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Physicochemical Properties of Cassava Processing Residue Flour and Sensory Evaluation of *Fufu* Prepared from it

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Abstract

This study evaluates the physicochemical properties of the residues obtained from the sieving operation during cassava (*Manihot esculenta*) gari and starch processing. Residue obtained from the sieving of dried fermented cassava pulp during gari production and extraction of starch, were dried on a mounted platform in an open space before processing into flour. Commercial wheat flour was used as a standard. Physiochemical properties of each flour samples were investigated using standard methods. Results obtained shows significant differences ($p<0.05$) in the parameters investigated. Cassava gari residue flour sample ranked the lowest in moisture (6.371%). The percentage fat in; cassava gari was found to be 0.057%, cassava starch 0.031%, wheat 3.331%. Ash ranges from 1.786% (cassava starch) to 1.3015% (Wheat). Crude fibre from 2.701% (wheat) to 4.383% (cassava gari) while dry matter was from 93.630% (cassava gari) to 81.680% (wheat). Oil absorbing capacity ranked the highest in cassava starch residue flour (1.745), while in water absorption capacity cassava gari residue flour ranked the highest (1.995). Swelling index ranged from 1.429 (cassava gari) to 1.505 (wheat). The lowest in bulk density and pH was cassava starch flour (0.556, 5.36), while gelation temperatures were 66.5°C, 64°C, 60.15°C in cassava gari, cassava starch and wheat flour samples respectively. Eight (8) sets of *fufu* samples were prepared using the residues flour, coded and subjected to sensory evaluation using a twenty-member panel. The panellists were instructed to evaluate the coded *fufu* samples for Texture, Mouldability, Elasticity, Smoothness, Appearance, Thickness and General acceptability. A nine (9) point hedonic scale was used, results obtained were statically analysed. The results show that there were significant differences between the different methods of preparation.

Keywords: Boiling; Cassava residue flour; *fufu*; Physicochemical; Roasting

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Introduction

Cassava is consumed as food, like yam and sweet potato, it is the most important root crop in Nigeria [1]. Root and tuber play important roles in the dietary of Nigeria, cassava is grown in Nigeria, a very popular tuber crop in sub-Sahara Africa [2]. Cassava processing generates waste right from harvesting (farm) to the table (consumer). There is need for proper management of these wastes, these involves analysis and evaluation of the physicochemical properties of the wastes and how to channel these to useful products like *fufu,* cookies, crackers cake etc. *Fufu* is an extremely popular and common food in Nigeria and in number of other countries in west Africa [3]. *Fufu* is obtained mainly from root and tuber crops such as cassava and yams. It is prepared in slightly different ways in different communities. Converting agriculture wastes such as cassava wastes into useful product is one of the ways of generating income, reducing post-harvest losses, combating food security for sustainability development. In addition, it can lead to creation of jobs, boast energy security and reduce the dependent on foreign countries [4,5].

Wastes generated during cassava processing can be converted into useful products. Liquid (effluent) obtained from cassava processing can be fermented to bioethanol, the peels (solid waste) can be used for feed stock and also fermented to bioethanol. The sludge deposits from the products of bioethanol can be used as manure in improving the soil nutrient value [6]. Much work has been done on gari and starch processing however, little or no work on the solid residues (wastes) have been reported. This study was aimed at investigating the physicochemical properties of the flour obtained from cassava residues and the *fufu* (meal) made from the residue flour.

Materials and Methods

Source of experimental material

The cassava roots local variety called Nwageli were obtained from National Root Crops Research Institute Umudike, Nigeria. Commercial wheat flour used as a standard in the proximate and functional properties evaluation was bought from retail seller at Ubani market in Umuahia, Abia State.

Production of residue flour

The cassava roots were peeled, washed and grated. The grated mash for gari was dewatered and left to ferment for 3 days [7]. The de-watered mash was disintegrated and sieved with a local mesh to obtain the residue. Residues from cassava starch production were obtained using the method of starch extraction by Minggu [8]. These residues from gari and starch processing were sun- dried to obtain a constant weight, milled and sieved to obtain equal fine particles of the flour using sieve of aperture 150 micrometer (µm) and stored in air tight bag. **Figures 1 and 2** present the flow charts of the production of residue flour from cassava gari and starch processing.

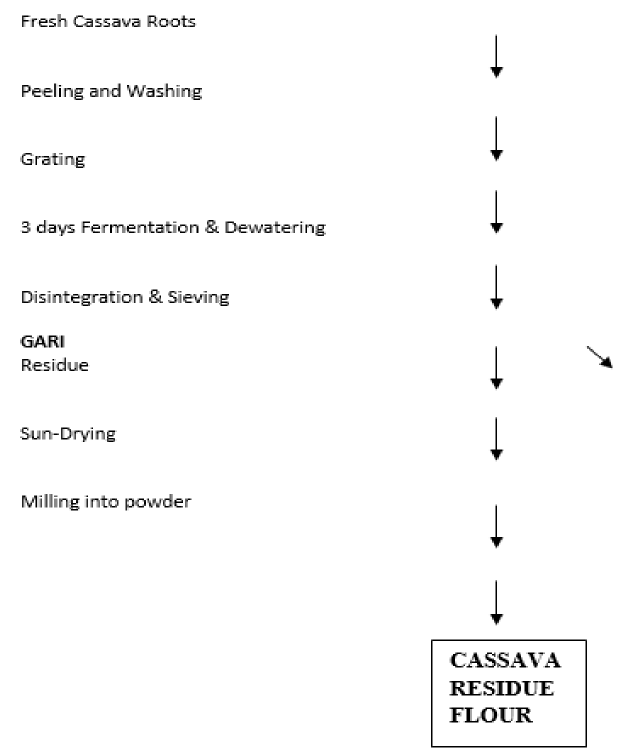

Figure 1 Flow chart of cassava residue flour obtained from gari processing.

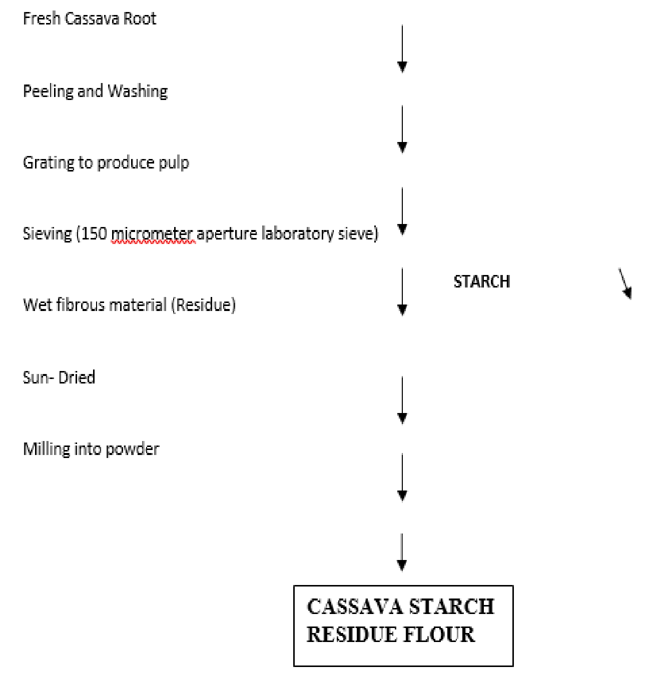

Figure 2 Flow chart of cassava residue flour obtained from starch extraction.

Experimental

Analysis carried out on the residue and wheat flour

Proximate composition: Proximate composition (moisture, crude fiber, ash, crude protein, fat) and dried matter of the residues flour samples were determined using standard methods described by Association of Official Analytical Chemistry [9,10].

Function properties: The swelling index of the residue and flour samples was done using the method by Iwuoha [11,12]. The Bulk density was determined by the method of Nep and Conwey [13]. The methods as stipulated by Onwuka [14] were used to determine the gelatinization temperature, pH, water and oil absorption capacity (WAC/OAC).

Preparation of *fufu*

The residue flours obtained from gari and starch processing were divided into four (4) equal samples each and coded 1G, 2G, 3G, 4G for residue flour samples from gari (G) processing and 1S, 2S, 3S, 4S for residue flour samples from starch (S) processing. Half of the residues from the two sources were separately toasted. *Fufu* was then prepared from the samples. The two methods of preparation were either boiling and stirring, and addition of boiled water with stirring. The coded eight (8) sets of *fufu* samples were; 1G and 1S toasted cassava gari and starch residue flour, 2G and 2S untoasted, each subjected to boiling with stirring; 3G and 3S toasted cassava gari and starch residue flour, 4G and 4S untoasted were added hot water with stirring. The *fufu* samples were subjected to sensory evaluation using a twenty-member panel. The panellists were instructed to evaluate the coded fufu samples for texture, mouldbility, elasticity, smoothness, thickness, appearance and general acceptability. A nine (9) point hedonic scale was used (**Figures 3-5**) [15,16].

Statistical analysis

All experiments were carried out in triplicates. Data were analysed using one-way analysis of variance (ANOVA) to obtained mean values. Duncan's Multiple Range test ($P < 0.05$) was used to determine the significant differences among the samples by using Statistical Package Social Science (SPSS) 21.0 for Window Evaluation Version.

Results and Discussion

The proximate composition of the residue flour obtained from cassava gari and starch processing is presented in **Table 1**. All the parameters investigated were significantly different ($p<0.05$). The moisture contents of both residue flours were significantly lower (6.3705% and 6.5715%) than the moisture content of wheat flour (18.3206%), the reason maybe that the residue flour before drying was obtained from dewatered cassava mesh. In addition, the moisture content of wheat being high could be due to inadequate storage of the wheat flour by the retailer in the market. The moisture content of the residue flour in this work is far lower than data obtained for other flours like the water yam (*Doscoreaalata*) flour used for amala reported by Ukpabi et al., [17]. The lower moisture content is an indication that the residue flour samples will last longer during storage if properly stored under good conditions to prevent absorption of moisture [18]. The higher the moisture content of food materials the lower the shelf-life (stability) [19,20]. Thus, cassava gari and starch residue flour could have shelf stable characteristics on storage than wheat flour. Cassava gari residue flour recorded the lowest fat content of 0.057 percent, this is expected since cassava roots are low in fat content [21]. Ash, crude fibre, crude protein and dry matter content from the samples (GR flour, SR flour and W flour) investigated ranged from; 1.3015 to 1.7855%, 2.7010 to 4.3825, 1.4360 to 7.8600% and 81.6795 to 93.6295% respectively. The crude fibre and ash content of the residues flour samples were higher than that of wheat flour sample, although in crude protein, wheat was higher, this is expected since root and tuber crops are low in protein content [22]. The results obtained could be comparable to the proximate composition results in the work done on cassava flour by Elevina and liz [23] and Idowu et al. [24].

Figure 3 Sample of untoasted cassava starch flour (SR) left and starch (GR) residue flour sample right.

Figure 4 Toasted cassava gari (left) and starch (right) residue flour samples.

Figure 5 Fufu samples prepared from the untoasted (2G, 4G,2S and 4S) and toasted (1G, 4G, 1S and 4S) cassava gari and starch residue flour; Left to right; Cassava gari residue flour fufu (1G, 2G, 3G and 4G) is shown on the first line from the top, while the second from the top is cassava starch residue flour fufu samples (1S, 2S, 3S and 4S).

The results of functional properties of cassava gari and starch residue flour are shown in **Table 2**. A range of 1.245 to 1.995 g/ml and 1.035to 1.745 g/mL were recorded for oil and water absorption capacities respectively. There were no significant differences between cassava residue flour and wheat flour in oil and water absorption respectively. The oil and water absorption capacities results of the residue flour samples indicate that the flour samples could be a good retainer of flavour and could also

Table 1 Proximate properties of the cassava gari (GR) and starch (SR) residues flour samples.

	Parameters (%)					
Samples	MC	FAT	ASH	C. FIBRE	C.PROTEIN	DM
GR flour	6.3705^c	0.057^b	1.5275^b	4.3825^a	4.7800^b	93.6295^a
SR flour	6.5715^b	0.0310^c	1.7855^a	3.3950^b	1.4360^c	93.4285^b
W flour	18.3206^a	3.3305^a	1.3015^c	2.7010^c	7.8700^a	81.6795^c

Samples with the same letter in the columns are not significantly different (p<0.05)
Moisture content (MC), Crude fibre (C. fibre), Crude protein (C. protein), Dried Matter (DM)

Table 2 Functional properties of cassava gari (GR) and starch (SR)residues flour.

	Parameters					
Samples	OAC	WAC	SI	D_B (g/mL)	GT°C	pH
GR flour	1.0350^b	1.9950^a	1.4285^c	0.6255^b	66.5^a	6.47^a
SR flour	1.7450^a	1.2450^b	1.4440^b	0.5555^c	64^a	5.36^c
Wflour	1.0350^b	1.9750^a	1.5050^a	0.7050^a	60.5^c	5.75^b

Samples with the same letter in the columns are not significantly different (p<0.05). OAC=Oil Absorption Capacity, WAC=Water Absorption Capacity, SI=Swelling Index, DB=Bulk Density, GT=Gelatilazation Temperature.

Table 3 Sensory attributes of *fufu* prepared using different methods from cassava gari and starch residue flour.

Samples	Texture	Mouldbility	Elasticity	Thickness	Smoothness	Appearance	General acceptability
1G	7.0^b	6.5^d	7.51^a	7.0^{bc}	7.5^{abc}	7.02^a	8.89^a
2G	6.0^d	6.0^f	5.5^d	5.3^e	7.0^d	7.02^a	5.5^e
3G	7.5^a	8.03^a	7.3^a	7.5^a	7.95^a	6.8^d	8.5^b
4G	6.8^c	6.2^e	7.5a	6.5^d	7.2^{cd}	6.8^b	7.5^d
1S	6.8^c	6.8^c	7.3^a	6.7^{cd}	7.5^{abc}	6.8^b	8.35^b
2S	5.5^e	5.5^g	5.0^c	5.2^e	7.35^{bcd}	7.0^a	5.3^f
3S	6.53^c	7.8^b	7.2^a	7.2^{ab}	7.8^{ab}	6.53^d	8.15^c
4S	6.03^d	6.9^c	7.5^a	6.82^{bcd}	7.2^{cd}	6.74^c	7.55^d

Samples with the same letter down the columns are not significantly different (p<0.05) 1G and 1S toasted cassava gari and starch residue flour, 2G and 2S untoasted each subjected to boiling with stirring. 3G and 3S toasted cassava gari and starch residue flour, 4G and 4S untoasted each added hot water with stirring.

give a better mouth feel when used in food preparation [25]. The high-water absorption capacity of cassava gari residue flour could be an indication of high affinity for water molecules [26,27]. Swelling index results recorded were from 1.4285 to 1.5050, this is the measure of hydrations ability of food granule [28]. Swelling index is a property which provide the evidence of the interaction among flour (food) [29,30]. It has been reported that the content of component substances, especially fat, protein and starch influences swelling index [31]. Therefore, the results of the swelling index of the cassava residue flours may be attributed to the low fat and proteins in the investigated samples. The results of the swelling index obtained in this work is comparable to that reported in the work by Suresh and Samsher [32]. Cassava starch residue flour (0.556) has the lowest bulk density compared to cassava gari residue (0.626) and wheat flour (0.70). This may be due to the fact, there is little or no starch content in the starch residue samples, since starch was almost completely extracted from the cassava mash to obtain the residue flour. The bulk density results of the residue flour samples obtained in this research were lower than that reported by Suresh and Samsher [32]. Low bulk density of flour indicates good physical attributes when determining transportation and storability [19,33], thus cassava starch residue flour could be easily transported and distributed to required locations. The gelatilization temperature ranges from 60.5°C to 66.5°C, while pH was from 5.36 to 6.47.

Table 3 shows the results of the sensory evaluation of the different attributes. There were significant differences (p<0.05) between the different methods of preparation. The mean scores range from 5.0 (neither like or dislike) to 8.89 (approx. mean score 9 = like extremely). 1G (toasted cassava gari residue flour subjected to boiling with stirring) ranked the highest in terms of general acceptability (8.89), 3G (toasted gari residue flour with hot and stirring) and 1S (toasted starch residue flour subjected to boiling water with stirring) ranked second (8.5 and 8.35= like very much). 3G ranked first in texture, mouldbility, elasticity, thickness and smoothness. Least general acceptability mean scores for the *fufu* samples by the Panellist were 2G (5.5), followed by 2S (5.3), although the panellists tend to like moderately (mean score of 7) their smoothness and appearance. There is visually no documentation on *fufu* prepared from cassava residue flour or the method of preparation, however these recorded results can be compared to work on cassava *fufu* by Keith et al., [34], where the mean scores were between 4.8 (approx. means score 5= neither like or dislike) and 6.9 (approx. means score 7 = like moderately). The result of this study was general accepted compared to that recorded by Omodamiro et al., [35], in which the least acceptable mean score of 3.5 (dislike) was recorded for some *fufu* samples.

Conclusion

The results of the proximate properties of cassava gari and starch residue flour show that these flours could be utilized due to their high ash, crude fibre, dry matter and low moisture and fat content which are very good attributes for a stable shelf life characteristic. In addition, the low-fat content could be good for persons that would want to check their percentage fat in-take. The functional properties of the experimental flour samples obtained indicate good functional attributes which are needed as guides for food technologists that produce certain food products.

The sensory evaluation results show that *fufu* can be prepared from cassava gari and starch processing residue flour samples. The best consumer acceptable method of preparation is toasted flour subjected to either boiling and stirring or adding hot water with stirring. Individuals who need little or no starch in their diets could use the *fufu* as meal.

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