 – 462 nanometer, from which the amount of protein was determined.

Fat Content Determination: 10g of each sample was put into a cleaned, dried conical flask. Samples were heated with 10ml alcohol for 10 minutes on a water bath at a temperature 62^0C. Samples were allowed to cool using desiccators. 12ml diethyl ether was added to the samples in each flask. 4.5ml was on, the device indicated ready on its screen. Sample was added on the foil plate in it, and the cover water and 12.5ml light petroleum was added and were mixed together gently upper layer of each sample was siphoned off into a cleaned weighed beaker. Extract were then heated to remove solvent by evaporation and were then weighed and values were recorded and calculated thus

$$\text{\% fat content} = \frac{\text{weight of extract}}{\text{Weight of sample}} \times \frac{100}{1}$$

Hydrogen Cyanide Determination: The determination of the hydrogen cyanide (HCN) in the samples was done using the alkaline picrate method of Wang and filled as described by Onwuka, (2005). A blank reagent was prepared by measuring 4ml of alkaline picrate in 1ml of distilled water. The blank was used to standardize the spectrophotometer before taking the absorbance of the samples.

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Statistical Analysis: The data generated from the laboratory analysis were organized and presented in simple percentage**.**

Result

Effects of processing techniques on proximate composition of TME 419 and TMS 30555 is as indicated in the Table 1a and b below. Blanching and direct methods of processing recorded lower moisture content of 9.84 and 9.40 respectively in TMS 30555 cassava variety, whereas fermentation with daily change of water ($FM\bar{C}\Delta H_2O$) and fermentation without daily change of water ($FM\underline{C}\Delta H_2O$) recorded higher moisture content (MC) of 10.18 and 10.20%. Percentage DM value of the blanched and direct processing methods is within range of between 90.76 – 90.60% but fermentation with daily change of water ($FM\bar{C}\Delta H_2O$) and fermentation without daily change of water ($FM\underline{C}\Delta H_2O$) had a lower dry matter value of 89.82 and 89.75% respectively. Percentage Ash value of the Direct processing method was higher (2.90%) whereas the blanching processing method had lower Ash value of 2.10%. Blanching method of processing had least % crude protein, as against higher crude protein value of between 3.84 – 3.24% recorded with the utilization of Direct (DP), $FM\bar{C}\Delta H_2O$ and $FM\underline{C}\Delta H_2O$ methods of processing. Analysis of the proximate value of TMS 30555 cassava varieties shows that percentage carbohydrate (CHO) was highest with the use of blanching (83.22%) and lowest (80.11%) at $FM\underline{C}\Delta H_2O$. (Table 1a.) Hydro cyanide (HCN) value of the tested TMS 30555, cassava variety was higher (16.09%) with the use of $FM\underline{C}\Delta H_2O$ and declined with the use of direct method of processing. Similarly Direct processing method recorded higher percentage fat value of 1.06% but across the various other processing methods percentage Fat value declined (0.72 – 0.94%) considerably (Table1a). Crude fibers at blanching method of processing was 1.49% but the rate was higher at Direct (1.72%), $FM\bar{C}\Delta H_2O$ (1.62%) and $FM\underline{C}\Delta H_2O$ (1.60%) processing methods. (Table 1a).Records of the effects of processing methods on proximate composition of TME 419 cassava varieties is shown in Table 1b. Moisture content (MC) of the blanching method of processing was 10.19% but across Direct, $FM\bar{C}\Delta H_2O$ and $FM\underline{C}\Delta H_2O$ percentage moisture declined to values between 8.90 – 9.20%. Lower percentage dry matter of 89.81% was obtained with the use of blanching method of processing but Direct, $FM\bar{C}\Delta H_2O$ and $FM\underline{C}\Delta H_2O$ had a high dry matter value of between 90.80 – 91.10%. Variability in Ash content across the processing methods shows that blanching recorded an Ash value of 2.06% whereas Direct and $FM\underline{C}\Delta H_2O$ had higher Ash values of 2.85 and 2.78% respectively. (Table 1b.)Furthermore, the crude protein value of the blanching method was lower (2.42%) with Direct and $FM\bar{C}\Delta H_2O$ recording higher values of 3.89 and 3.25% respectively; showing that Direct and $FM\bar{C}\Delta H_2O$ had higher positive impact on crude protein value of the cassava variety. Mean carbohydrate (CHO) value of 81.67% obtained at the direct processing is lower than 84.74 and 83.14% obtained at the $FM\bar{C}\Delta H_2O$ and direct methods of processing.

The HCN values of the TME 419 cassava varieties were higher with the use of direct (18.25%) and $FM\underline{C}\Delta H_2O$ (17.90%) methods of processing and lower at blanching (14.70%) and $FM\bar{C}\Delta H_2O$ (15.86%) processing methods. Higher fat values of 1.06 % was recorded at the direct processing methods, whereas the least fat value of 0.63% were obtained at the blanching and $FM\bar{C}\Delta H_2O$. Crude fiber value vary between 1.56 – 1.69 percent across the various processing methods with $FM\bar{C}\Delta H_2O$ recording the highest value of 1.69%.

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Table 1a: Processing methods and it's effect on proximate composition of TMS 30555

Composition Details %	Blanching (BPT)	Direct (DPT)	Fermentation with daily change of water (FMCΔH_2O)	Fermentation without change of water (FMC̲ΔH_2O)
MC	9.84	9.40	10.18	10.2
DM	90.76	90.60	89.82	89.75
ASH	2.10	2.90	2.20	2.36
CP	2.60	3.84	3.85	3.24
CHO	83.22	81.80	81.42	80.11
HCN	15.30	10.94	15.78	16.09
Fat	0.75	1.06	0.72	0.94
CF	1.49	1.72	1.62	1.60

Key: Blanching processing technique (BPT), Direct processing technique (DPT), Fermentation with daily change of water) (FMC̄ΔH_2O), Fermentation without daily change of water (FMCΔH_2O)

Table 1b: Influence of processing methods on proximate composition of TME 419

Composition Details %	*Blanching (BPT)*	*Direct (DPT)*	*Fermentation with daily change of water (FMCΔH_2O)*	*Fermentation without change of water (FMC̲) ΔH_2O)*
Moisture Content	10.19	8.90	9.20	8.94
Dry Matter	89.81	91.10	90.80	91.06
Ash	2.06	2.85	2.18	2.78
Crude Protein	2.42	3.89	3.25	2.92
Carbohydrate (CHO)	83.14	81.67	84.74	84.67
Hydro-cyanide HCN	14.70	18.25	15.86	17.90
Fat	0.63	1.06	0.63	0.72
CF	1.56	1.63	1.69	1.65

(BPT), Direct processing technique (DPT), Fermentation with daily change of water) (FMC̄ΔH_2O), Fermentation without MCΔH_2O)

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Drying Methods and Proximate Composition

In this study, the proximate composition of sun and oven dried cassava varieties were determined across various processing techniques (BPT, DPT, $FMC\Delta H_2O$ and $FM\underline{C}\Delta H_2O$ and result obtained is as shown in table 2a and 2b respectively.

Table 2a: Effects of drying methods on proximate composition of TMS 30555.

Composition Details	Blanching (BPT)		Direct (DPT)		Fermentation with daily changing of water ($FM\underline{C}\Delta H_2O$)		Fermentation without changing of water ($FMC\Delta H_2O$)	
	Sun Dry %	Oven Dry %	Sun Dry %	Oven Dry %	Sun Dry %	Oven Dry	Sun Dry %	Oven Dry %
MC	9.84	10.63	9.40	8.55	10.18	9.45	10.25	9.38
DM	90.16	80.31	90.60	91.50	89.82	90.65	89.75	90.22
ASH	2.10	1.96	2.90	3.26	2.20	2.28	2.86	2.94
CP	2.60	2.72	3.84	3.65	3.65	3.60	3.24	3.18
Carbohydrate (CHO)	83.22	82.32	81.08	81.73	81.73	82.20	80.11	81.63
Hydro-cyanide (HCN)	15.30	15.86	10.94	17.84	17.84	14.25	16.09	17.45
Fat	0.75	0.76	1.06	1.06	1.06	0.85	0.94	0.83
Crude Fiber	1.49	1.56	1.72	1.80	1.80	1.62	1.60	1.64

Key: Blanching processing technique (BPT), Direct processing technique (DPT), Fermentation with daily change of water ($FM\bar{C}\Delta H$ O), Fermentation without daily change of water($FMC\Delta H_2O$)

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Table 2b: Effects of drying methods of proximate composition of TME 419

Composition Details	*Blanching processing technique (BPT)*		*Direct processing technique (DPT)*		*Fermentation with daily change of Water FMC*		*Fermentation without daily change of water ((FMC̅ΔH2O)*	
	Sun Dry %	*Oven Dry %*	*Sun Dry %*	*Oven Dry %*	*Sun Dry %*	*Oven Dry %*	*Sun Dry %*	*Oven Dry %*
Moisture Content	10.19	9.60	8.90	8.24	9.20	9.54	8.84	9.86
Dry Matter	89.81	90.40	91.10	91.26	90.80	90.46	91.06	90.14
Ash	2.06	2.13	2.85	3.12	2.18	2.34	2.78	2.82
Crude Protein	2.42	2.80	3.89	3.75	3.25	3.45	2.92	3.14
CHO	83.14	83.43	81.67	81.59	84.74	82.21	84.67	81.62
Hydro Cyanide	14.70	14.85	18.25	16.58	15.86	15.78	17.90	16.48
Fat	0.63	0.56	1.06	1.04	0.63	0.68	0.72	0.70
Crude Fiber	1.56	1.48	1.63	1.73	1.69	1.78	1.65	1.86

Key: Blanching processing technique (BPT), Direct processing technique (DPT), Fermentation with daily change of water (FMC̅ΔH O), Fermentation without daily change of water(FMC H_2O)

Percentage moisture content (MC) obtained from the Blanched (BPT) and oven dried TMS 30555 Cassava variety was 10.63% whereas the sun dried TMS 30555 recorded a moisture percentage of 9.84. However across the DPT, FMC̅ΔH2O and FMC̲ΔH2O, moisture content (MC) of the sun dried TMS 30555 was higher than the MC obtained with use of oven drying processing technique. (Table 2a)
Sun drying method of processing recorded higher DM only at blanching (BPT) and Direct processing technique (DPT) but percentage dry matter (DM) for the FMC̅ΔH2O and FMC̲ΔH2O processing methods were low with the use of sun drying and higher at the oven drying processing method. The least oven dried ash level for BPT was 1.96%, whereas the highest oven dried level of 3.26% was obtained at DPT. Percentage Crude protein (C.P) content varied with sun and oven drying processing technique and across BPT, DPT, FMC̅ΔH2O and FMC̲ΔH2O methods of processing (Table 2a). Variability in carbohydrate contents was between 83.22% and 81.08% within Blanched and Direct processing method of the sun-drying technique, whereas highest and lowest CHO content of between 82.33% and 81.63% was

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obtained with oven drying processing method. Least HCN Value obtained for TMS 30555 cassava variety was 14.70% for the sun dried /BPT processing method but highest HCN value of 18.25% was recorded at Sun dried/DPT processing method . HCN value in the Sun drying across DPT, $FM\bar{C}\Delta H_2O$ and $FM\underline{C}\Delta H_2O$ was between 10.94 and 17.94. Lowest fat value of 2.06 was recorded with the use of Sun drying/ BPT processing method whereas the highest percentage of 1.06 was obtained at the Sun dried/DPT method of processing . Percentage variability in crude fiber content is more or less a function of the processing method rather than method of drying employed. In TMS 419 cassava varieties, result obtained shows that sun dry method of processing recorded higher Moisture content, Dry matter, Crude protein, Hydro-cyanide, except for crude fiber and Carbohydrate content. (Table2b)

Discussion of Findings

Moisture content of food products is a measure of water content of the product. It is an important index for the determination of duration of storability and shelf-life of food products. A moisture level of between 9.30 – 9.86% obtained from TMS 30555 cassava variety and the 8.94 –10.25% recorded in the TME 419 cassava variety across the various processing techniques (BPT, DPT, $FM\bar{C}\Delta H_2O$ and $FM\underline{C}\Delta H_2O$ is less than the lowest and highest range of 10.78 and 12.22% moisture level reported in Maziya – Dixon, Adebowale, Onabanjo and Dixon; (2005). This indicate prolonged shelf- life of the cassava products. The nutritional composition of cassava depends to a large extent on the specific tissue (root or leaf) and factors such as geographic location, variety, age of the plant at harvest and environmental conditions. Percentage dry matter of 90.15 to 90.65 obtained from TMS 30555 and 89.82 – 91.06% recorded for TME 419 across the various processing techniques in this study are quite higher than DM of 40.32 reported **in;** Montagnac et al., (2009). Higher dry matter in this case is an indication of higher biomass quality of the sampled cassava varieties and shows that the processing methods did not produce a meaningful reduction effect on the DM percentage of the sampled varieties**.** With respect to nutritional value of cassava Salvador et al., (2014**)** reported a protein level of 1.36% for raw cassava and 0.3 – 3.5% for cassava roots. Average protein content for the dry mass is between 1 – 3% (Gil & Buitrago**,** 2002) whereas average protein content for fresh mass is about 1.5mg/100g (Bradbury & Holloway; 1988). However, mean protein value of 3.60 recorded for BPT in TMS 30555 and 3.85% recorded for the TME 419 across the processing techniques are higher than the protein level obtained in the cited reports. This is expected as studies have shown that processing techniques enhances nutritional quality of products. Again, result obtained in this study have also shown that BPT has the capability to produce higher protein value than the rest other processing techniques employed in the study. It is most likely that the heat associated with the blanching method of processing enhanced break down and deamination of protein into amino acid components which was reflected as higher protein value. The lowest and highest fat content of 0.63 and 0.94 obtained across the processing methods are slightly higher than 0.28 and 0.5% recorded in a previous review report (Montagnac et. al, 2009). Higher fat content obtained in this study could be attributed to varietal influence and environmental factors.

Crude fiber content of 1.86% obtained with the use of $FM\underline{C}\Delta H_2O$ for TMS 30555 and 1.67 percentage crude fiber rate obtained from the TME 419 cassava variety at BPT are within range (1.8) of dietary crude fiber for fresh weight, earlier reported in USDA National Nutritional database for standard reference (USDA, 2007). Crude fiber is an essential part of a healthy diet that can help to reduce problems of constipation and may help to prevent colon cancer (Rock, 2007). Though the rich fiber constituent of the cassava may assists in promoting intestinal peristalsis and bolus progression (Favier,

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1977) very high fiber content from any source may produce negative effects in humans. Recommended dry matter content is between 2 – 4% in root flour (Gil & Buitrago, 2002). According to Baer and Olumese,. (1996) fiber content can be of nutritional concern because it can decrease nutrient absorption in the body (Baer et al., 1996). Excess fiber in the diet will increase fecal nitrogen, cause intestinal irritation and reduce protein digestibility (Favier, 1977, Baer et al, 1996). Cassava root is an energy dense food with very efficient carbohydrate production per-hectare. Mean percentage carbohydrate content of cassava roots ranges from 80 – 90% on dry matter basis (Gil & Buitrago, 2002) and this agrees with the mean carbohydrate of 83.22 -81.08% recorded across the various processing techniques (BPT, DPT, $FM\bar{C}\Delta H_2O$ and $FM\underline{C}\Delta H_2O$) employed in the study. High carbohydrate content of cassava makes it an important energy source and a major source of dietary calories.

Hydro cyanogenic glycoside is an important phyto - chemical substances found in cassava. Its presence in cassava roots and leaves in high quantity is no doubt a threat to human life. The amount of HCN content in cassava depends largely on varietal difference, cassava types, age at maturity of roots, and environmental factors. HCN level of the sampled TMS 30555 and TME 419 cassava variety is within range of 8.33 to 28.8mg/kg dry weight basis reported as potential Cyanide level for cassava in Thailand (Charles et al., (2005). Uganda standards for total hydrocyanic acid content of cassava flour is put at 10mg/kg (USDA; 2007). Incidentally the recommended safe cyanide content for cassava is 10mg/cyanide equivalents/dry matter (FAO/WHO, 1991). The Nigerian standard organization (SON) had earlier recommended cassava cyanide safe level of 20ppm (Almazan, 1992).

However, cyanide content isolated from the sample cassava varieties are higher than the recommended standards. This portends danger to human health as health challenges associated with increasing consumption of cyanide rich cassava roots include acute poisoning (Halstrom & Moller, 1945).

Effect of Drying Method on Proximate Composition of TMS 30555

Drying as a means of cassava root processing helps to reduce moisture percentage and prolong shelf-life of products. Moisture content of 9.38 – 10.63% reported in the study across the various drying methods will further enhance storage of the products. Result obtained in this study further shows that effects of drying methods and processing techniques are variable. Blanching processing technique, followed by oven drying recorded higher moisture content, whereas Direct processing technique followed by sun drying technique recorded higher moisture. In $FM\bar{C}\Delta H_2O$ and $FM\underline{C}\Delta H_2O$ sun drying recorded a moisture content higher than that obtained from oven dried products. Blanching processing technique (BPT) involves initial heating of the product in water, this may have caused the carbohydrate to break down into disaccharide sucrose through a process often referred as caramelization. The process may have interfered with further drying of the (BPT) blanched cassava products hence the reported higher moisture level. Percentage dry matter (DM) in the oven dried products were slightly higher than percentage DM obtained in the sun dried products.

However, mean DM obtained across the various treatment was higher than percentage dry matter of 29.8 – 39.3% reported earlier (Salvado et al., 2014). Higher ash level (1.96 – 3.26%) obtained in the oven dried products across the processing techniques shows that drying method has effect on ash content of cassava root. Crude protein of the sun and oven dried products vary with variation in the processing techniques employed. Sun dried products recorded a relatively higher crude protein content than the oven dried. However, mean crude protein obtained in this study is higher than the mean protein level (1.00 – 3%) reported in (Salvador et al., 2014) and protein value of 1.2 and 1.8% reported earlier in Charles et. al.,

(2005). Higher status of 3.18 – 3.84 reported in this study could be attributed to both processing techniques and drying methods employed. Variability in mean carbohydrate (CHO) content across the drying methods did vary but it is within range of 80 – 90% (dry matter basis), reported earlier in Montagnac et. al., (2009). Variation in percentage HCN level across the respective processing method is not consistent across the drying methods but the respective HCN contents are higher than the permissible limit of <10mg/cyanide equivalents/kg on dry matter basis (FAO/WHO, 1991). Fat level of 0.75 and 1.06% is far higher than 0.2% obtained from gari and 0.04 –
0.06% obtained from peeled and retted cassava flour (Montagnac et al., 2009). Crude fiber across the processing technique did not maintain any specific trend with respect to drying methods. Higher crude fiber obtained across the sun and oven drying techniques could be attributed to processing method rather than to method of drying employed.

Summary

Though blanching method of tuber processing (BPT), recorded higher moisture content in this study , percentage moisture obtained across the processing methods (DPT, $FM\bar{C}\Delta H_2O$ and $FMC\Delta H_2O$) were within limits that could support prolong shelf-life. Dry matter percentage of the sampled cassava variety varied with processing methods indicating the potency of processing technique to influencing proximate properties of the sampled cassava varieties. Blanching method of processing recorded better protein values than values obtained with the use of other processing methods. Higher Crude fiber content obtained with the use of $FMC\Delta H_2O$ and BPT to process TMS 30555 and TME 419 cassava variety respectively, suggest potency of the processing methods to promote percentage crude fiber. Sun drying method of processing produced better effect on the proximate composition of the sampled cassava varieties, particularly when BPT and DPT methods of processing were employed prior to drying.

Conclusion

Though processing methods and varietal influence has marked effect on proximate composition of sampled varieties, virtually all methods employed in processing the sampled cassava variety maintained a carbohydrate value that is within levels needed to supply the required energy for sustenance of good health . Where a processor's target is to enhance the protein and fat value of the product , then the use of DPT and fermentation with daily change of water (FMCAHO) is recommencded

Recommendations

With respect to the findings in this study therefore, we recommend thus: (i} Fermentation method of cassava tuber processing be adopted as measure to produce flour for fufu preparation as this will enhance protein level (ii) Sun drying method of cassava root drying is also recommendedforflourmakingsinceithasbeen showntoincreaseproteinvalueoftheproduct. However, since HCN reduction in cassava tuber is a major concern to processors and the fact that DPT processing method in this study achieved lowest HCN reduction only in TMS30555 cassava variety and could not produce same effect on TMS419, processors are hereby advised to employ processing methods best suitable for HCN reduction in line with choice of cassava variety as varietal differenceseemstoinfluenceeffectsofprocessingmethodsinthiscase

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