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Research Article

Quality of Cassava Fufu Sold in Abakaliki Metropolis

M.O. Odo, P.A. Okorie, F. Azi and F. Ngah
Department of Food Science and Technology, Ebonyi State University, Abakaliki, Nigeria

Abstract: Cassava *fufu* as sold and consumed in Abakaliki metropolis was evaluated for its shelf stability and microbial quality. Ten different samples of cooked cassava *fufu* were purchased from 5different sellers in Abakaliki metropolis, Ebonyi State. This was divided into wrapped and unwrapped (five wrapped in low density polyethylene bags and five unwrapped) cassava *fufu* and stored at ambient temperature in the Food Microbiology Laboratory of the Department of Food Science and Technology. These samples were assayed for both chemical and microbial qualities. The chemical analyses included Moisture, pH and TTA. The result revealed that moisture content of the samples ranged from 52.5-54.9%. The values of the pH ranged from 3.70-6.40, while the values of Total Titrable Acidity (TTA) ranged from 0.004-0.063%. The result of the microbial analysis showed that there were increase in the fungal (1.0×10^4 (cfu/g)) and bacterial (2.91×10^6(cfu/g)) counts as the storage time increased with the control having microbial load within the acceptable levels. The fungal isolates from the samples include *Aspergillus niger, Aspergillus flavus and Penicillium spp,* while the bacteria isolates from the samples include *Bacillus spp and Staphylococcus aureus.* Statistically, there were significant difference ($p<0.05$) in appearance of the *fufu* as storage time increased. This study therefore will encourage good manufacturing practices among the producers and marketers to reduce proliferation of pathogenic microorganisms in processed cassava fufu.

Keywords: Cassava fufu, microorganisms, pH, quality, total titrable acidity

INTRODUCTION

Cassava (*Manihot esculenta Crantz*) is among the major root crops in the world and is cultivated in all tropical and subtropical regions particularly in Africa, Asia and South America where it provides over 50% of the average daily calorific intake (De Bruijn and Fresco, 1989). Cassava root is more perishable than other tuber crops such as yam and sweet potato because it has no dormancy and it senesces soon after harvesting (about 2-5 days), followed by microbial deterioration 3-5 days later (Poulter, 1995; Nweke, 1994). Cassava tuber varies widely in their cyanogenic contents with most varieties containing about 15 to 400 mg of HCN per Kg of fresh weight (Padmaja, 1995).

Cassava fufu is a fermented wet paste made from cassava. It is ranked next to gari as an indigenous food of most Nigerians. Cassava fufu has a very strong odour and is an important staple food widely eaten in Nigeria, many parts of West Africa and the Tropics (Sanni, 1989). Cassava *fufu* has gained popularity and acceptance to the point that it is being sold in the market and hawked in the streets of most cities and metropolis of South East, South-South and South-West Nigeria. The cooked ready-to-eat cassava *fufu* is wrapped in low density polyethylene bags that are transparent and packed in plastic buckets, while some quantities are displayed on plastic/stainless trays for prospective buyers. Cassava *fufu* as sold in the market is a ready-to-eat food that does not require further heat treatment before consumption. Moreover, it is convenient as no further processing is needed. The *fufu* as it were, is usually exposed to sunlight and the shelf-life depends on the vagaries of weather. As microorganisms are known to thrive under different temperatures, the *fufu* is prone to weather changes giving rise to the development of some microorganisms in the *fufu*. Besides, the *fufu* usually lasts for 4 to 7 days before the sales could be finished. Thus, the *fufu* is exposed to post processing contaminations just like every other food largely due to poor handling and marketing/channel of distribution. Hence, this study is undertaken with a view to evaluating the post processing qualities of cassava *fufu* as sold and marketed in the study area. The aim of this study among other things is to determine the quality of cassava *fufu* as sold and consumed in Abakaliki Metropolis.

Corresponding Author: M.O. Odo, Department of Food Science and Technology, Ebonyi State University, Abakaliki, Nigeria

MATERIALS AND METHODS

Collection of samples: Cassava "*fufu*" was purchased from five different sellers in meat-market, Abakaliki metropolis. Two samples each were purchased from those sellers, making a total of 10 samples. The *fufu* was collected in a low density polyethylene bag and transferred into different plastic containers.

Sample preparation: The samples were divided into two; five wrapped in low density polyethylene bags and the other five unwrapped and then placed in different plastic containers with covers. The samples were labeled appropriately for easy identification and kept under room temperature. Samples were drawn in alternate days for microbial analysis and every day for chemical analysis.

Analysis of samples: The samples obtained were assayed for Chemical analyses (Moisture, pH and Total titratable acidity), Microbial analyses (Characterization and Identification of Isolates) and Sensory evaluation.

Chemical analysis: The chemical analysis which included moisture content, pH and Total Titrable Acidity (TTA) were analysed according to Association of Official Analytical Chemists (A.O.A.C.) (1990) methods of analysis.

Microbial analysis: One gram each of the *fufu* was separately homogenized in 9ml of distilled water. Tenfold serial dilution of each sample was performed until 10^{-4} level of dilution was obtained. 1ml of the lowest dilution (10^{-1}) and other dilutions were pour plated on plates of nutrient agar and Sabouraud dextrose agar for the determination of microbial counts in each sample of the respective agar media, followed by incubation at laboratory (ambient) temperatures for 48 and 72 h for bacterial and fungal growths respectively. Total viable counts of bacterial and fungal were determined by enumerating the colony forming units (cfu/g) at the end of the incubation period using the following formula as described by (Jideani and Jideani, 2006):

$$c = n/vd$$

where,
c : Colony forming unit per gram (cfu/g)
n : Number of colonies
d : Dilution blank factor
v : Volume transferred to plate

The microorganisms isolated were sub-cultured by repeated streaking into sterile nutrient agar, macConkey agar slants for bacterial and Sabouraud dextrose agar slants for fungal until pure cultures were obtained.

Characterization and identification of isolates: The isolation and identification were done using the method of Ogbulie *et al*. (2005) and International Commission on Microbiological Specification for Food (I.C.M.S.F.) (1978). Bacterial isolates were characterized and identified by initially examining colonies' morphology on their cultural properties followed by biochemical tests (Motility, citrate, coagulase, gram stain, catalase and oxidase). The fungal isolates on the other hand, were characterized by their cultural properties stained with cotton-blue lacto phenol solution and morphological observations under low power objective lens.

Sensory evaluation: A nine point Hedonic scale with 1 corresponding to dislike extremely, 5 corresponding to neither like nor dislike and 9 corresponds to like extremely was used to analyse the differences in the samples by twenty five (25) panelists. The attribute of interest was change in appearance of the *fufu* during storage.

Statistical analysis: Data obtained in colony forming unit per gram (cfu/g), pH and total titratable acidity were analysed using statistical package for the social sciences (SPSS version 20). The mean values were separated using Duncan Multiple Range Test at ($p = 0.05$).

RESULTS AND DISCUSSION

The result of the moisture content of the sample is presented in Fig. 1. The moisture content of the cassava *fufu* ranged from 52.5 to 54.9%, with samples D_1 and D_2 having the lowest (52.5%) moisture content. Hussein *et al*. (2012) reported that the moisture content of *fufu* flour processed from selected cassava mosaic disease resistant cultivars to range from 7.31 to 8.40%. Olapade *et al*. (2014) equally found that the moisture

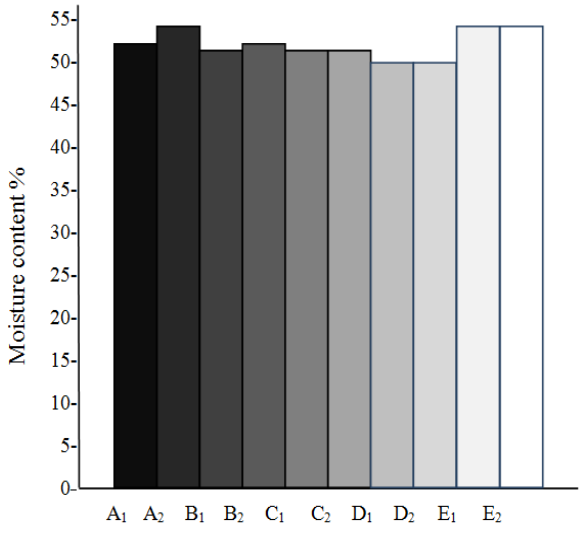

Fig. 1: Moisture content of the stored cassava *fufu*

Table 1: pH of cassava *fufu* stored for 8 days under room temperature

	Samples				
Time (Days)	A_1	A_2	B_1	B_2	C_1
0	3.75±0.01^{a}	3.75±0.01^{a}	3.70±0.01^{b}	3.70±0.01^{b}	3.90±0.01^{c}
1	3.80±0.01^{a}	3.80±0.01^{a}	3.80±0.01^{a}	3.80±0.01^{a}	3.80±0.01^{a}
2	3.90±0.01^{a}	4.10±0.06^{b}	3.60±0.01^{c}	3.90±0.01^{a}	3.40±0.01^{d}
3	4.50 ±0.1^{a}	5.00±1.0^{a}	3.90±0.1^{b}	3.80±0.1^{b}	3.60±0.1^{b}
4	4.30±0.1^{a}	5.30±0.1^{b}	3.95±0.01^{c}	4.20±0.1^{a}	3.90±0.1^{c}
5	4.30±0.1^{a}	5.20±0.1^{b}	4.20±0.1^{a}	4.30±0.1^{a}	5.50±0.1^{c}
6	4.10±0.1^{a}	4.50±0.1^{b}	3.80±0.1^{c}	4.70±0.1^{bc}	5.80±0.1^{d}
7	4.00±0.1^{a}	4.20±0.1^{b}	3.90±0.1^{a}	4.10±0.1^{ab}	6.40±0.1^{c}
8	4.50±0.1^{a}	4.10±0.1^{b}	4.10±0.1^{b}	4.80±0.1^{c}	5.50±0.1^{d}
	Samples				
Time (Days)	C_2	D_1	D_2	E_1	E_2
0	3.90±0.01^{c}	3.80±0.01^{d}	3.80±0.01^{d}	3.80±0.01^{d}	3.80±0.01^{d}
1	3.80±0.01^{a}	3.80±0.01^{a}	3.80±0.01^{a}	3.70±0.05^{b}	3.60±0.01^{c}
2	3.60±0.01^{c}	3.40±0.01^{d}	4.00±0.01^{e}	3.80±0.01^{f}	3.90±0.01^{a}
3	3.90±o.1^{b}	3.60±0.1^{b}	5.00±0.1^{a}	3.70±0.1^{b}	3.90±0.1^{b}
4	4.45±0.01^{ab}	4.70±0.1^{d}	6.00±0.1^{e}	3.80±0.1^{c}	3.80±0.1^{c}
5	5.10±0.1^{b}	4.60±0.1^{d}	5.90±0.1^{e}	4.30±0.1^{a}	4.10±0.1^{ab}
6	5.60±0.1^{e}	4.60±0.1^{b}	6.20±0.1^{f}	4.40±0.1^{bd}	4.10±0.1^{a}
7	6.40±0.1^{c}	4.70±0.1^{d}	6.70±0.1^{e}	4.20±0.1^{b}	4.10±0.1^{ab}
8	6.40±0.1^{e}	6.80±0.1^{f}	6.80±0.1^{f}	3.90±0.1^{g}	3.70±0.1^{h}

Means within the same rows that have the same superscripts are significantly not different from one another ($p>0.05$)

content of fermented cassava flour supplemented with bambara flour had moisture content ranging from 4.91 to 11.44%. High moisture content as established by this study is expected since the processing methods did not entail drying of the cassava mash before reconstituting. Moisture content in foods has a potential effect on the chemical reaction rate and microbial growth rate (Labuza, 1970). It influences microbial spoilage and storage life of the *fufu*. The result indicates that samples E_1, E_2 and A_2 have the tendencies of deteriorating faster than others. Troller and Christian (1975) reported that moisture content is an exact indicator of the susceptibility of a product to undergo microbial spoilage. This implies that these cassava *fufu* with these levels of moisture contents are susceptible to microbial invasion.

Table 1 shows the pH values of the cassava *fufu.* The pH of the *fufu* ranged from 3.70 to 6.80. This pH range is in agreement with the findings of previous researchers (Odom *et al*., 2012). The pH values indicated that the *fufu* maintained acidic pH despite the source and storage time. These pH ranges will support the growth of pathogenic microorganisms. Release of ammonia by spoilage microorganisms has been linked to the increasing pH of food during storage (Sarkar *et al*., 1993; Olawepo *et al*., 2001). Moulds constitute the greatest danger to food spoilage. This is because mould can grow over a wide range of pH values than most yeast and bacteria. Fermentative yeast grows well at pH levels between 4-4.5 and film yeast grows well at pH 3.4- 3.6 while bacteria grow well at pH near neutrality (Umeh, 2009). The pH result indicates that the pH of the *fufu* were significantly different ($p>0.05$) at zero day despite the source. But on day 1 the pH remained virtually non significant ($p<0.05$). The changes in pH were independent of the storage conditions.

The result of the total titrable acidity of the sample is shown in Table 2. The values of the titrable acidity like the pH fluctuated from day 0 to day 8. Odom *et al*. (2012) reported that the total titrable acidity of cassava *fufu* stored for several days decreased as the pH increased. This fluctuation in pH and titrable acidity could be attributed to microbial activities, biochemical reactions and environmental conditions such as fluctuation of the ambient temperature, presence of carbon (iv) oxide, lack or presence of oxygen and storage humidity http://www.researchgate.net.(October, 2013). These determine the type of metabolites produced by the different microbes. Lactic acid bacteria in cassava *fufu* produce acetic acid, lactic acid, ethyl alcohol and carbon (iv) oxide from the available carbohydrate consumption that cause pH decrease http://www.researchgate.net.(October,2013). Also, if a microbiological oxidation of organic substance which contain sulphur or nitrogen takes places, then inorganic acid such as tetraoxosulphate (vi) acid and trioxonitrate (v) acid are developed therefore resulting in decrease the pH.

Table 3 indicates the total fungal count (cfu/g) of the cassava *fufu*. The result revealed increase in microbial count among the samples as the storage days increased. On day zero, the total fungal count was observed to fall within the range of 1.0×10^{4}-4.0×10^{4}. On the 3rd day, there was an increase in the total fungal count till 9th day when the counts were too numerous to count. Higher microbial count was observed in unwrapped *fufu* samples compared to counts in wrapped ones. This could be attributed to the free

Table 2: Total titrable acidity of cassava *fufu* stored at room temperature

	Samples				
Time (Days)	A_1	A_2	B_1	B_2	C_1
0	0.042±0.00^{a}	0.042±0.00^{a}	0.052±0.00^{b}	0.052±0.00^{b}	0.036±0.00^{c}
1	0.063±0.00^{a}	0.051±0.00^{b}	0.030±0.00^{c}	0.047±0.00^{d}	0.063±0.00^{a}
2	0.024±0.00^{a}	0.021±0.00^{b}	0.027±0.00^{c}	0.036±0.00^{d}	0.032±0.00^{e}
3	0.018±0.00^{a}	0.012±0.00^{b}	0.027±0.00^{c}	0.036±0.00^{d}	0.045±0.00^{e}
4	0.015±0.00^{a}	0.009±0.00^{b}	0.018±0.00^{c}	0.009±0.00^{b}	0.024±0.00^{d}
5	0.033±0.00^{a}	0.012±0.00^{b}	0.033±0.00^{a}	0.027±0.00^{c}	0.009±0.00^{d}
6	0.027±0.00^{a}	0.021±0.00^{b}	0.027±0.00^{a}	0.012±0.00^{c}	0.006±0.00^{d}
7	0.033±0.00^{a}	0.027±0.00^{b}	0.024±0.00^{c}	0.018±0.00^{d}	0.006±0.00^{e}
8	0.048±0.00^{a}	0.027±0.13^{a}	0.024±0.00^{ab}	0.012±0.00^{ab}	0.009±0.00^{ab}
	Samples				
Time (Days)	C_2	D_1	D_2	E_1	E_2
0	0.036±0.00^{c}	0.036±0.00^{c}	0.036±0.00^{c}	0.036±0.00^{c}	0.036±0.00^{c}
1	0.018±0.00^{e}	0.051±0.00^{b}	0.045±0.00^{f}	0.048±0.00^{d}	0.33±0.00^{g}
2	0.027±0.00^{c}	0.041±0.00^{f}	0.018±0.00^{g}	0.042±0.00^{f}	0.030±0.00^{h}
3	0.027±0.00^{c}	0.036±0.00^{d}	0.006±0.00^{f}	0.045±0.00^{g}	0.039±0.00^{h}
4	0.012±0.00^{e}	0.009±0.00^{b}	0.006±0.00^{f}	0.042±0.00^{g}	0.039±0.00^{h}
5	0.009±0.00^{d}	0.015±0.00^{e}	0.005±0.00^{f}	0.018±0.00^{g}	0.024±0.00^{h}
6	0.007±0.00^{d}	0.009±0.00^{e}	0.004±0.00^{f}	0.018±0.00^{g}	0.018±0.00^{g}
7	0.006±0.00^{e}	0.009±0.00^{f}	0.008±0.00^{f}	0.015±0.00^{g}	0.015±0.00^{g}
8	0.008±0.00^{ab}	0.008±0.00^{ab}	0.009±0.00^{ab}	0.033±0.00^{a}	0.033±0.00^{a}

Means within the rows that have the same superscripts are significantly not different from each other (p>0.05)

Table 3: Total fungal count of stored cassava *Fufu* (cfu/g)

	Samples					
Time (Days)	A_1	A_2	B_1	B_2	C_1	C_2
0	$4.0\times10^{4\,a}$	$4.0\times10^{4\,a}$	$4.0\times10^{4\,a}$	$4.0\times10^{4\,a}$	$2.0\times10^{4\,b}$	$2.0\times10^{4\,b}$
3	$4.7\times10^{5\,a}$	$6.8\times10^{5\,b}$	$1.8\times10^{5\,c}$	$2.1\times10^{5\,c}$	$1.2\times10^{5\,c}$	$1.2\times10^{6\,d}$
6	$4.0\times10^{6\,a}$	$2.59\times10^{6\,b}$	$2.05\times10^{6\,c}$	$3.24\times10^{6\,d}$	$4.0\times10^{6\,a}$	$4.8\times10^{6\,e}$
9	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC
	Samples					
Time (Days)	D_1	D_2	E_1	E_2		
0	$1.0\times10^{4\,c}$	$1.0\times10^{4\,c}$	$1.0\times10^{4\,c}$	$1.0\times10^{4\,c}$		
3	$1.5\times10^{6\,e}$	$2.7\times10^{6\,f}$	$1.7\times10^{5\,c}$	$2.2\times10^{5\,c}$		
6	$3.2\times10^{6\,d}$	$5.2\times10^{6\,f}$	$3.11\times10^{6\,cd}$	$4.51\times10^{6\,g}$		
9	TNTC	TNTC	TNTC	TNTC		

Means within the rows that have the same superscripts are significantly not different from each other at (p>0.05). TNTC = too numerous to count

Table 4: Total bacteria count of stored cassava *Fufu* (cfu/g)

	Samples					
Time (Days)	A_1	A_2	B_1	B_2	C_1	C_2
0	$3.2\times10^{5\,a}$	$3.2\times10^{5\,a}$	$7.0\times10^{4\,b}$	$7.0\times10^{4\,b}$	$4.0\times10^{4\,c}$	$4.0\times10^{4\,c}$
3	$5.1\times10^{5\,a}$	$7.2\times10^{5\,b}$	$2.2\times10^{5\,c}$	$5.1\times10^{5\,a}$	$2.1\times10^{5\,c}$	$2.6\times10^{5\,d}$
6	$6.8\times10^{5\,a}$	$9.9\times10^{5\,b}$	$4.8\times10^{5\,c}$	$1.11\times10^{6\,d}$	$5.1\times10^{5\,e}$	$6.5\times10^{5\,f}$
9	$8.5\times10^{5\,a}$	$1.17\times10^{6\,b}$	$1.08\times10^{6\,b}$	$1.2\times10^{6\,bc}$	$1.2\times10^{6\,bc}$	$1.87\times10^{6\,d}$
	Samples					
Time (Days)	D_1	D_2	E_1	E_2		
0	$1.2\times10^{5\,d}$	$1.2\times10^{5\,d}$	$1.4\times10^{5\,e}$	$1.4\times10^{5\,e}$		
3	$3.0\times10^{5\,e}$	$3.5\times10^{5\,f}$	$2.2\times10^{5\,c}$	$4.2\times10^{5\,g}$		
6	$8.8\times10^{5\,g}$	$1.42\times10^{6\,h}$	$1.21\times10^{6\,i}$	$1.78\times10^{6\,j}$		
9	$1.32\times10^{6\,e}$	$2.4\times10^{6\,f}$	$2.81\times10^{6\,g}$	$2.91\times10^{6\,h}$		

Means within the rows that have the same superscripts are significantly not different from each other (p>0.05)

entrance of microbes from the environment in which it was stored.

Total bacterial count is presented in Table 4. The result indicates that the total bacteria count ranged from 4.0×10^{4}-2.91×10^{6} (cfu/g). This indicated increase in bacterial count with increase in storage time. High bacteria count as recorded by wrapped *fufu* shows that storage temperature and packaging material favoured the growth of bacteria. This could be attributed to the increased temperature of the wrapped *fufu*. Aderinto (2003) found that *fufu* will keep best when packaged in leaf and stored under refrigeration as pH and total titratable acidity of "*fufu*" stored at 8^{o}C remained more stable than those stored at 28^{o}C (ambient temperature).

Table 5: Biochemical characteristics of microbial isolates

Microbial isolate	Cell morphology	Gram reaction	Motility	Catalase	Coagulase	Oxidase	Citrate
Bacillus cereus	Rods	+	+	+	-	+	+
Staphylococcus aureus	Cocci	+	-	+	+	-	-
Aspergillus spp.	Black irregular dry and powdery						
Penicillum spp.	Brown dense brush-like spore						

Table 6: Changes in the physical appearance of stored cassava *Fufu*

	Samples									
Time (Days)	A_1	A_2	B_1	B_2	C_1	C_2	D_1	D_2	E_1	E_2
0	NVC	NVC	NVC	NVC	NVC	NVC	NVC	NVC	NVC	NVC
1	NVC	NVC	NVC	NVC	NVC	NVC	NVC	NVC	NVC	NVC
2	NVC	NVC	NVC	NVC	NVC	NVC	NVC	NVC	NVC	NVC
3	NVC	MO	DB	DB	DB	MG	DB	DB	DB	DB
4	RS	MO	DB	BB	DB	MG	DB	DB	DB	DB
5	RS	MO	DB	BB	BB	MG	YG	YG	DB	DB
6	RS	MO	DB	RS	BB	MG	YG	YG	DB	DB
7	RS	MO	DB	RS	BB	MG	YG	YG	DB	DB

NVC: No visible change; MG: Mould growth; RS: Reddish spots; YG: Yellowish green colour; MO: Moistened crust observed; Alphabet with subscript (1) = wrapped *fufu*; DB: Dirty brown colour; Alphabet with subscript (2) = unwrapped *fufu*; BB: Blackish brown colour

Table 7: Mean sensory evaluation scores of appearance of stored cassava *Fufu*

	Samples				
Time (Days)	A_1	A_2	B_1	B_2	C_1
1	8.24 ± 0.01^{a}	8.24 ± 0.01^{a}	8.12 ± 0.01^{b}	8.12 ± 0.01^{b}	8.20 ± 0.01^{a}
4	2.56 ± 0.01^{a}	1.48 ± 0.01^{b}	2.76 ± 0.01^{c}	1.56 ± 0.01^{d}	2.68 ± 0.01^{e}
	Samples				
Time Days	C_2	D_1	D_2	E_1	E_2
1	8.20 ± 0.01^{a}	8.12 ± 0.01^{b}	8.12 ± 0.01^{b}	8.00 ± 0.1^{c}	8.00 ± 0.1^{c}
4	1.56 ± 0.01^{d}	2.48 ± 0.01^{g}	1.44 ± 0.01^{h}	2.64 ± 0.01^{i}	1.16 ± 0.01^{j}

Means within the same rows that have the same superscripts are significantly ($p>0.05$) not different from each other

Thus, given the method of storage as practiced by the processors and marketers of this cassava *fufu* in the study area, the *fufu* is predisposed to bacterial contamination. Besides, the high moisture content of the *fufu* will support microbial growth as the *fufu* will maintain high level of water activity (a_w). International Commission on Microbiological Specification for Food (I.C.M.S.F.) (1986) reported that plate count within the range of 5.0×10^5-5.0×10^7 is considered acceptable in foods. However, the acceptability of the *fufu* will depend largely on the type of bacteria isolated from the *fufu.*

Table 5 shows the dominant microorganisms isolated from the *fufu*. The organisms include *Staphylococcus aureus, Bacillus cereus, Aspergillus flavus, Aspergillus niger and Penicillum spp.* Isolation of these organisms may be attributed to poor handling during post processing and storage. Contamination by *Staphylococcus aureus* could be from human skin, mouth when coughed, nose when sneezed (Umeh, 2009). *S. aureus* produce a number of disease-causing factors such as coagulase, alpha exotoxin and haemolytic beta toxin which are the principal agents in food borne intoxication. The symptoms of *staphylococcal* intoxication include extreme distress, nausea, diarrhea and vomiting (Okaka *et al*., 2006). *Bacillus cereus* is an inhabitant of soil, leaf surface and wrapping materials (Odom *et al*., 2012). *B. cereus* produces an exotoxin which causes an intoxication characterized by abdominal pain, flatulence, diarrhea, headache, dizziness, vomiting and dehydration. It occurs from contamination from packaging materials as well as eating cold *fufu* after being held at room temperature for several days/hours (Umeh, 2009). It is worthy of note that the *fufu* as marketed in the study area is usually eaten as purchased thereby exposing consumers to bacterial contamination. *Aspergillus spp.* Found growing in the *fufu* could lead to *mycotoxins* with concomitant *mycotoxicosis.*

The physical change in the cassava *fufu* is as presented in Table 6. On days zero, one and two, no visible changes were observed on the cassava *fufu*. But from day 3, there were changes in appearance of the *fufu.* The change in appearance could be attributed to biochemical reactions and different microbial developments (Jideani and Jideani, 2006). The change in appearance increased as storage days increased. However, the wrapped *fufu* had firm texture, good appearance and tolerable odour at 3rd day of storage than unwrapped *fufu*. This could be attributed to low permeability of the cellophane to air, oil and/or grease, water vapour and microorganism.

Table 7 shows the mean sensory scores of appearance of the stored cassava *fufu*. The result showed that there was a significant difference ($p>0.05$) on the *fufu* as the storage time increased. Thus,

increased storage of cassava *fufu* will not only increase the microbial proliferation but will reduce consumer acceptability of the *fufu.*

CONCLUSION

Hawking and storage of cassava *fufu* at ambient temperature for more than two days predisposes the *fufu* to microbial growths and loss of acceptability due to poor appearance. Besides, the type of microorganisms found on the stored cassava *fufu* could lead to some health hazards. Thus, cassava *fufu* intended for marketing should be stored for not more than two days and wrapped properly using low density polyethylene bag. Sanitary/health workers should be alive to their responsibilities by ensuring that processors and marketers of processed cassava *fufu* develop the culture of good manufacturing practices and general cleanliness to reduce contamination of the product.

REFERENCES

Aderinto, T.A.T., 2003. Effects of storage and packaging on the quality and stability of cooked "fufu". B.Sc. Thesis, Department of Food Technology, University of Agriculture, Abeokuta.

Association of Official Analytical Chemists (A.O.A.C.), 1990. Official Methods of Analysis. 15th Edn., Vol. 2. Darlington, Virginia, U.S.A.

De Bruijn, G.H. and L.O. Fresco, 1989. The importance of cassava in world food production. Neth. J. Agr. Sci., 37: 21-34.

Hussein, E.A., N.T. Ugochukwu and S.O. Lateef, 2012. Nutritional quality and preference of Fufu processed from selected Cassava Mosaic Disease (CMD) resistant cultivars. Adv. Appl. Sci. Res., 3(5): 2687-2692.

International Commission on Microbiological Specification for Food (I.C.M.S.F.), 1978. Microbial Ecology of Food. Vol. 2, Food Commodities. Academic Press, London.

International Commission on Microbiological Specification for Food (I.C.M.S.F.), 1986. Microorganisms in Foods. Sampling for Microbiological Analysis: Principles and Specific Application. 2nd Edn., University Toronto Press, Canada.

Jideani, V.A. and I.A. Jideani, 2006. Laboratory Manual of Food Bacteriology. Amana Printing and Advertising Ltd., Kaduna, Nigeria, 10: 196.

Labuza, T.P., 1970. Oxidative Changes in Foods at Low and Intermediate Moisture Levels. In: Duckworth, R.B. (Ed.), Water Relations of Foods. Academic Press, New York, pp: 415.

Nweke, F.I., 1994. Cassava processing in sub-Saharan Africa: The implications for expanding cassava production. Outlook Agr., 23(3): 197-205.

Odom, T.C., E.C. Nwanekezi, E.A. Udensi, C.A. Ogbuji, C.A. Ihemanma, R.O. Emecheta and R.U. Aji, 2012. Biochemical qualities of cassava fufu sold in Imo and Abia States of Nigeria. Glob. Adv. Res. J. Environ. Sci. Toxicol., 1(7): 178-180.

Ogbulie, T.N., T.C. Uwaezuoke and S.I. Ogiehor, 2005. Introductory Microbiology Practical. Spring Field Publication, Owerri, pp: 67-82.

Okaka, J.C., E.N.T. Akobundu and A.N.C. Okaka, 2006. Food and Human Nutrition. pp: 414-427. ISBN: 978-2665-21-5.

Olapade, A.A., Y.O. Babalola and O.C. Aworh, 2014. Quality attributes of *fufu* (Fermented cassava) flour supplemented with bambara flour. Int. Food Res. J., 21(5): 2025-2032.

Olawepo, O., O. Akoma and A.O. Akoma, 2001. Changes in quality attributes of preserved zobo during ambient temperature storage. Proceeding of the 25th Annual Conference of Nigeria Institute of Food Science and Technology. University of Lagos, Nigeria, pp: 72-74.

Padmaja, G., 1995. Cyanide detoxification in cassava for food and feed uses. Crit. Rev. Food Sci., 35(4): 299-339.

Poulter, D., 1995. Foreword. In: Agbor, E., A. Brauman, D. Griffon and S. Tre'che (Ed.), Cassava Food Processing. ORSTOM Edn., Paris, pp: 9-13.

Sanni, M.O., 1989. The mycoflora of gari. J. Appl. Bacteriol., 67(3): 239-242.

Sarkar, P.K., P.E. Cook and J.D. Owens, 1993. Bacillus fermentation of soybeans. World J. Microb. Biot., 9(3): 295-299.

Troller, J.A. and J.H.B. Christian, 1975. Water Activity and Food. Academics Press, New York, pp: 9-11.

Umeh, C.N., 2009. Food in relation to human diseases. Proceeding of the Paper Presented on NIFST'S Day Celebrations. Federal Secretariat Auditorium, Enugu.