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EFFECTS OF FERMENTATION PERIODS AND CONDITIONS ON THE QUALITY ATTRIBUTE OF *FUFU* FLOUR

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ABSTRACT: *Fufu has been described as a wet paste produced from fermented cassava and it is ranked next to garri as an indigenous food of most Nigerians especially in the southern part of the country. Fermentation is a major unit operation in the production of fufu that dictate the quality attribute of the final products. In this study, the effects of fermentation period and conditions on the quality attribute of fufu flour were carried out. The freshly harvested cassava was peeled, washed, cut into chunks and soaked at different fermentation conditions (opened and closed) for a period of 4, 5 and 6 days respectively. The fermented cassava was then subjected to wet milling, de-watering, granulated, drying and milling. The experiment was considered as a factorial design in Randomized Completely Block Design (RCBD) with the fermentation condition as the blocking factor. A total of 18 samples of fufu flour were subjected to proximate analysis to determine their quality attributes. The result obtained were subjected to statistical analysis using SPSS 23 to check for the effect of the fermentation condition and period on the proximate composition of the samples. The statistical result revealed that fermentation condition does not have any effect on any of the proximate composition considered. Only fermentation period has effect on the moisture and carbohydrate content of the sample but does not have a significant effect on the ash, protein, fat and fiber content of the sample at 95% confidence level. The optimum moisture content (9.67%), ash (0.69%), protein (2.54%), fat (2.21%), fiber (1.52%) and carbohydrate content (83.67%) of the flour was obtained in a closed sample for 5 days.*

Keywords: *Cassava, Fufu Flour, Fermentation Period, Fermentation Condition, Proximate Analysis*

1. INTRODUCTION

Nigeria has been reported as one of the leading producer of cassava in the World with an annual production of about 45 million tonnes (Asante-Pok., 2013). The crop is processed into many food items such as *fufu, gari, lafun. Fufu* (also called *akpu*) is the meal of soaked fermented cassava roots which is widely consumed in Nigeria (Shittu *et al.,* 2010). It is one of the major food from cassava fermentation, which is reconstituted by stirring in boiling water to form dough and eaten with desired sauces. In some areas, low cyanide cassava roots can be boiled or steamed and pounded into *fufu* (Hahn, 2011). *Fufu* contains 6.50, 1.68, 1.32, 1.84, 1.42 and 87.24% moisture, protein, fat, ash, crude fiber and carbohydrate, respectively (Olumide, 1999).

The traditional operations involved in the production of *fufu* are peeling of cassava, washing of the peeled cassava, cutting into thick chunks and steeped in water in earthenware pots or in a slow-flowing stream for 4-5 days to ferment, before reconstitution by stirring in boiling water to form dough. *Fufu* has a characteristic sour aroma and its modern production is an improved method of *fufu* production from fresh cassava roots into *fufu* flour. (Omodamiro *et al.*, 2012). The sour taste, flavor, appearance, and texture are generally recognized as the main factors that determines the acceptability of the product (*fufu*). The consumer considers the product best when it has a smooth texture, a characteristic sour aroma, and a creamy-white color.

Traditionally, *fufu* is sold as a wet paste and this renders it highly perishable with a short shelf life. This problem can be addressed with the production of *fufu* flour that can be easily reconstituted into a paste with hot water (Tomlins *et al*., 2007), hence the need for an investigation on the effects of processing of the quality of *fufu* flour to determine its quality attribute for both storage and consumption purposes and to help increase its market value and acceptability of the product.

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 (3-5days) are required during the rainy (cold) season for proper retting of cassava for *fufu* production.

Akingbala *et al.,* (1991) also reported that drying of *fufu* in an oven at 60^{o}c for 48 hours reduces the odour of *fufu* but the product is sticky thereby making it unacceptable for *fufu* flour production. Sanni *et al.,* (1991) reported that *fufu* flour is

assumed to be hygroscopic in nature and would be expected to gain or lose moisture depending on the relative humidity of the atmosphere.

2. MATERIALS AND METHODS

2.1. Sample Preparation

100kg of TME 419 of cassava variety (Figure 1) was purchased from Leventis Farm, Weppa, Agenebode, Edo State, Nigeria. The cassava was peeled and washed in a clean bowl with a sponge was subjected into two conditions of fermentation (open and closed) and ferment period of 4, 5 and 6 days respectively.

Figure 1: Sample of freshly Harvested Cassava used for the Study

2.2. Experiment Procedure

The peeled cassava were washed, cut into chunks, and soaked in clean water for fermentation period of 4, 5 and 6 days and at fermentation conditions (open and closed) as shown on Figure 2. (a) Opened Condition sample
(b) Closed Condition sample

Figure 2: Fermentation Conditions

The samples were than sieved separately and allowed to settle in a synthetic cloth for decantation which was then dewatered with a pressing machine. The dewatered samples were granulated before drying with the aid of a rotary flash dryer and mill with hammer for particle size reduction (Figure 3).

Figure 3: Milling of Dried *Fufu* into Powder

2.3. Determination of proximate Composition of the Sample:

The proximate composition of the different samples produced was carried out at the Central Research Laboratory, Federal University of Technology, Akure, Ondo State, Nigeria. The proximate parameters considered are the moisture, ash, fat, protein, carbohydrate and fiber content of the *fufu* powder produced.

3. RESULTS AND DISCUSSIONS

3.1. Statistical Analysis of the Proximate Composition of the Samples

The average values of the data obtained for proximate analysis of the *fufu* flour at different fermentation conditions and period is as presented in Table 1.

OPEN						
FERMENTATION PERIOD (DAYS)	MOISTURE CONTENT (%)	ASH (%)	PROTEIN (%)	FAT (%)	FIBER (%)	CARBOHYDRATE (%)
4	7.41 ± 0.26	0.92 ± 0.60	2.10 ± 0.74	1.33 ± 0.21	1.54 ± 0.45	86.54 ± 1.20
5	8.21 ± 0.42	0.95 ± 0.49	2.14 ± 0.20	2.76 ± 0.40	0.8 ± 0.22	85.14 ±1. 11
6	8.44 ± 0.21	0.83 ± 0.38	2.06± 0.22	2.04 ± 0.84	1.77 ± 0.38	84.86 ± 1.01
CLOSED						
4	7.13 ± 0.26	0.50 ±0.08	2.10 ± 0.10	2.13 ± 0.69	1.20 ± 0.50	86.76 ± 1.03
5	9.67 ± 0.17	0.69 ±0.18	2.54 ± 0.21	2.21 ± 1.03	1.52 ± 0.31	83.67 ± 1.08
6	7.40 ± 0.29	0.75 ±0.29	2.10 ± 0.04	3.39 ± 0.25	1.38 ± 0.43	85.65 ± 1.44

**The average values ± standard deviation of the values*

Table 4.1: average values of the data obtained for proximate analysis of the *fufu* flour

3.2. Analysis of Variance (ANOVA)

The ANOVA for the effects of fermentation condition and period on the proximate composition of the *fufu* flour produced is as shown on the Table 2. The Table reveals that the fermentation conditions and period and interaction between them does not have significant effects on the ash content, protein content, fat content and fiber content of the *fufu* flour produced. Only the moisture and carbohydrate content are significantly affected by the fermentation period but has no effect on the fermentation condition and their interactions at 0.05 confidence limit.

Table 2: ANOVA for the Effects of Fermentation Condition and Period on the Proximate Composition of the *Fufu* Flour

Ash Content (%)					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
FP	.037	2	.018	.083	.921
FC	.286	1	.286	1.290	.278
FP * FC	.083	2	.042	.188	.831
Error	2.663	12	.222		
Total	13.850	18			
Corrected Total	3.070	17			
Protein Content (%)					
FP	.043	2	.021	.125	.884
FC	.007	1	.007	.040	.845
FP * FC	.009	2	.005	.027	.974
Error	2.041	12	.170		
Total	83.295	18			
Corrected Total	2.099	17			
Fat content (%)					
FP	3.155	2	1.578	2.515	.122
FC	1.275	1	1.275	2.032	.179
FP * FC	2.897	2	1.449	2.310	.142
Error	7.526	12	.627		
Total	110.949	18			
Corrected Total	14.853	17			
Fiber Content (%)					
FP	.504	2	.252	1.045	.382
FC	2.222E-5	1	2.222E-5	.000	.993
FP * FC	1.186	2	.593	2.458	.127
Error	2.895	12	.241		
Total	38.206	18			
Corrected Total	4.586	17			
Carbohydrate Content (%)					
FP	16.593	2	8.297	4.203	.041*
FC	.616	1	.616	.312	.587
FP * FC	2.710	2	1.355	.687	.522
Error	23.685	12	1.974		
Total	131100.245	18			
Corrected Total	43.604	17			
Moisture Content (%)					
FP	8.498	2	4.249	9.037	.004*
FC	.008	1	.008	.018	.896
FP * FC	4.968	2	2.484	5.283	.023*

Error	5.642	12	.470
Total	1183.148	18	
Corrected Total	19.117	17	

**Significant at $P \leq 0.05$; FC-Fermentation Condition; FP-Fermentation Period*

3.3. Duncan's New Multiple Range Test (DNMRT)

Further analysis of the result using DNMRT is as presented on the Table 3. The Table shown that the proximate results obtained for the ash content, protein content, fat content and fiber content, at different fermentation period are not significantly different. In the case of carbohydrate content, the value of fermentation period obtained at fourth day is different from that obtained on the fifth day but not significantly different from that of the sixth day. Also, the moisture content obtained on the fourth day was not significantly different from that of the fifth day but was significantly different from that which was obtained on the sixth day.

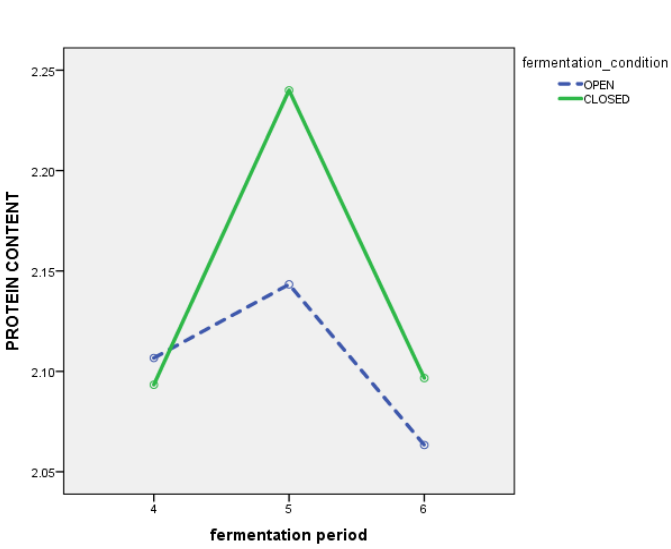
Table 3: Duncan's New Multiple Range Test (DNMRT)

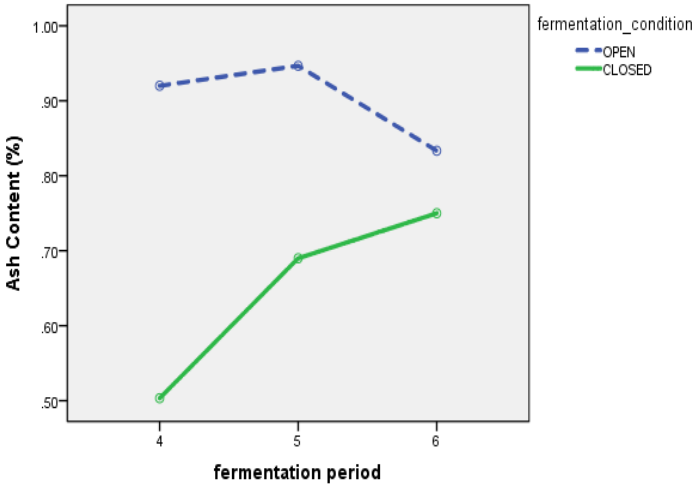
Fermentation period	Ash	Protein	Fat	fiber	Carbohydrate	Moisture content
4	0.7117[a]	2.0800[a]	1.7333[a]	1.1617[a]	86.6517[a]	7.2717[a]
5	0.8183[a]	2.1000[a]	2.4850[a]	1.3667[a]	84.4033[b]	7.9133[a]
6	0.7917[a]	2.1917[a]	2.7133[a]	1.5717[a]	84.9300[ab]	8.9400[b]

**means with the same letters are not significantly difference but means with different letter are significantly different at 5% confidence level.*

3.4. Effects of Fermentation Period and Conditions on the Proximate Composition of the *Fufu* Flour

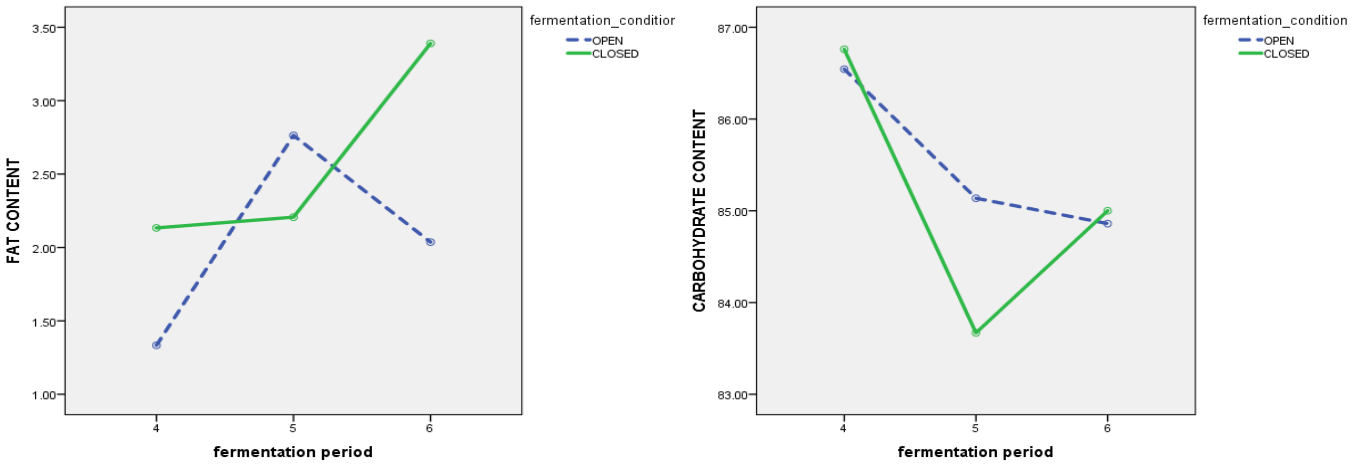
The effect of fermentation period and conditions on the proximate composition of the *fufu* samples is as represented on the charts below for ash content, protein content, fat content, fiber content, carbohydrate content and the moisture content respectively.





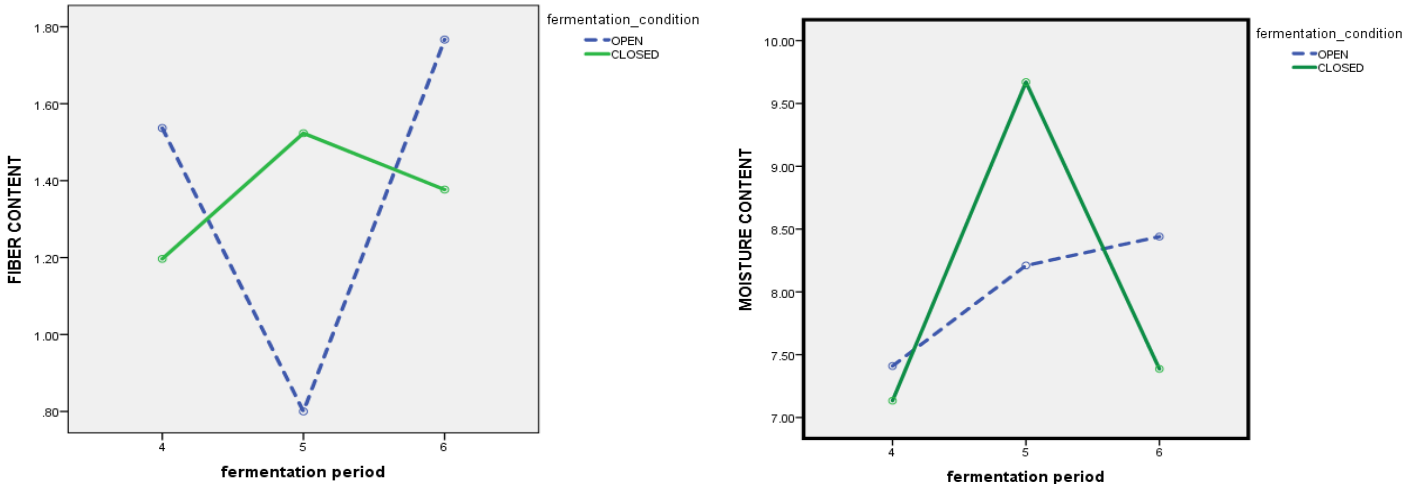
(a) (b)

Figure 4: Effect of Fermentation Period and Conditions on the Protein (a) and ash (b) Content of the Flour



(k) (b)

Figure 5: Effect of Fermentation Period and Conditions on the Fat (a) and Carbohydrate (b) Content of the Flour



(a) **(b)**

Figure 6: Effect of Fermentation Period and Conditions on the Fiber (a) and Moisture (b) Content of the Flour

4. CONCLUSION AND RECOMMENDATION

4.1. Conclusion

Fufu flour was produced from the freshly harvested cassava and investigation of the effects of fermentation periods and conditions on the quality characteristics of *fufu* flour was carried out. The proximate analysis result of *fufu* flour shows that the flour has an optimum value of 85.14, 8.21, 0.95, 0.8, 2.76 and 83.67, 9.67, 0.69, 1.52, 2.54, 2.54, 2.21 for open and closed conditions respectively for carbohydrate, moisture content, ash, fiber, protein and fat respectively. The proximate analysis result obtained was subjected to statistical analysis using SPSS software and the statistical result revealed that fermentation condition does not have any effect on any of the proximate composition considered. Only fermentation period that has effect

on the moisture and carbohydrate content of the sample but does not have a significant effect on the ash content, protein content ,fat content and fiber content of the sample at 95% confidence level.

4.2. Recommendation

This study revealed that Protein, fiber and fat content was very low based on the proximate analysis and can be improved upon by adding some calculated amount of soya beans or tiger nuts during milling to improve the nutrients.

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