EFFECTS OF LENGTH OF FERMENTATION AND VARIETIES ON PASTING PROPERTIES OF SOUR CASSAVA STARCH.

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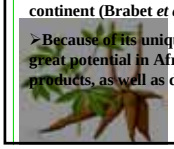
INTRODUCTION

- Cassava is a tropical root crop that serves as a food security and income generation crop for many millions of people in the developing world (Scott *et al*, 2000).
- It is mainly used as food, but is also readily converted chemically, physically and biologically into many useful products (Sanni *et al,* 2003).
- Cassava sour starch is a traditional product from Latin America, especially Brazil and Colombia (Brabet *et al*, 1998).
- Cassava sour starch and its production process are totally unknown in this continent (Brabet *et al,* 1998).
- Because of its unique baking expansion property, sour cassava starch has great potential in Africa for enhancing quality of cassava based bakery products, as well as developing new products.



OBJECTIVES

This paper reports our findings on effect of length of natural fermentation and varieties on the pasting properties of sour starch bread

MATERIALS AND METHODS

Cassava Used: Obtained from UNAAB & IITA Farms

Processing of Starch: The method described by Osunsami *et al* (1989) will be used for the extraction of starch from the cassava varieties.

Determination of pasting properties

- Pasting properties of starches were measured by using a Rapid Visco Analyser (RVA) (Newport Scientific Instruments, Warriewood, Australia, following the RVA corn starch method (AACC, 2000).
- Sour cassava starch (3.0g, db), was suspended in distilled water (25ml), and the suspension was thoroughly stirred in the RVA at 960rpm for 10sec and then at 160rpm for the remainder of the test.
- The temperature was first maintained at 50 degree C for 1min for equilibration and then raised to 95 degree C at 12 C/min. The sample was kept at 95 C for 2.4min, cooled to 50 degree C at 12 C/min and finally maintained at 50 degree C for 2 min.
- The experiments were conducted in duplicate and the average values were recorded.
- The parameters recorded were pasting temperature (P temp), peak viscosity (PV), peak time (P time), trough, breakdown, set back and final viscosity.

Statistical analysis

- Data generated from all experiments were subjected to Analysis of variance and means were separated using Duncan's Multiple Range Test while Pearson's correlation and Factor Analysis were also determined using Statistical Analysis Software (SAS), (Model 8e,SAS institute Inc. Cary, NC, USA).

Results and Discussion

Table 1: Pasting properties of fermented starch for 5days length of fermentation.

Varieties	Peak Viscosity (RVU)	Trough (RVU)	Break Down (RVU)	Final Viscosity (RVU)	Set Back (RVU)	Peak Time (Minutes)	Pasting Temperature (°C)
30572	466.63a	155.63a	320.25a	199.71a	44.08a	3.88a	63.10c
4(2)1425	460.09a	194.63a	224.80c	192.83ab	34.71c	3.80a	64.13a
92B/00061	357.25c	114.71a	235.42bc	153.09c	38.38bc	3.90a	63.73ab
96/01632	308.50d	109.79a	194.83d	144.50c	34.71c	3.93a	63.38ab
96/0603	395.75b	139.96a	255.33b	182.67b	42.71ab	3.96a	63.45bc
TME1	458.36a	194.58a	222.26c	192.41ab	36.20c	3.83a	64.13a
P of Clone	**	NS	**	**	*	NS	*

*P<0.05
** P<0.01; *** P<0.0001; NS Not Significant

Table 2: Pasting properties of fermented starch for 10days length of fermentation.

Varieties	Peak Viscosity (RVU)	Trough (RVU)	Break Down (RVU)	Final Viscosity (RVU)	Set Back (RVU)	Peak Time (Min)	Pasting Tempe-rature (°C)
30572	370.63b	133.13b	230.33bc	167.08bc	33.96a	3.88ab	63.23ab
4(2)1425	364.34b	130.50bc	208.34c	175.50b	35.15a	3.78b	63.10ab
92B/00061	353.50b	113.21d	235.04abc	153.92c	40.71a	3.99ab	64.08a
96/01632	352.08b	121.96c	215.29bc	160.34bc	38.38a	3.81b	63.80ab
96/0603	446.54a	152.84a	283.33a	200.42a	47.58a	4.06a	62.85b
TME1	402.80ab	133.09b	262.21ab	174.21b	41.13a	3.88ab	63.93a
P of Clone	NS	**	NS	*	NS	NS	NS

*P<0.05
** P<0.01; *** P<0.0001; NS Not Significant

Table 3: Pasting properties of fermented starch for 15days length of fermentation.

Varieties	Peak Viscosity (RVU)	Trough (RVU)	Break Down (RVU)	Final Viscosity (RVU)	Set Back (RVU)	Peak Time (Min)	Pasting Tempe-rature (°C)
30572	440.33a	135.58ab	293.42a	184.84a	49.25b	3.85ab	63.53ab
4(2)1425	406.50b	134.59b	243.04b	188.21a	53.63a	3.72b	63.98ab
92B/00061	347.84c	115.67c	231.55b	147.25c	31.59d	4.04a	63.00b
96/01632	333.25c	110.05c	199.17c	151.13c	41.08c	3.73b	64.55ab
96/0603	388.92b	145.42a	241.46b	189.29a	43.88c	3.98a	64.50ab
TME1	414.54ab	140.75ab	246.38b	173.25b	32.50d	3.70b	65.08a
P of Clone	**	**	**	**	***	*	NS

*P<0.05
** P<0.01; *** P<0.0001; NS Not Significant

Table 4: Pasting properties of fermented starch for 20days length of fermentation.

Varieties	Peak Viscosity (RVU)	Trough (RVU)	Break Down (RVU)	Final Viscosity (RVU)	Set Back (RVU)	Peak Time (Min)	Pasting Tempe-rature (°C)
30572	400.67a	157.00ab	207.08b	211.58a	54.58a	3.68bc	65.45a
4(2)1425	410.84a	198.75a	174.71c	233.00a	34.25bc	3.65c	64.25b
92B/00061	358.42ab	67.25c	229.50a	100.29d	33.04c	3.60c	64.58ab
96/01632	290.290c	103.13bc	147.71d	145.50c	42.38abc	3.63c	64.73ab
96/0603	378.54a	147.04ab	211.38b	198.33b	51.29a	3.78a	64.48b
TME1	325.13bc	135.63b	168.79c	184.50bc	48.88ab	3.75ab	64.43b
P of Clone	**	*	***	*	*	*	NS

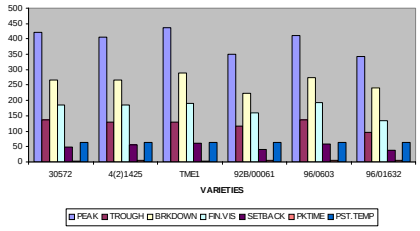
*P<0.05
** P<0.01; *** P<0.0001; NS Not Significant

Table 5: Pasting properties of fermented starch for 25days length of fermentation.

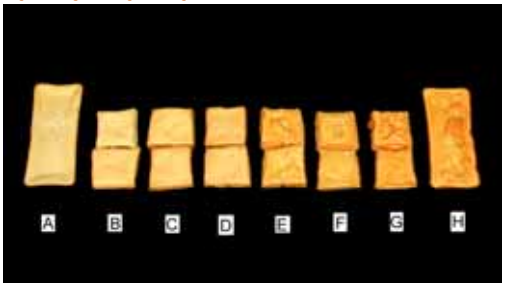
Varieties	Peak Viscosity (RVU)	Trough (RVU)	Break Down (RVU)	Final Viscosity (RVU)	Set Back (RVU)	Peak Time (Min)	Pasting Tempe-rature (°C)
30572	360.38b	134.17a	209.96ab	167.75a	33.58b	3.78b	65.14a
4(2)1425	333.17c	98.790d	201.30b	140.33b	41.54a	3.60c	64.28a
92B/00061	342.29c	123.71b	214.50ab	165.54a	41.84a	3.91a	63.78a
96/01632	334.46c	109.00c	208.84b	149.88b	40.88a	3.77b	64.13a
96/0603	362.96b	132.59a	211.75ab	166.38a	33.79b	3.75b	64.08a
TME1	380.75a	127.92ab	228.96a	163.00a	35.09b	3.74b	64.45a
P of Clone	*	**	NS	*	*	*	NS

*P<0.05
** P<0.01; *** P<0.0001; NS Not Significant

Figure 1: Varietal effect on pasting properties of sour starch



Sour Starch Bread



Conclusion

- The study has shown that significant effect exists at 5% and 10% respectively for peak viscosity, breakdown, final viscosity, setback values For the sour starch bread samples
- The result from this research work showed that varieties have significant effect on the pasting properties (except breakdown and pasting temperature) of sour starch.
- The wide variations in the pasting properties of the starches from the different cassava varieties imply that the starches have potentials for a wide range of products.

Development and Application of Hazard Analysis Critical Control Points (HACCP) for cassava 'fufu' produced in South-West Nigeria

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- Cassava (*Manihot esculenta* Crantz) is one of the most important food plants in West Africa and many parts of the tropics (Brujin and Fresco, 1989).
- Cassava has assumed the status of security and industrial crop in the tropics (Oyewole, 2002).
- In Nigeria, it is widely grown where it serves as one of the basic food sources for about 80-60 million people and it provides over 70% of daily calorie intake (Oyewole, 1991).
- Most of the cassava produced in Nigeria is processed into various food forms for consumption rather than for the industrial use. Such food forms include popular fermented food product such as *gari*, *fufu* and *lafun* (Idowu and Akindele, 1994).

- Worldwide, it is recognised that the application of the HACCP system to food production and processing has clear benefits and the potential of enhancing food safety and preventing many cases of food borne diseases.
- The problem of implementing HACCP in small industries and in developing countries have been a subject of extensive discussions at meetings of the Codex Committee on Food Hygiene (CCFH).
- It was recognized that there is need to develop a strategy for implementing the HACCP system in industries where food safety management system is not yet developed and resources are scarce.
- The joint FAO/WHO Consultation on the Role of Government Agencies in Assessing HACCP also acknowledged the need to work out, facilitating and evaluating the implementation of HACCP in small business (WHO, 1998).
- It has been recognised that regardless of the stage of development of a country, small businesses still have greater difficulties in implementing HACCP (WHO, 1998).
- At the meeting held in Hague, 1998 it was concluded that governments and professional bodies have a clear role to play in facilitating the implementation of HACCP in small business and other food businesses with less developed food safety management system, and that there is a need to develop specific guidelines for them.

- *Fufu* is a lactic fermented cassava wet paste traditionally prepared from cassava by peeling the tuber, washing, cutting into pieces and steeping in water to ferment for 3-4 days.
- The fermented mash is pounded or simply washed over a fine sieve to remove fibre and the starch extract is dewatered to produce fufu (Akingbala et. al., 1991).
- *Fufu* is an important staple food widely eaten in Nigeria and many parts of West Africa and the Tropics (Sanni, 1999)
- Wet *fufu* has moisture content of about 50%, and is therefore highly perishable.
- It is consumed in the eastern and western parts of southern Nigeria as well as some other areas of West and Central Africa.

- Study areas:
- Two states were covered due to the high processing of *fufu* in these states. These states are (Ogun and Lagos state) the highly densed fufu processing centers were selected for the study, the centres are: Ereji, Soso, Remo, Ilewo-Orile, Ilaro, Lusada, Ifo, Osiele, Mushin, Camp, Osiele, Obantoko
- Assembling of HACCP Team: A 5-man HACCP Team was set up comprising of the following; food Microbiologist (1),food processors (2), Food Quality controller (2).
- Term of Reference (TOR) for HACCP of *fufu*
- *Fufu* is a fermented product manufactured from fresh cassava by small-scale rural producers.
- It is manufactured by peeling, washing, grating, sieving. Submerged fermentation and dewatering. The product is commonly sold in the wet and cooked form.
- The hazards considered by the HACCP plan include biological and physical. It is assumed that pre-requisites (GHP, GMP, and GAP) will be in place but when they are not, training will be provided.
- Product description and identification of intended use (Appendix 1)
- *Fufu* is a fermented wet-paste from cassava and it is ranked next to gari as an indigenous food of most Nigerians in the South.
- *Fufu* is made by steeping whole or cut peeled cassava in water to ferment for 3-5 days.
- During steeping, the fermentation decreases the pH of the roots from 6.10 to 4.13 or 4.08 depending on the length of fermentation.
- It softens the roots and facilitates the reduction in potentially toxic cyanogenic

- **Construction of Flow diagram**
- **The following flow chart described the current processing practices for *fufu* production in South-West Nigeria: (Appendix II)**

- **Identification of hazards**
- **Hazards associated with the production and consumption of *fufu* was identified by the HACCP team (Appendix III).**

- **Identification of Critical Control Points (CCPs)**
- **The Critical Control Point in the manufacture of wet and cooked *fufu* was identified by the HACCP Team using the Decision tree (Table 1).**

- ***Establishment of critical limits for each CCP***
- **The cassava tubers should be visually free from mould growth.**
- **Water to be used for washing, steeping and fermentation should be colourless, odourless, neutral in taste and potable.**
- **Cassava should be steeped for 72 to 96 hours and attain a pH of 4.0 – 4.2 and titrable acidity of 0.24 – 0.33% expressed as lactic acid.**
- **After steeping the water should not have a bad odor and fermented wet *fufu* should have a pH below 3.8.**

- **Wet *fufu* after pressing on hydraulic press should have a moisture level of less than 50%, foreign mesophilic aerobic bacterial counts, i.e. non lactic acid bacteria of less than 100 colony forming units per gram and mould counts of less than 100 colony forming units per gram.**
- **No pathogen should be detectable in 25 gram of the products.**
- **The wet *fufu* for cooking should be subjected to cooking temperature for a minimum of 1 hour.**
- **The wet *fufu* should be packaged in clean jute sacks lined with clean polypropylene materials while the cooked *fufu* should be packaged in washed polythene material or leaves.**

- ***Establishment of a monitoring system for each CCP***
- **All the CCPs identified in the production of wet and cooked *fufu* were monitored regularly during each batch production by the procedures established.**
- **Cassava tubers to be processed should be visually inspected for absence or presence of moulds.**
- **Fermentation of cassava tubers during steeping should be monitored by visually observing the production of gas bubbles in steep water, assessing the odour and measuring the pH of steep water with a pH strip.**
- **Fermentation of wet *fufu* should be monitored should by measuring the pH and assessing the odour for unusual or offensive smell.**
- **Pressed wet *fufu* should be assessed for dryness by visual observation and rubbing a sample between the fingers.**
- **The time of cooking *fufu* should be monitored by taking the time.**
- **The color and viscosity of the cooked *fufu* should be assessed visually. Equipment should be inspected visually for cleanliness.**

- **During the cause of the project, the activities of the identified wet and cooked *fufu* processors were audited to assess the effectiveness of the HACCP system.**
- **The audit ensures that all activities described in the HACCP procedure (Table II) prepared are being carried out.**

- ***Establishment of corrective actions***
- **Corrective measures have to be taken immediately when monitoring results that shows a CCP is not conforming to the critical limits defined.**
- **If cassava tubers to be used for the production of wet fufu are found to be mouldy they should not be used but fresh bacth should be purchased for processing.**
- **If water to be used for steeping is dirty or has an off odour, it should not be used.**
- **To correct the situation and eliminate the problem, water tanks/containers for storing water and fermentation vessels should be cleaned and disinfected before further use and investigations should be carried out to identify the root cause.**
- **Smelly pressed *fufu* cake should not be processed to cooked *fufu*.**
- **If cooked *fufu* are cooked for less than 1 hour, they should be cooked further and the processor reprimanded and told to follow the instructions for cooking the wet *fufu*.**

- ***Verification and audits***
- **The microbiological safety of wet fufu and cooked fufu were verified periodically by carrying out microbiological analysis of the raw material, intermediary and finished products.**
- **The HACCP team listed all tests to be carried out for verification and it includes determination of pH, mould and bacteria in cassava tubers, initial and final pH and titrable acidity of steepwater, pH, titratable acidity, presence and levels of coliforms, E. coli, salmonella and shigella, Bacillus spp. in fermented wet and cooked fufu. Verification was carried out twice during the cause of the project.**

Table III: Microbial counts of wet and cooked 'fufu' before and after Hazard Analysis and Critical control Points (HACCP) Application

Microbial test	Wet 'fufu'			Cooked 'fufu'		
	Before HACCP	After HACCP	t	Before HACCP	After HACCP	t
Aerobic count	$4.0 \times 10^4 \pm 1.5 \times 10^4$	$4.5 \times 10^2 \pm 4.2 \times 10^5$	1.173	$5.0 \times 10^3 \pm 1.7 \times 10^3$	$4.5 \times 10^3 \pm 2.2 \times 10^3$	0.239
Anaerobic count	< 10	< 10	-	<10	<10	-
Fungal count	<10	< 10	-	<10	<10	-
Coliform	$3.8 \times 10^3 \pm 2.2 \times 10^3$	-ve	4.781	$2.4 \times 10^3 \pm 1.8 \times 10^3$	-ve	3.543
Feacal coliform	-ve	-ve	-	-ve	-ve	-
Bacillus cereus	$2.2 \times 10^2 \pm 1.7 \times 10^2$	-ve	3.118	$1.4 \times 10^2 \pm 0.7 \times 10^2$	-ve	2.843
Staphylococcus aureus	$4.0 \times 10^4 \pm 3.6 \times 10^4$	$2.3 \times 10^2 \pm 2.0 \times 10^2$	1.138	$8.4 \times 10^3 \pm 3.2 \times 10^3$	$1.5 \times 10^2 \pm 1.1 \times 10^2$	1.837
Salmonella spp.	-ve	-ve	-	-ve	-ve	-

Values are given as mean ± standard deviation.
Number of samples = 10 from each product before HACCP and 10 from each product after HACCP
*Significant at $P < 0.05$

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APPRECIATION

I wish to thank you for the time taking to listen to this presentation.

Table II: Summary of the HACCP control charts of '*fufu*' production

Process step	Hazards	Control Measure	Critical limits	Monitoring Procedure	Corrective Action
STEEPING/ FERMENTATION	Growth and contamination by pathogenic and spoilage organisms	Use of potable water, pH control, timing of steeping, cleaning of containers	Portable water pH 4.7, TTA >0.144% 84-96hours Clean containers Good hygiene.	Sensory evaluation, pH strips, timing of steeping period. Inspection of containers	Educate personnel
COOKING	Contamination by vegetative cell bacteria and spore formers	temperature control, proper timing	100°c, Good hygiene	sensory and visual inspection	Educate personnel

Appendix 1: Products description and intended use (fermented *fufu*)

Name of product	***Fermented wet Fufu***
Description	Fermented cassava product served as a cooked dough
Packaging	Jute sack lined with Polythene sheets
Conditions of Storage	Room temperature
Shelf-life	Less than 7 days
Instructions on the label	No labels
Target consumer groups	Adults and children for household consumption
Recommendations for further processing required before consumption	Make a slurry with water followed by Cooking and stirring into gel/dough like product

Appendix II: Construction of Flow diagram

The following flow charts described the current processing practices for *fufu* production in South-West Nigeria:

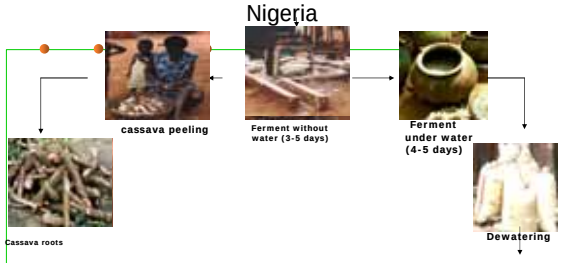
Process	Notes
Harvest/Sorting of cassava	Selection of fresh, mature cassava roots without rot
↓	
Peeling	This is done manually by Knives
↓	
Size Reduction (optional)	Using knives
↓	
Washing	Washing is carried out using clean water to remove pieces of peel, sand
↓	
Steeping/Fermenting	Soak is done using water in a bowl for 72h at room temperature
↓	
Sieving	Using a plastic sieve for separation of fibrous materials to control the size of the particles
↓	
Settling	fufu mash is allowed to be concentrated before decanting
↓	
Pressing	The fermented paste is filled into Hessian or polypropylene sacks and placed in a jerk press.
↓	
Grating	motorized grater is used to pulverize cake into smaller particle size and increase surface area for easy drying
↓	
fufu cake	

Process Step	Hazard	Source	Control Measure
1.Harvesting/Sorting of Cassava	Chemicals Cyanide *Pesticide *Heavy metals Chlorine Stones Microbiology Vegetative pathogens [E.coli, S. aureus, Salmonella]	Root Farm Water by processors Water Rural processors Processors	Supplier Q Ass/inspection SQA (GAP) SQA SQA Inspection SQA, inspection
2. Peeling	Physical: Peels Microbiology : Vegetative pathogens [E.coli, S. aureus, Salmonella]	Incompletely peeled roots Processors and Equipment	GMP GMP and GHP
3. Washing	Heavy metals Stones, clays V. Pathogens	Well water Well water, soil Sewage, Handlers	GMP GMP GHP, GMP
4. Steeping	Veg pathogens Stones Metals	Food handlers, Environment Knives/Environment Equipment	GHP GHP/GMP GMP
5. Sieving	Vegetative pathogens	Water/Equipment, Handlers	GMP
6. Settling	Heavy metals Vegetative pathogens	Tap and well water Food handlers	GMP GHP
7. Pressing	Vegetative pathogens Metals, stones	Food handlers Equipment	GHP (wash hands), GMP (cleaning)
8.Grating/Pulveri-zing	Vegetative pathogens Metals Oils etc	Food handlers/Equipment	GHP (wash hands), GMP (cleaning)

Table I: CCP Identification for *fufu* using decision Tree

Process step	Q1	Q2	Q3	Q4	CCP	Comment
Harvesting/ Sorting of cassava	Y	N	Y	Y	X	
Peeling	Y	N	Y	Y	X	
Size Reduction	Y	N	N		X	
Washing	Y	N	Y	Y	X	
Steeping	Y	Y			**CCP**	
Sieving	Y	N	Y	Y	X	
Settling	Y	N	Y	Y	X	
Pressing	Y	N	N		X	
Bagging	Y	N	Y	Y	X	
Cooking	Y	Y			**CCP**	

Traditional *fufu* Processing in South West Nigeria



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THANK YOU FOR LISTENING