

ASSESSMENT OF *FUFU* PRODUCTION TECHNOLOGIES IN OGUN STATE, NIGERIA

O. K. Owolarafe¹, B. O. Adetifa^{2*}, A. C. Oyekanmi², T. G. Lemikan² and T. M. Samuel²

¹ Department of Agricultural and Environmental Engineering, Faculty of Technology, Obafemi Awolowo University, Ile-Ife, P.M.B 13, Osun State, Nigeria.

² Department of Agricultural Engineering, Faculty of Engineering, College of Engineering and Environmental Studies, Olabisi Onabanjo University, 112104, Ibogun, Ifo, Ogun State, Nigeria)

*Corresponding Author's Email address: olusola.adetifa@oouagoiwoye.edu.ng

Abstract

The quality of *fufu* has been known to vary from one location to another. The processing technique may be responsible for this variation in quality. A study was carried out to investigate the different processing technologies adopted for production of *fufu* from cassava at different processing centres in Abeokuta and Ilaro, Ogun State. Hundred *fufu* processing centres were randomly selected, while data was collected using structured questionnaire, sensory analysis and physical observation. Information about the ownership, operator, enterprise, source of water supply, unit operations alongside their equipment and the waste disposal methods were gathered. Results showed that most *fufu* processing centres were owned by individuals. Most of the unit operations were carried out manually usually by women with low education level. Plastic drums and concrete pots were commonly used for soaking cassava for 3-5 days. Cassava mash is sun-dried for an average of 2.79 ± 1.1 days and packaged into nylon or jute bags. Cassava peel and chaff are often reused while the wastewater is either drained into pits or left unattended to. Delay in processing cassava tubers, increase in the length of soaking, ineffective dewatering method, unhygienic source of water for *fufu* processing, etc. were some of the factors observed to affect the physical quality of *fufu*. Statistical analysis shows that the categories in most of those unit operations do not have equal probabilities of occurrence in the population. It is therefore imperative to develop appropriate technologies affordable by the small scale processors for the people in the area.

Keywords: Cassava mash, decanting, soaking, dewatering, cassava waste disposal

1. Introduction

Cassava is an important food crop produced in Nigeria in large quantity. The country is the leading producer of cassava in the World with an annual production of about 45 million tonnes (Asante-Pok, 2013). Owing to the large production, the crop is processed into many food items such as *fufu*, *gari*, *lafun* etc. *Fufu* (also called *utara akpu*) is the meal of soaked fermented cassava roots which is widely consumed in Nigeria (Iwuoha and Eke, 1996). It is one of the major food forms of cassava fermentation, which is reconstituted by stirring in boiling water to form dough and eaten with flavoured sauces. In some areas, low cyanide cassava roots can be boiled or steamed and pounded into *fufu* (Hahn, 1988). *Fufu* contains 6.50, 1.68, 1.32, 1.84, 1.42 and 87.24% moisture, protein, fat, ash, crude fibre and carbohydrate, respectively (Bamidele *et al.*, 2015).

The unit operations involved in the production of *fufu* using the traditional method are as follows: The Cassava tubers are peeled, washed, cut into thick chunks and steeped in water in earthenware pots or in a slow-flowing stream for 4-5 days to ferment, soften and produce a characteristic of retted cassava meal. The tubers are disintegrated in clean water, sieved and allowed to settle for decantation of water; the sediment is the *fufu* (raw) (Iwuoha and Eke, 1996; Uzogara *et al.*, 1990).

Umeh and Odibo (2014) identified two modified methods used in *fufu* production. These include peeling the cassava tubers, cutting them into smaller cubes of about 2-4 cm before soaking, or grating the tubers into a mash, bagging the mash and pressing out some liquid before soaking the bag in water. Similarly, Omodamiro *et al.* (2012) carried out the production of *fufu* from yellow cassava roots using the odourless flour technique.

One potential problem in processed *fufu* is the flavour of the product, which may be undesirable to many people. Another major problem with *fufu* production is that the quality of the product varies from one processor to the other and from one processing batch to the other by same processor. Factors that could be responsible for the variability of quality of *fufu* include; the size to which the roots are cut prior to soaking (Okafor *et al.*, 1984), variety differences in dry matter content and the quality of roots or water used for soaking.

The fermentation process of *fufu* production is initiated as a result of chance inoculation by microorganisms from the environment. Although convenient, there are concerns about the reliability of this process, the control of which is the basis of all technological measures that are used to obtain product at a defined quality. The presence of unspecified microorganisms complicates the control of the fermentation process and leads to the production of objectionable odours. Such problems have led to the development of several other processing techniques suitable for odourless *fufu* (Okpokiri *et al.*, 1984; Ezeronye, 2003). Okolie *et al.* (1992) proposed a modification of the microbiological process in order to upgrade the cassava product but in practice is yet to receive great attention.

According to Oyewole and Sanni (1995), cassava processors confirmed that shorter fermentation periods (2-3 days) are required during the dry (hot) season while longer fermentation periods (3-5 days) are required during the rainy (cold) season for proper retting of cassava for *fufu* production. Some processors expose fermenting roots to direct sunlight as a means of enhancing the fermentation process.

Achi and Akomas (2006) carried out a comparative assessment of fermentation techniques in processing of *Fufu*. Two major techniques were identified. In one process, *fufu* was produced by steeping cassava tubers for 48 hours followed by grating and fermenting for another 48 hours while the other technique involved grating cassava tubers and dewatering/fermentation for 24 hours before re-steeping for another 48 hours (Achi and Akomas, 2006). they further observed that though there was no difference in colour or texture due to the processing method, the fermentation of grated cassava produced a more acceptable product.

Previous research has shown that there are differences in processing methods utilized and level of quality of *fufu* produced in Ogun State, but this is insufficient. Some specifics of the unit operations are not available in literature. Some of this specifics include; duration of operation, equipment used for operation, tasks carried out before and after an operation, etc. The variation in these specifics is capable of leading to variation in the quality of *fufu* from one location to another. This work is therefore aimed at investigating and assessing the different processing technologies adopted for production of *fufu* from cassava at different processing centres in Abeokuta and Ilaro, Ogun State.

2. Materials and Methods

2.1 Study area, sampling technique and sample size

Ogun State was selected as the study area because of the predominant *fufu* processing activities going on within the state. The state captures a variety of situations in terms of access to urban and rural markets, importance of cassava processing activities, prominence of *fufu* processing as a source of livelihood, and type of *fufu* produced. Ogun State has been divided into four Agricultural Zones, i.e. Ilaro, Ijebu-Ode, Ikenne and Abeokuta by Ogun State Agricultural Development Programme (OGADEP) (Adewuyi *et al.*, 2009). For this study, two of the agricultural zones were selected i.e. Ilaro and Abeokuta because they are predominantly *fufu* production area (Oyewole and Sanni, 1995; Adebayo *et al.*, 2003).

Fufu processing communities were selected using systematic sampling method from the agricultural zones. Twelve *fufu* processing communities were selected in Ilaro zone (i.e. Oja-Adan, Ado-Odo, Oke-Odan, Ipokia, Ihumbo, Igbesa, Idolehin, Sawonje, Aton, Agbara, Ibese and Isaga), while thirteen *fufu* processing communities were selected in Abeokuta zone (i.e. Odeda, Ifo, Ibogun Osungboye, Ibogun Akinside, Ibogun Egbeda, Ibogun Fashina, Imala, Arigbajo, Osiele, Itori, Olugbo, Wasimi and Ajegunle). Within each of the processing communities, four *fufu* processing centres were randomly selected; hence, 100 *fufu* processing centres were investigated. The major difference in the sample populations is the perceived difference in *fufu* production technologies and the quality.

2.2 Data collection and analysis

The methods used to collect data from each specified location include interview, using structured questionnaire, sensory analysis and physical observation.

The questionnaire used was divided into two major parts as follows i.e. *fufu* processing method and operator's perception of *fufu* industry. The section on processing method focused on collecting comprehensive information on the processing centre. The information gathered include, the ownership status of the centre, number of employee, educational level of operator, age of the enterprise, predominant sex, and source of water supply. The amount of raw materials used was also elicited.

The unit operations involved were investigated to determine the method and equipment in use. The unit operations investigated include; peeling, washing, soaking, water replacement, decanting of effluence/wastewater, pulverization/pulping/mashing, dewatering the mash, drying dewatered mash, cooking, packaging and sales. Aside the unit operations, other issues investigated include; waste generated and uses, estimate of *fufu* processing waste/by product and general cleanliness of processing centre. The section on operator's perception of *fufu* industry was used in gathering information on the problems confronting *fufu* processing centres and suggested solution. Physical observation was used to note the general outlook of the processing sites and activities of the processors

A preliminary sensory analysis was carried out which involved the collection and evaluation of samples of *fufu* sold at the markets around six different *fufu* processing centres. The samples were accessed in terms of colour, odour, texture and taste.

The data obtained was statistically analysed using both descriptive and inferential statistics appropriately. The data collected from the questionnaire were presented and analysed using graphs and other descriptive statistical tools to enhance proper interpretation. One sample Chi-Square test, Binomial test and Kolmogorov-Smirnov test were used to test the null hypothesis of equal probabilities. It was also used to make generalisation from a sample to a population. These were done using SPSS 20 software by IBM and Microsoft Excel, 2010.

3. Results and Discussion

3.1 *Fufu* processing enterprise

This study investigated the ownership of *fufu* processing enterprises across the selected Agricultural Zones. It was observed that 83% of these enterprises were owned by individuals. Also, 43% of the individual processing centres have being existing for more than 5 years, 16% for 5 years; while, 12% have existed for less than 5 years (figure 1). Figure 1 also shows that 40% of the enterprises were owned by group of processors; 20%, 15% and 4% of these enterprises have existed for more than 5 years, approximately 5 years and less than 5 years, respectively. It was also estimated that 36.4% of the enterprise owned by Government have existed for more than 5 years, 27.3% for 5 years and 36.4% for less than 5 years. Statistical analysis using one sample chi-

square test revealed a significant difference in the proportions of individual, government and group ownership. This shows clearly that cassava processing into *fufu* is dominated by individuals. This result corroborates with that of Okorji *et al.* (2003) who observed that cassava processing centres in the rural communities of Ahiazu, Ikeduru, Mbaitoli, Owerri and Ohaji Egbema in Imo State, Nigeria were completely owned by individuals; but on the other hand, Adebayo (2009) ascribed the ownership of cassava processing centres to households.

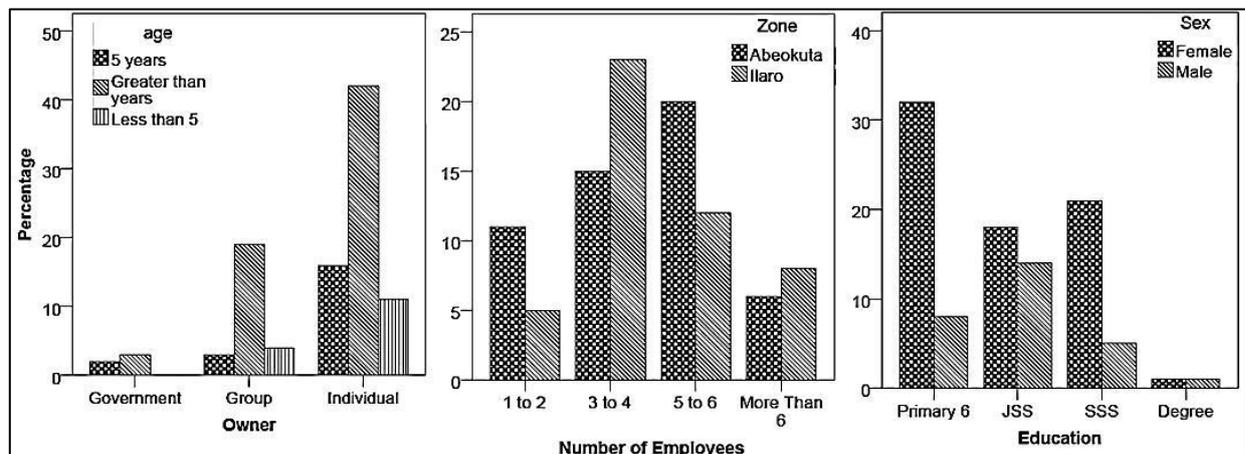


Figure 1: *Fufu* production Enterprise and Employees

3.2 *Fufu* Production Employees

In the data obtained, it was observed that higher percentage of processing centres employs 3-6 employees this result is presented in figure 1. This is similar to the report of Adebayo (2009) that the households involved in cassava processing in south-west Nigeria has about 3-6 persons. In Ilaro zone, most *fufu* processors employ 3-4 workers, while 5-6 workers are mostly found in Abeokuta zone. All these categories are significantly different in terms of the probability of occurrence (from one sample chi-square test).

It was also discovered that primary 6 was the highest educational level of *fufu* processors – 35% of females and 5% of males (Figure 1). This implies that female with low educational level dominate *fufu* processing centres. This low literacy level hinders the adoption of new *fufu* processing techniques, as an upshot, the development of the centres and the improvement in processing method suffers a great set back. This study confirms the dominance of women in *fufu* processing or any other cassava production process (Hahn, 1988; Adebayo, 2009; Ferrar, 1992; Igbeka, 1995, Davies *et al.*, 2008; Samuel *et al.*, 2010; Nsoanya and Nenna, 2011; Adetifa and Samuel, 2012).

3.3 Source of power supply

The field study showed that 77% of the processing centres do not have any power source, while, 10% use the national grid supply, and 13% used generators for processing cassava into *fufu*. Based on the result of the one sample chi-square test, these three categories of power source do not have equal probabilities of occurrence. It can therefore be concluded that, most *fufu* processing centres do not have access to electricity, which means that, *fufu* processing in those areas are not mechanised. This could lead to drudgery which will affect the profit obtained from the product. This result shows that most of the operations carried out at the *fufu* processing centres are manual. This confirms that manual energy use is higher than electrical energy use in most cassava processing centres (Jekayinfa and Olajide, 2007).

3.4 Procurement of raw materials

This research work revealed that 75% of the cassava tubers used in processing *fufu* was bought from the market, while 25% were self-cultivated. Hence, a good number of the processing centres buy their cassava from the market, some of these centres buy cassava directly from the farm, and later convey to the processing centres by a motor cyclist. Ani *et al.* (2013) also observed that most of the cassava tubers used in cassava processing is purchased off farm in Enugu state, Nigeria.

3.5 Operator's perception of *fufu* production technologies

Women processors described *fufu* processing as a flexible activity that can be taken up easily with little investment; but, a good number of processors interviewed complained of the difficulties and cost of procuring large amount of fresh cassava tubers; lack of mechanised *fufu* processing technologies; and the inability to store *fufu* for reasonable period of time due to product perishability. In some processing centres at Ilaro, some women were seen mashing soaked cassava tubers with their bare foot. They complained of how ineffective and time consuming it is to make use of hands to mash soaked cassava especially when handling large volume of soaked cassava. According to Ferrar (1992), the effect of exposure to cyanide (which may still be present in the soaked cassava tubers) include spastic paralysis and goitre which is suffered by the women who process the cassava.

Furthermore, lack of good source of water affect the quality of *fufu* produced in Ado- Odo, Itori and Igbesa. The streams or rivers which are the source of water for *fufu* processing also have cassava waste water channelled into it. In a way, the water gets polluted and becomes unhygienic for consumption. This goes a long way in affecting the taste, colour and odour of ready-to-eat *fufu*. Finally, the need for provision of mechanical devices to reduce drudgery involved in *fufu* processing was emphasized in all the processing centres visited as identified by Dipeolu *et al.* (2001).

3.6 Unit Operations

It was observed that the processing operations varied across the two Agricultural zones and within different locations in each zone. These variations affected the methods and materials used. Figure 2 shows the prevalence level of different methods adopted in each unit operation.

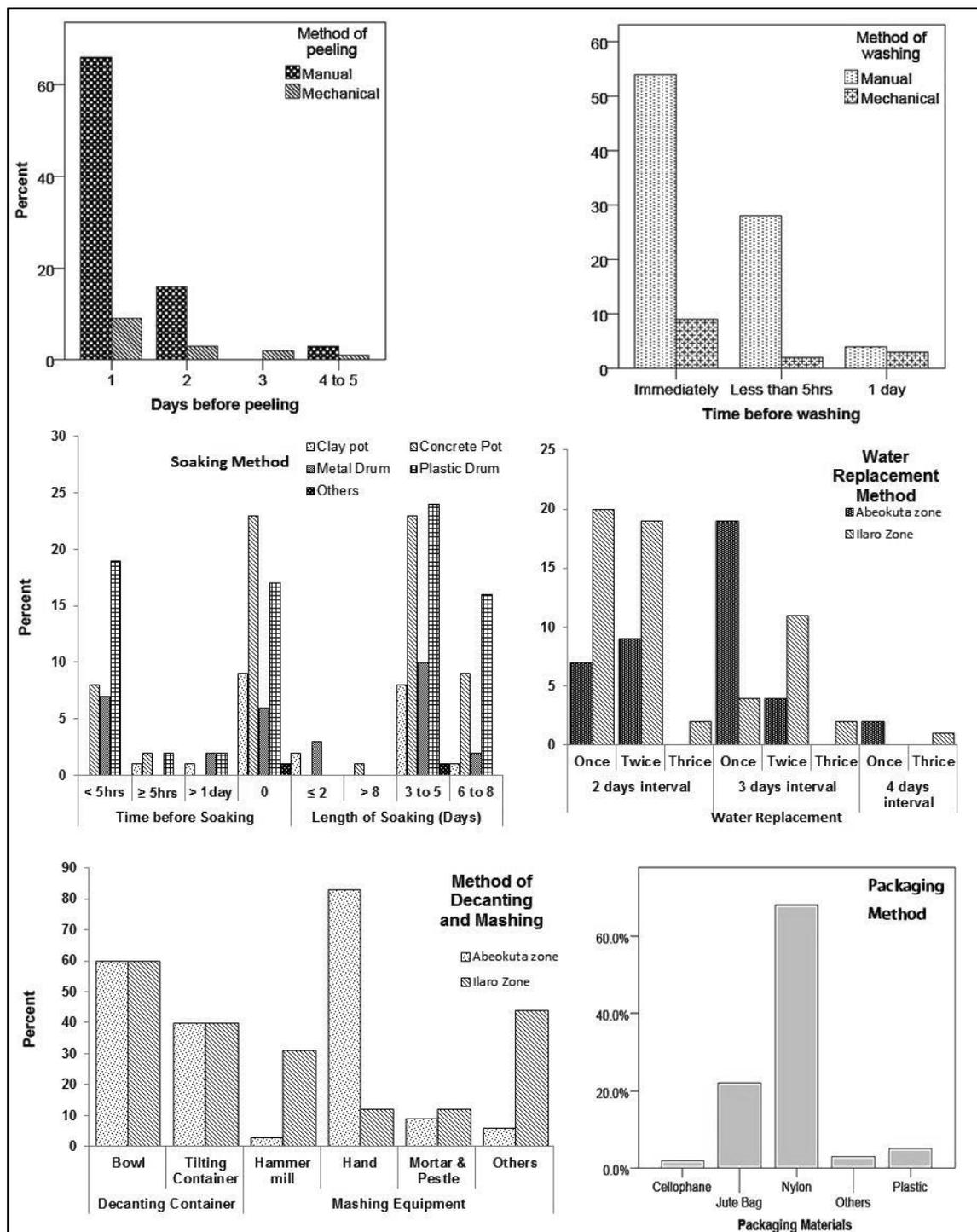


Figure 2: Unit operations for fufu production

1. Peeling and washing: Figure 2 shows that 65% of the cassava processors commence manual peeling of the cassava a day after harvesting, 18% after 2 days, and 2% after 4-5 days. On the other hand, 9% of the cassava processors commence mechanical peeling method a day after harvesting, 3% after 2 days, 1.5% after 3 days and 1% after 4-5 days. This implies that majority of the cassava processors adopt manual means of peeling cassava. Also Figure 2, 2% of the cassava processors wash their cassava mechanically a day after peeling, 1% wash in less than 5 hr after peeling, while 9% wash immediately using the mechanical method. Conversely, 3% of the cassava processors wash their cassava manually a day after peeling, 27% wash their cassava less than 5 hours, while 53% wash immediately.

Generally, the method of peeling and washing were significantly different in terms of the probability of occurrence (from one sample binomial test). This therefore confirms the fact that most of the cassava processors prefer using manual means of washing their cassava. The use of large vessels or moving water can be used in washing peeled cassava (Howeler, 1990).

Table 1 shows that borehole, river and wells are the major sources of water used. This water sources are mostly available within the processing centres and at least 100 m from the processing centres.

Table 1: Source of water and distance from the main source

Source of water	Distance		
	< 100 m	≥ 100 m	Within Processing Centre
Borehole	12%	1%	21%
River	11%	5%	17%
Well	6%	4%	23%

2. Soaking: It was confirmed from this research that different processors adopt various method to facilitate cassava soaking, although higher percentage of processors adopt concrete pot method (Figure 2). Based on the one sample chi-square test carried out, these soaking methods have significantly different probabilities of usage. Figure 2 shows that most of the processors soak the cassava immediately after peeling. Figure 2 also shows soaking for 3-5 days is predominant in the study area which is the best for cyanogen removal (Tivana, 2012). Montagnac *et al.* (2008) reported that soaking cassava for three days before sun drying ensures 97.8-98.7% cyanogen removal although Amsalu and Esubalew (2011) observed that soaking for 1 day is sufficient before sun drying. The percentage of cyanogen removed can be increased by increasing the soaking time; but, soaking for longer periods increase nutrient loss, fungi, mould spores and undesirable bacteria in the final product (Montagnac *et al.*, 2008).

3. Water replacement: Water replacement is one of the major factors that determine the quality of *fufu* produced. Around 51% of the *fufu* processing centres prefer replacement of water during soaking, while 41% of the *fufu* processing centres do not replace water during soaking. The frequency of water replacement (number of times soaking water was replaced) amongst the *fufu* processing centres during the soaking period is presented in figure 2. The prominent method of soaking in Abeokuta is to replace the water once within three days interval. In Ilaro, soaking water is replaced either once or twice within two days interval. Periodical change of soaking water improves the taste, colour and texture of *fufu* (Akingbala *et al.*, 1991).

4. Decanting and mashing: Majority (around 85%) of the cassava processors used manual decanting method, 12% of the cassava processors used mechanical decanting method, while 3% had no response regarding the decanting method used which stipulates that most of the *fufu* processors are locally built or constructed in large volumes for more productivity rate.

Figure 2 shows the equipment used by processors for decanting and mashing process of *fufu* production in each agricultural zone. Generally, 60% of the processors use bowl, while 40% use tilting containers for decanting. Cassava mashing by hand was observed to be the dominant method of mashing in Abeokuta agricultural zone (Figure 2). Mashing with hand was possible due to the softening of the tubers after soaking. Mashing by hand was the only method identified by Oyewole and Isah (2012). The use of mortar and pestle and hammer mill for mashing is prominent in Ilaro agricultural zone, although mashing with the legs was also identified. Statistical analysis using one sample chi-square test shows that there is significant difference between the methods used in decanting and mashing within the study area.

5. Dewatering: Manual dewatering was observed as the dominant method (77.5%) compared to using mechanical equipment (22.5%). Manual dewatering is done majorly by pressing with wood (46%) followed by pressing with stone (34%). Hanging the mash on plank (20%) is not a prominent manual dewatering method in the areas under study. Mechanical dewatering is done majorly with the use of a single screw press and hydraulic press. The result of the one sample chi-square test shows that these methods of dewatering differ significantly within the study area. From the processors using hydraulic press for dewatering, 40% of the cassava processors use 10 tons as the maximum hydraulic jack capacity while 59% use 15 tons. Usually, pressing time depends on the efficiency of the press and the moisture content of the mash (Oti et al., 2010).

6. Drying, Cooling, Re-sieving and Packaging: Sun drying is the popular method of drying *fufu* mash in Ilaro and Abeokuta agricultural zones. This method of drying *fufu* has been reported to have no appreciable difference in terms of yield, proximate composition and acidity compared to using a rotary or cabinet drier, although it falls short in pasting properties (Sanni and Akingbala, 2000). From figure 3, the mean sun drying days is 2.79 ± 1.1 days. It was observed that 13% of the cassava processors sun dry wet *fufu* paste for 1 day, 29% sun dry for 2 days, 27% sun dry their wet *fufu* paste from 3-4 days, while 4% sun dry their wet *fufu* paste for 5 days. Kolmogorov-Smirnov test revealed that there is no significant difference between the sun drying days adopted by *fufu* processors in the study area.

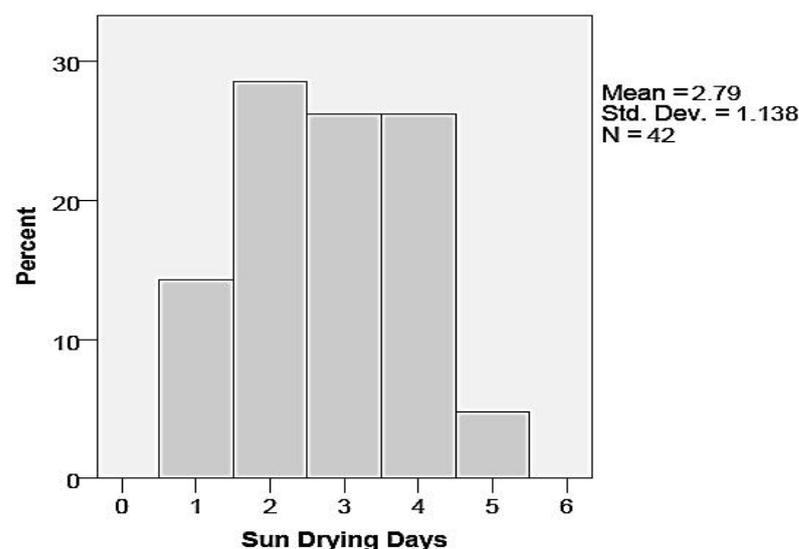


Figure 3: Sun drying days

The quantity of cassava mash dried in each agricultural zone is usually around 4 bags. Statistical analysis reveals that there is a positive but low correlation between the quantity dried and the sun drying days. This correlation was found to be significant at 72%. In addition, analysis using one sample chi-square test revealed that there is no significant difference between the quantities dried by *fufu* processors in the study area.

In Abeokuta zone, 94.2% do not cool after drying the cassava mash before packaging and 63.5% do not re-sieve the cassava mash; while in Ilaro zone, 35% do not cool 70.8% do not re-sieve. This may also be responsible for the difference in the quality of *fufu* within these zones. A study to investigate the effect of cooling and re-sieving operations on the quality of *fufu* is therefore required.

The prevalence of different packaging materials used for wet *fufu* mash is presented in figure 2. It reveals that packaging materials made of nylon and jute are common in the study area for packing

the wet *fufu*. Plastic and cellophane are other materials used. Hahn (1988) reported that wet cassava pulp of about 0.5-1.0 kg is packed in a plastic or polypropylene bag. The packaging materials have significantly different probabilities of occurrence within the study location (using one sample chi-square test).

3.7 Sales of finished product

It was observed that 44.4% of consumers placed advance order for finished products. It was further observed that certain factors affect the sales of finished products. The study revealed that in Abeokuta zone; 5% of cassava processors have insufficient cassava, 7% have insufficient equipment and 10% have low work rate; while in Ilaro zone; 4% have insufficient cassava, 1% have insufficient equipment and 4% have low work. Adebayo *et al.* (2003) identified similar factors like availability and price of cassava and the price of fuel as external contextual factors affecting the profitability of wet paste *fufu*. Dipeolu *et al.* (2001) identified poor access to finance as one of the constraints affecting the marketability of *fufu*.

3.8 Waste Disposal Method

Table 2 shows the various methods adopted in the disposal of waste. Cassava peel, cassava chaff and wastewater were identified as the major types of waste generated during *fufu* processing. It was observed that the major method for disposing cassava peel is by reusing it. It is usually dried and sold to livestock farmers. In Ilaro zone, most of the cassava peels are buried, dumped in dump sites or unattended to. The disposal method for cassava chaff is similar to that of cassava peel. In Abeokuta zone, wastewater is usually drained into pit, while in Ilaro zone; it is usually left unattended to. Based on the result of the one sample chi-square test, these cassava waste disposal methods all have different probability of being used. The potential in cassava wastewater is usually underutilized in the study area. This result is similar to report of Coker and Achi (2015) who observed that in Ibadan, 70-75% of cassava peels, bagasse and waste effluents were discharged indiscriminately into nearby bushes and water bodies. Cassava waste transformation offers the possibility of creating marketable value-added products (Ubalua, 2007).

Table 2: Waste disposal method in each agricultural zone

Zone	Cassava Peel Disposal (%)					Cassava Chaff Disposal (%)					Wastewater Disposal (%)			
	B	R	D _U	U	O	B	R	D _U	U	O	R	D	U	O
Abeokuta	8	73	15	2	2	6	65	12	15	2	2	58	30	10
Ilaro	13	47	28	10	2	17	36	32	13	2	15	30	53	2

Key: B-Bury, R-Reuse, D_U-Dumped, D-Drain into pit, U-Unattended, O-Others

3.9 Preliminary Sensory Analysis

Fufu is considered by consumer to be of good quality when it has a smooth texture, characteristic aroma, and is creamy white, grey or yellow in colour. The quality of *fufu* was observed to depend on the technologies adopted, method of processing and material used for processing. *Fufu* produced in wet form with moisture content of 40%-50% had a repulsive smell. This smell was caused by; delay in processing cassava tubers, increase in the soaking time, ineffective dewatering method and source of water.

The colour variation in *fufu* production was due to inappropriate dewatering method, low water replacement frequency, delay in processing and soaking and the water used for soaking. A well processed *fufu* should also have a smooth and fine texture, but the use of over matured tubers resulted to a rough texture.

Some of the factors observed to affect the taste of *fufu* are; unsuitable dewatering and mashing method increase in soaking time, delay in cassava tuber processing and the improper management

of cassava peel, chaff and waste water. According to Uyo *et al.* (2009), the taste, colour and texture of cooked *fufu* are not affected by the fermentation technique. Oyewole and Ogundele (2001) reported similar results.

4. Conclusion

This paper presented the assessment of various *fufu* processing techniques across two selected agricultural zones in Ogun State (Ilaro and Abeokuta). It has also been able to identify the quality variation of *fufu* due to the various processing techniques adopted. It revealed that higher percentages of *fufu* processing centres were owned by individuals, who adopt majorly manual method in *fufu* processing, thereby increasing drudgery and yielding low income. The cassava tubers used for *fufu* were mostly purchased off-farm; peeled and washed manually a day after harvest; soaked for either 3-5 days; and mashed manually either by hand or with the use of mortar and pestle. Inadequate financing and insufficient education were observed as some of the factors affecting the development of *fufu* processing centres and the adoption of new technologies. It is therefore important that all concerned agencies and parastatals create policies to make funds easily accessible to rural farmers, educate farmers on the new technologies available, subsidise the purchase of processing equipment and provide technical assistance.

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