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Synthesis and Quality Evaluation of Fufu from Cassava (Manihot esculenta) via Various Fermentation Aids

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ABSTRACT :

The rate of the fermentation of cassava during fufu preparation within 72 h using diverse locally employed methods were comparatively studied. The fermentation conditions compared were; sunlight vs indoors and bitter leaf vs detergents vs aqueous. Functionality test, HCN determination, anti-nutrient factor determination and FTIR analyses were also carried out on these samples. The results revealed that the indoor samples produced more yield after fermentation compared to the samples under sunlight. The samples fermented with anti-bacterial detergent aid showed the least water absorption capacity of 1.7260 g compared to the rest of the samples. This may be because of less water retention or less water absorption due to the presence of anti-bacterial ingredients. The swelling capacity of the samples ranged between 3.2193 – 6.8837 g. The bulk density of the samples had values between 0.0590 - 0.0675 kgm3. FTIR results revealed that the samples fermented with detergent aid had low levels of anti-nutrients. The presence of detergent residue was also evident in the cooked samples as observed in FTIR results. It could be inferred from the study that fermentation of cassava is more favourable at room temperature than under sunlight as opposed to the beliefs by the locals. Using detergent as an aid for cassava fermentation should be strongly discouraged as it may pose serious acute and chronic health issues to consumers of cassava fufu.

Keywords: Bitter leave, Cassava, Detergent, Fermentation-aids, Fufu-paste, Health

1. Introduction :

Cassava (Manihota esculenta) is one of the most important staple foods in Africa (Onyenwoke & Simonyan, 2014). It is a root tuber that is consumed at different levels after undergoing various processes (Nsa Oduro, 2016). In Nigeria, cassava is used to make a local meal popularly known as akpu or fufu, among other foods (Apeh et al., 2023). Fufu is widely consumed in the southern, western and eastern Nigeria (Chijioke et al., 2021). Similar to other cassava fermented food, the tubers are washed, peeled, cut into thick chunks, and steeped in water in earthenware pots to ferment for four to five days. The tubers are immersed in clean water, sieved, and allowed to settle for decantation of water (Halake & Chinthapalli, 2020).

Fermentation is a natural process that involves the conversion of complex macromolecules (e.g., polysaccharides and polypeptides) into a new product via a chemical reaction and the action of microorganisms (Lee et al., 2015). Fermentation of cassava reduce cyanide content of the cassava (Aisien et al., 2009). There are some aids that hasten the fermentation, thereby increasing the speed of the reaction (Ogbete et al., 2022 and Oghobase et al., 2020). Some local processors who depend on the sale of fufu for their daily income and home use have resorted to certain aids to accelerate and optimize fermentation in order to increase profit. To speed up the fermentation process, they add detergents, kerosene, and potash (palm ash) from palm fruit trees to the mixture (Ogbete et al., 2022). Usually, natural fermentation without an aid takes about 5 days. (Ray & Sivakumar, 2009). However, the presence of fermentation aids hastens the process to 3 days or less with high yield of fufu paste (Ogbete et al., 2022). Human health effects associated with detergent use have been reported to include dyspnea, vomiting, diarrhea, nausea, and distension of the abdomen. Therefore, it is essential to assess the possible effects of adding detergent and other aids to the cassava tubers during fermentation (Oghobase et al., 2020). The research evaluates the quality of Fufu from Cassava (Manihot esculenta) using different Fermentation Aids.

2. Experimental *:*

2.1 Fermentation of Cassava

Different aids were employed for the fermentation of Cassava Fufu under different conditions. Natural fermentation process of cassava using Normal water (clean water) was employed under the different conditions and tag as *Control Sample*.

2.1.1 Anti-bacterial (So Klin) and normal detergent as fermentation aids

The fermentation was done as described by Panghal et al., (2019) with modifications. The cassava tubers were peeled, rinsed with clean water to remove dirt, detergent (So Klin and Normal detergent) was then dissolved in water and introduced in the samples and allowed for a few minutes, the detergent decanted, clean water was added and kept under room temperature for fermentation. The same procedure was repeated and kept under sunlight. After the fermentation was complete, the samples were washed, sieved, and stored in sacks for the water to drain out.

2.2.2 Bitter leaves (Vernonia amygdalina) as fermentation aid

The fermentation was done as described by Panghal et al., (2019) with modifications. The peeled cassava tubers were washed and immersed in water, bitter leaves (Vernonia amygdalina) were carefully washed with distilled water and introduced in the samples and allowed at room temperature for fermentation. The same procedure was repeated and kept under sunlight. After the fermentation was complete, the samples were washed, sieved, and stored in sacks for the water to drain out.

2.2 Bulk Density Determination

The bulk density was determined as described by Engmann & Sanful, (2019). A 250 mL capacity measuring cylinder was weighed. Then the pre-weighed cylinder with finely ground fufu paste filled up to 100 mL mark. Next, the cylinder was weighed, and the equivalent gram taken.

2.3 Swelling Capacity

The swelling capacity was determined by slight modification of Bamidele et al., (2015) method. An amount 0.5 g of each sample was dispersed in 10 mL distilled water. The slurry was heated at a temperature of 70 °C for 30 min in a water bath, cooled to room temperature, and centrifuged at 2000 rpm for 10 min. The supernatant liquid was decanted, and the centrifuge tube was dried for 17 min at 100 °C inside a hot air oven. The residue was weighed (W_2). The centrifuge tube containing the sample alone (W_1) was weighed prior to adding distilled water.
Swelling capacity determination = W_2-W_1

2.4 Water Absorption Capacity and Anti-nutrient Factor

This was determined using the method described by Awolu et al., (2020).

3.Results and Discussion :

3.1Results

Table 1: Observed Changes in the Samples during Fermentation

	Sample (NW)	Sample (BL)	Sample (ND)	Sample (AD)
Day 1				
Evening	No visible change	No visible change	No visible change	No visible change
Day 2				
Morning	Slight colour change, slight unpleasant smell and formation of few bubbles	Colour changes to light milky green, slight unpleasant smell and formation of few bubbles	Colour change and a slight unpleasant smell, formation of few bubbles	Colour change to light yellow with slight unpleasant smell and formation of few bubbles
Evening	Strong unpleasant smell and formation of more bubbles	Colour intensity increases, and formation of more bubbles	colour change to bright yellow and formation of more bubbles	Pungent smell and formation of more bubbles
Day 3				
Morning	Strong unpleasant smell, formation of more bubbles, few cassava tubers floating, colour change to milky-white	Colour changes to slight milky green, light smell, colour intensity increases	Colour changes to light yellow, slight unpleasant smell, presence of foam	Colour change to light yellow, pungent smell
Evening	Strong unpleasant smell	Foam present on the surface and leaves	colour change to bright yellow	Foam present on the surface

Note: NW (Normal water), BL (Bitter leave), ND (Normal detergent), AD (Antibacterial detergent)

Table 2: Weight of the samples before and after fermentation

Sample Name	Sample code	Weight before (g)	Weight after (g)	%
Normal-water + room tempt	NWRT	92.20	26.90	70.82
Normal-water + sunlight	NWSL	92.45	29.25	68.36
Bitter leave aid + room tempt	BLRT	91.65	24.40	73.78
Bitter leave aid + sunlight	BLSL	93.90	27.30	70.93
Detergent aid + room tempt	NDRT	92.80	18.15	80.44
Detergent aid + sunlight	NDSL	94.00	23.90	74.57
Anti-bacteria detergent aid + room tempt.	ADRT	91.80	40.40	55.99
Anti-bacteria detergent aid + sunlight	ADSL	91.75	43.40	52.70

Note: NWRT (Normal Water), BL (Bitter Leave), ND (Normal Detergent), AD (Antibacterial Detergent)
RT (Room Temperature), SL (Sun Light)

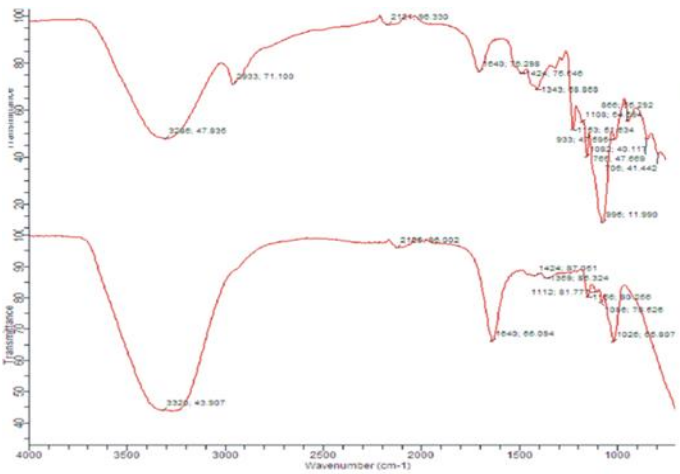
Table 3: Results for functionality test of the samples

Sample Code	NWRT	NWSL	BLRT	BLSL	NDRT	NDSL	ADRT	ADSL
Swelling capacity (g)	6.767	3.219	6.883	3.256	6.530	3.946	3.403	3.532
Water absorption capacity (g)	2.279	2.054	2.301	2.290	2.306	2.288	1.740	1.726
Bulk density determination (g)	0.059	0.065	0.065	0.059	0.064	0.060	0.061	0.067

Table 4:Anti-nutrients Factor for the samples

Sample code	Phytate	Tannins	Glycosides	Oxalate	Cyanides
NWRT	ND	0.002	0.038	ND	0.005
NWSL	0.008	0.002	0.043	ND	0.002
BLRT	0.008	0.033	0.005	ND	0.004
BLSL	0.008	0.001	0.006	ND	ND
NDRT	0.008	0.016	0.006	ND	0.004
NDSL	0.008	0.025	0.004	ND	0.003
ADRT	ND	0.053	0.065	ND	0.003
ADSL	ND	0.001	0.078	ND	0.002
CNDRT	ND	ND	0.005	ND	0.002
CNDSL	ND	ND	0.042	ND	ND
CADRT	ND	0.001	0.065	ND	ND
CADSL	ND	ND	0.032	ND	0.002

Note: CNDRT (Cooked Normal detergent room tempt.), CNDSL (Cooked Normal detergent sunlight), CADRT (Cooked Antibacterial detergent root tempt.), CADSL (Cooked Antibacterial detergent sunlight)



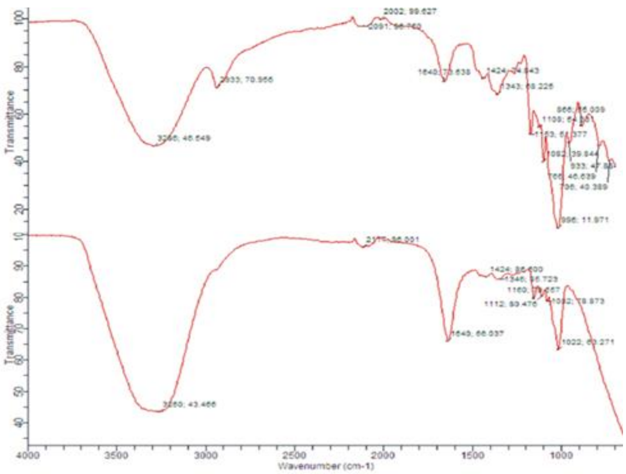
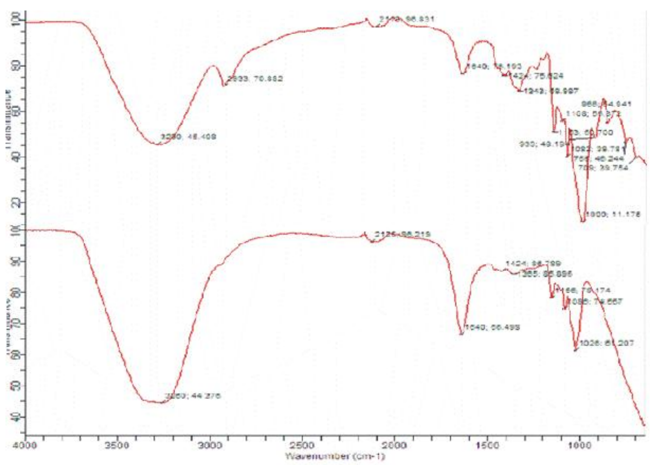


Figure 1: FTIR Spectrum for NDRT & CNDRT

Figure 2: FTIR Spectrum for NDSL & CNDSL



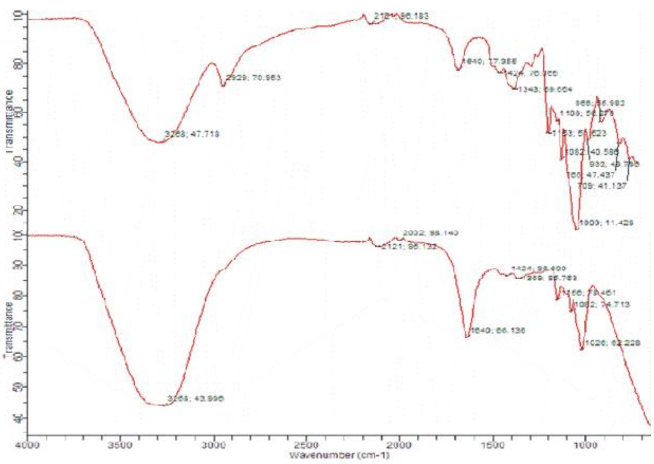


Figure 3: FTIR Spectrum for ADRT & CADRT

Figure 4: FTIR Spectrum for ADSL & CADSL

3.2 Discussion

Observed Changes in the Samples during Fermentation are represented in table 1. This changes were carefully noted to help the researcher know when best to stop the fermentation and allow for preparation and proper storage of the fufu past for analysis.

From the results in Table 2, all the samples (NWRT, BLRT, NDRT and ADRT) fermented under room temperature produced more yield compared to the samples (NWSL, BLSL, NDSL and ADSL) fermented under sunlight with the highest yield been NDRT (80.44 %) and the least been ADSL (52.70 %). Consequently, this implies that fermentation of cassava was more favourable in ambient temperature than in sunlight (Hawashi et al., 2020) as opposed to contrary belief by market women and farmers.

The result of functional properties of the fufu paste is shown in **Error! Reference source not found.**. The water absorption capacity of the fufu ranged between 1.726 g - 2.279 g for all the samples (NWRT – ADSL). It shows that the samples fermented with the aid of Anti-bacterial detergent under room temperature (ADRT – 1.740 g) and under sunlight (ADSL – 1.726 g) had lower water absorption capacity than the rest of the samples with the highest value been 2.306 g of NDRT. This low water absorption observed at sample ADRT and ADSL may be as a result of low water retention or less water absorption due to the presence of anti-bacterial ingredients. The swelling capacity of sample BLRT (fermentation with bitter leave under room temperature) had the highest value of 6.883 g. This was closely followed by sample NWRT (fermentation with normal water under room temperature) with 6.767 g. This result supports the findings of (Bamidele et al., 2014). The bulk density of the samples ranged from 0.0590 kgm^3 - 0.0675 kgm^3. The bulk density determination depends on the heaviness of the solid samples which determines the packaging requirements for materials handling and application in the food industry (Ezeocha et al., 2011).

Table **4** shows the result of the anti-nutrient tests. The anti-nutrients, also known as nutritional stress factors inhibit nutrient absorption (Ogbete et al., 2022). Therefore, the higher the anti-nutrients, the more toxic the food will be. It was observed that the oxalate values were all zero (0.00) which means that there was no trace of it in the sample. The tannins, phytate, cyanide and cardiac glycoside levels were within the ranges of 0.00 - 0.43. These values indicate that the anti-nutrients in both the cooked and uncooked samples are relatively low and may not inhibit the nutrients present in the cassava.

In **Error! Reference source not found.** - 4 the peaks contained single band area (600 - 3350 cm^{-1}). There are deep bands observed at ranges between 3260 - 3286 and 2929 - 2993 cm^{-1} in the single bond region indicating the presence of a normal polymeric peak OH stretch group and methyl C-H asymmetrical/symmetrical stretch respectively. Also, narrow peaks were seen at regions ranging between 2002 - 2125 cm^{-1} indicating the presence of cyanide ion, thiocyanate ion and related ions. There is a transmittance at 1640 cm^{-1} indicating organic nitrates which is present in raw cassava. The peaks at 1424 cm^{-1} indicates the presence of carbonate ions and those at 1343 cm^{-1}, 1168, 1153, 1112, 1108, 1122, 1112, 1086, 1056 and 1026 cm^{-1} represents sulfonates, aryl sulfones, sulfate ions and phosphate ions implying the presence of the detergent residue in the samples. It is worthy to note that, all the transmittance representing the presence of cyanide ions disappeared (see second spectrum in all figures) after the samples were subjected to heat (cooked) whereas, those indicating the presence of detergent residue in the samples remained even after the application of heat (cooked) as observed in figure 1 – 4 for all spectrums.

4.Conclusion :

Cassava, a root tuber is a famous and important staple food in Africa. It is widely consumed after undergoing different processes. In Nigeria, it is processed into a local meal popularly known as Akpu or Fufu, among other foods. Fermentation is the major way of converting the cassava root into this popular and sort-after fufu paste. Hence, the locals and farmers have devised different ways of hastening or shortening the fermentation period by using various aids like kerosene, ash, detergent and various leaves suspected to lessen the fermentation time in order to maximized profit. This study probes into these assertions to reveal whether or not these unconventional fermentation methods pose health hazards.

From the research, it was found that, there was residue of detergent left in the fufu paste even after it was subjected to heat (cooked fufu). The continuous use of sulphonates and phosphates containing substances like detergents in the processing of this staple food, may result to both acute and chronic health hazards. Therefore, the local processors of fufu paste should adapt the methods devoid of toxic substance for fermenting cassava tubers to avoid endangering the lives of people that consume them.

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