Fufu

Key Findings from RTBfoods in Period 2

Ugo CHIJIOKE, NRCRI, Nigeria

+Cameroon +CIRAD

Other Contributing Scientists (listed on last slides of the presentation)

RTBfoods 2nd Annual Meeting, Kampala, Uganda, 3-7 Feb. 2020

Countries of Activity Implementation

- WP1-Act.3 Surveys
- WP1-Act.4 Processing Diagnosis
- WP1-Act.5 Consumer Testing
- WP2/WP3 Lab.
- WP4 Fields
- WP5 On-Farm /Advanced Trials

Institutes & Main Scientists Involved

- **NRCRI** – Nigeria (T. Madu, M. Ofoeze, U. Chijioke, C. Egesi)
- **IITA** – Nigeria (B. Teeken, P. Kulakow, I. Rabbi)
- **CIRAD** - Montpellier (D. Mbéguié-A-Mbéguié, A. Bouniol, D. Dufour)

OUTLINE OF ACTIVITES CARRIED OUT

- **WP1** :
- NRCRI submitted full report for activity 3 on fufu and uploaded raw data for activity 4 and 5.
- Activity 4 and 5 were conducted in Imo and Abia, relevant information was collected for the different unit operation e.g peel loss, peeling time grating time yeild etc.
- 150 respondent were interviewed in each state during activity 5

WP2

- SOP for fufu processing in Nigeria and Camerron was done in the lab
- Trait disection study on retting ability and biophysical characterization of different cassava genotypes Approach
- comparing land races and improved clones as well as
- Comparing different fermentation methods
- Sensory Profiling
- Recuruitment of sensory panelist
- Generated vocabulary for sensory profiling of fufu
- WP3

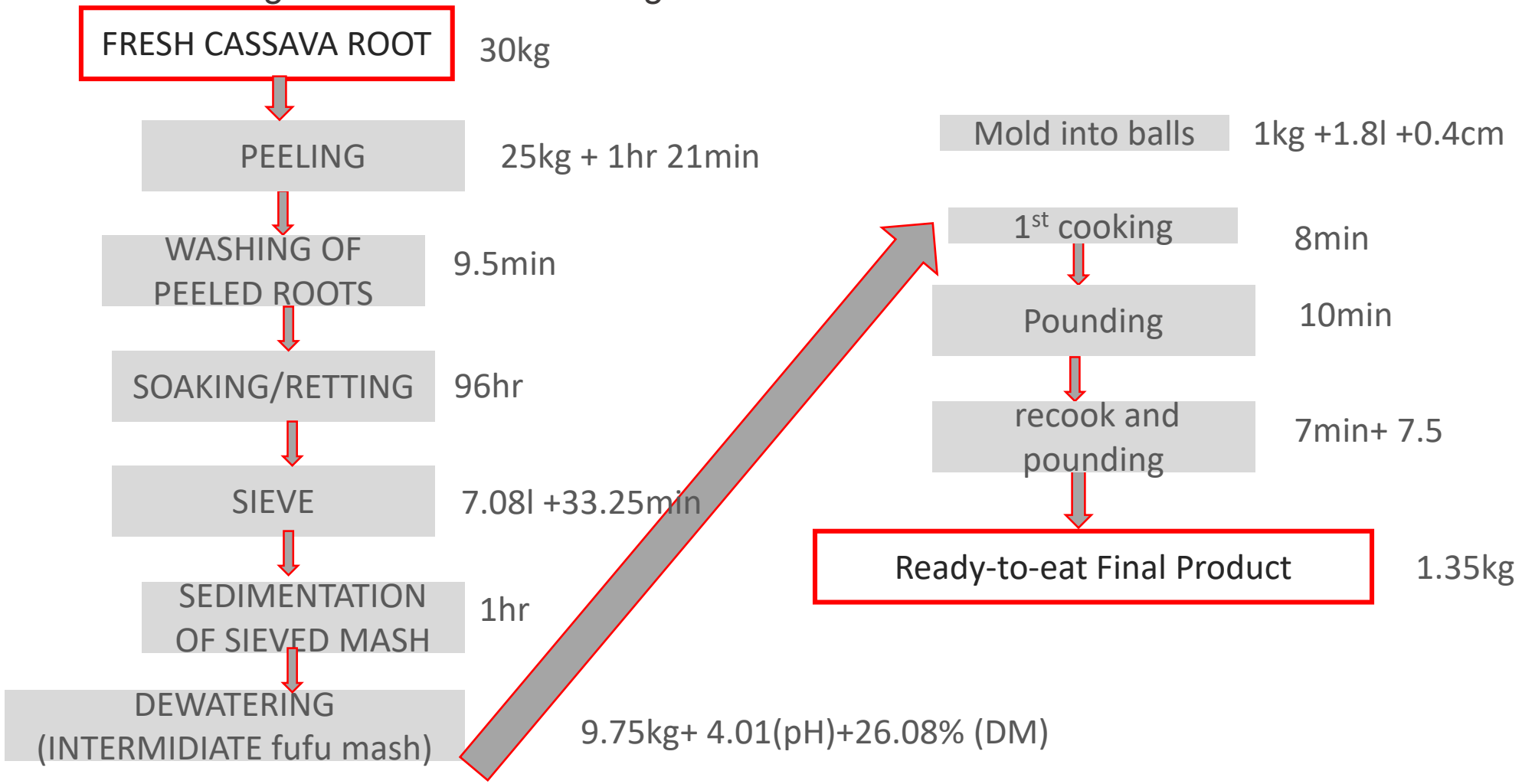
Preliminary study on developing sampling method and collecting specra on intermidiate fufu product

- WP4

WP1

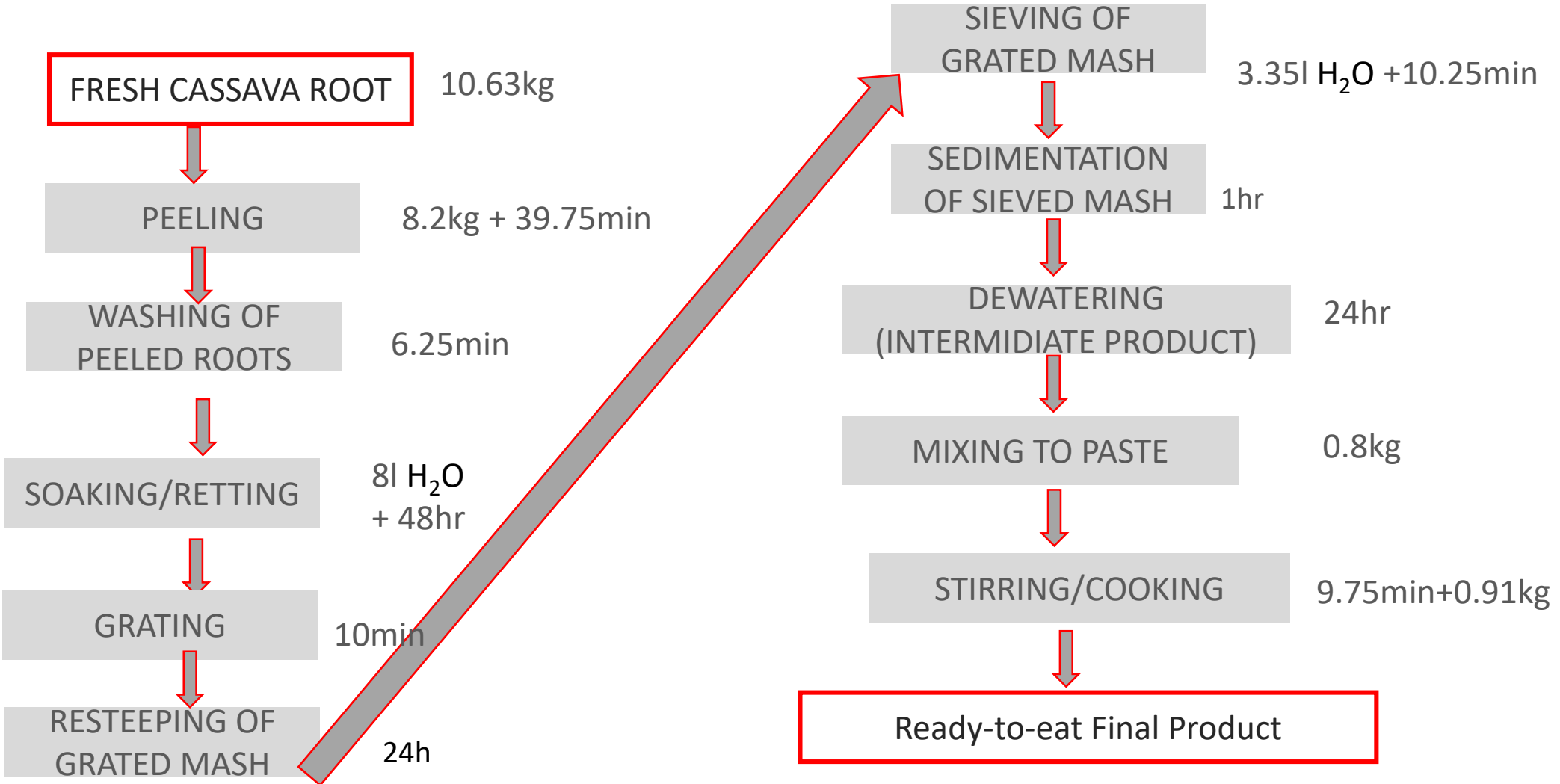
Process Description

- Flowsheet Diagram of Fufu Processing in Imo State



Process Description

- Flowsheet Diagram of Fufu Processing in Abia State



List of Quality Characteristics of the **Raw Material**

- List of Quality Characteristics (**agronomical, post-harvest**: morphological & storage ability), preferred **AND** less preferred (Act. 3 & 4 if available)

Preferred		**Less-preferred**	
Female	**Male**	**Female**	**Male**
Big sized roots	**Big sized roots**	Foamy root	**Light weight**
Heaviness	Dark colour skin	**Light weight**	**Not bright**
Smooth skin	**Smooth skin**	Not fresh	Small roots
White colour	**Heaviness**	**Not bright**	Not fresh
Maturity	Numerous root	Burnt root	Too soft
	White root	**High moisture**	long storage underground
			High moisture

List of Quality Characteristics of the **Raw Material** during **Processing**

- List of Quality Characteristics during processing (**technological & physico-chemical** at each step), preferred **AND** less preferred (Act. 3 & 4 if available)

Preferred		Less preferred
Male	**Female**	**Act 4**
Draws	**Draws**	Bad odour
Easy to form dough	Dull white colour	Watery
Not sticky	**Easy to form dough**	Dark colour
Starchy	Not sticky	Too soft
Not dissolve in water	Moderately soft	Lumpy
Smooth	Yellow colour	Sticky
Well cooked	Swelling ability	

List of Quality Characteristics of the **Raw** or **Ready-to-Eat Final Product**

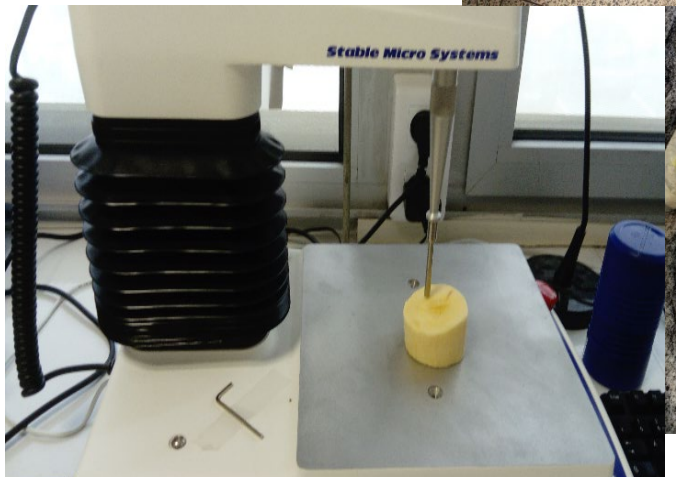
- List of Quality Characteristics (**sensory** characteristics: appearance, texture between fingers, odour, taste, texture in mouth, aroma, aftertaste), preferred **AND** less preferred (Act. 3, 4 & 5 if available)

Preferred		Less preferred	
Female	**Male**	**Female**	**Male**
Smooth	Not sticky	**Bad odour**	**Bad odour**
Drawability	White colour	**Sticky**	**Sticky**
Attractive	Yellow colour	Not drawy	**Too soft**
No bad odour	**No lumps**	Dark colour	Too hard
Moderately soft	**Moderately soft**	Hard	Difficult to swallow
Easy to swallow	**Drawability**	**Not mouldable**	**Scatters**
Easy to cut		**Too soft**	**Not easy to mould**

Main Preferred & Less Preferred Varieties

- Preferred AND Less Preferred varieties cited (Act. 3, 4 & 5 if available)

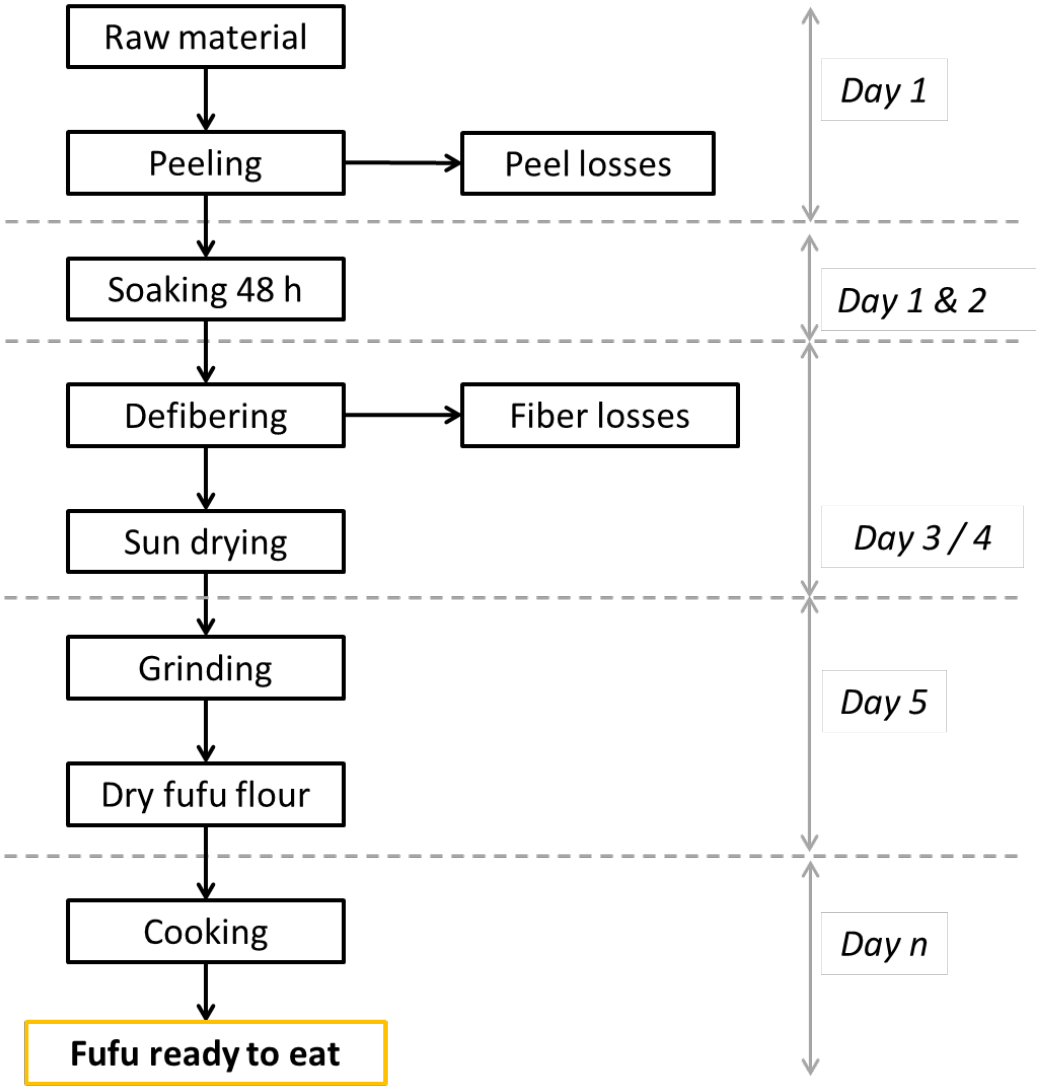
Preferred		Not-Preferred	
Female	**Male**	**Male**	**Female**
Daberechi	Isadep	Durungwo	
Agric	**Daberechi**	Nwanyibekee	
Imobest	**Imobest**		
Durungwo	Agric		
Nwaoji	**Nwaoji**		
Nwaocha	**Nwaocha**		
Yellow root	**yellow root**		



WP2

Fufu process – Bertoua – Cameroon

(A. Bouniol – D. Dufour – T. Tran – G. Fliedel - N Akissoé – L.Adinsi - M.A Ospina)



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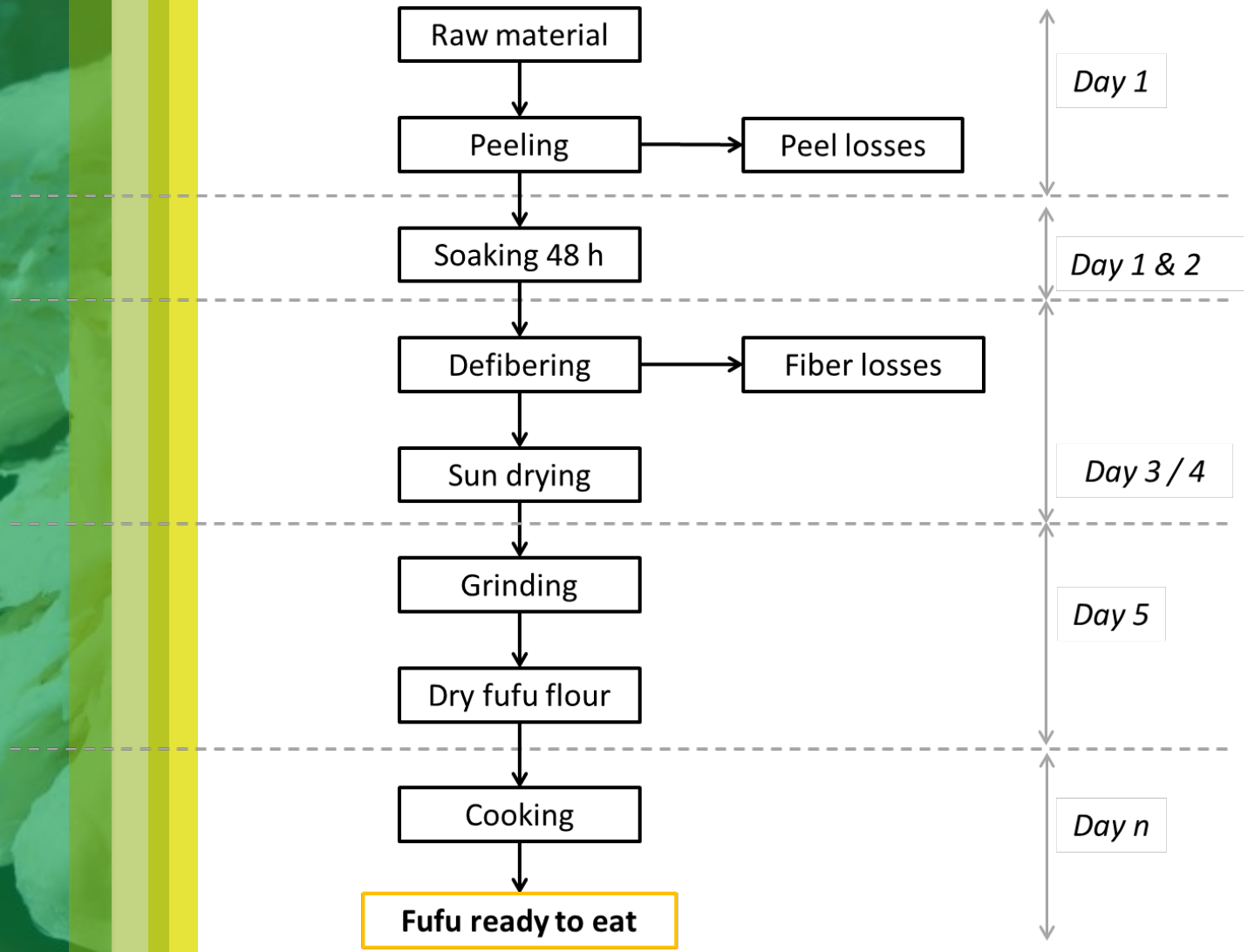

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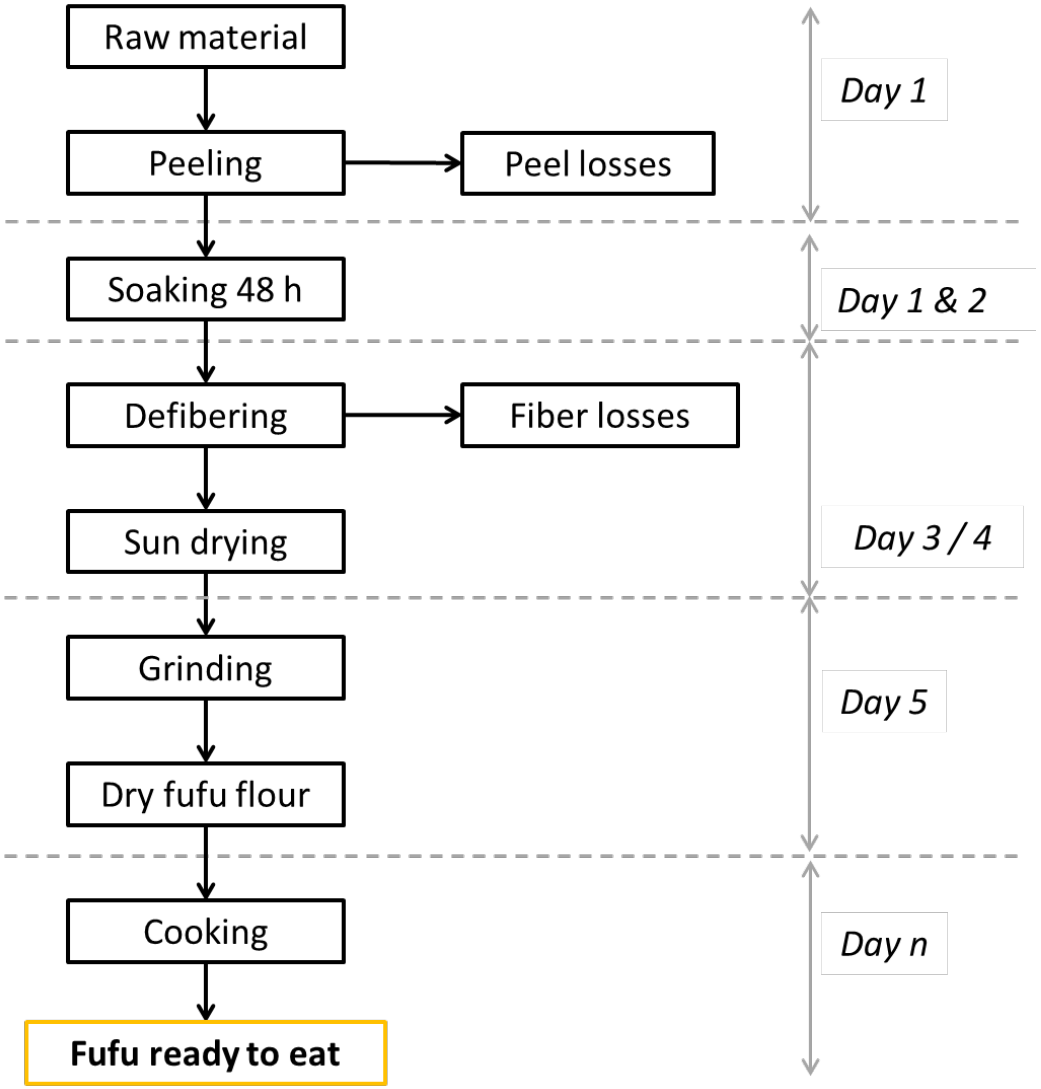

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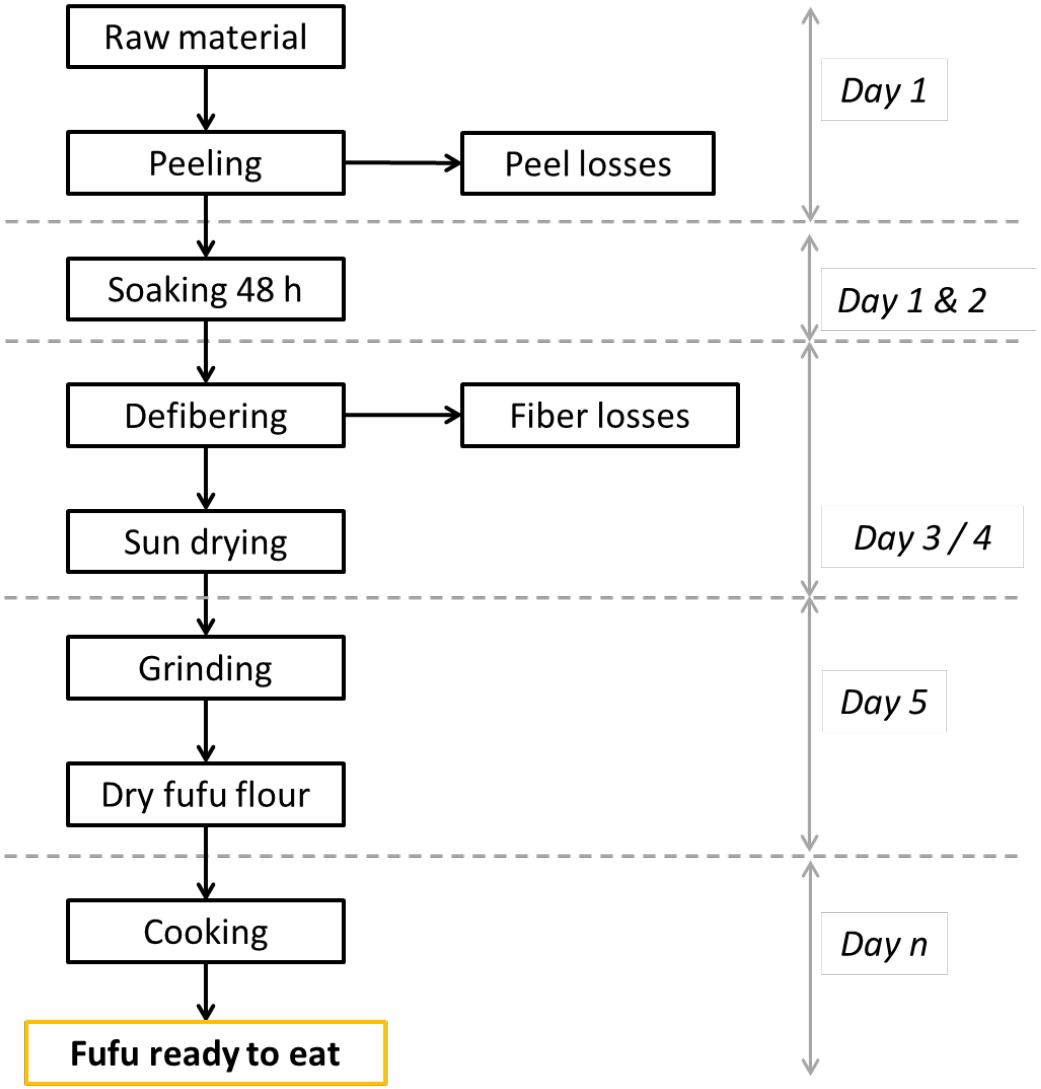

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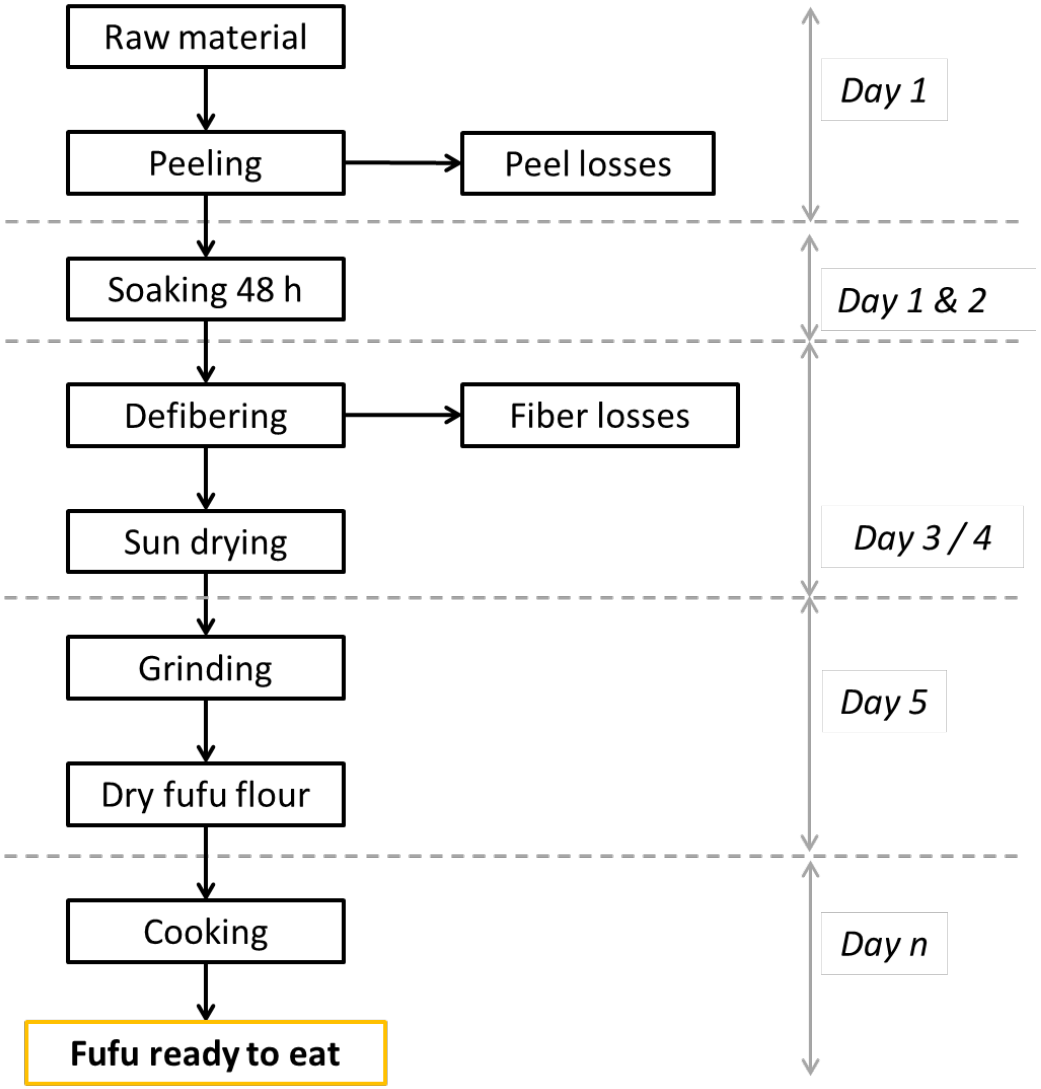

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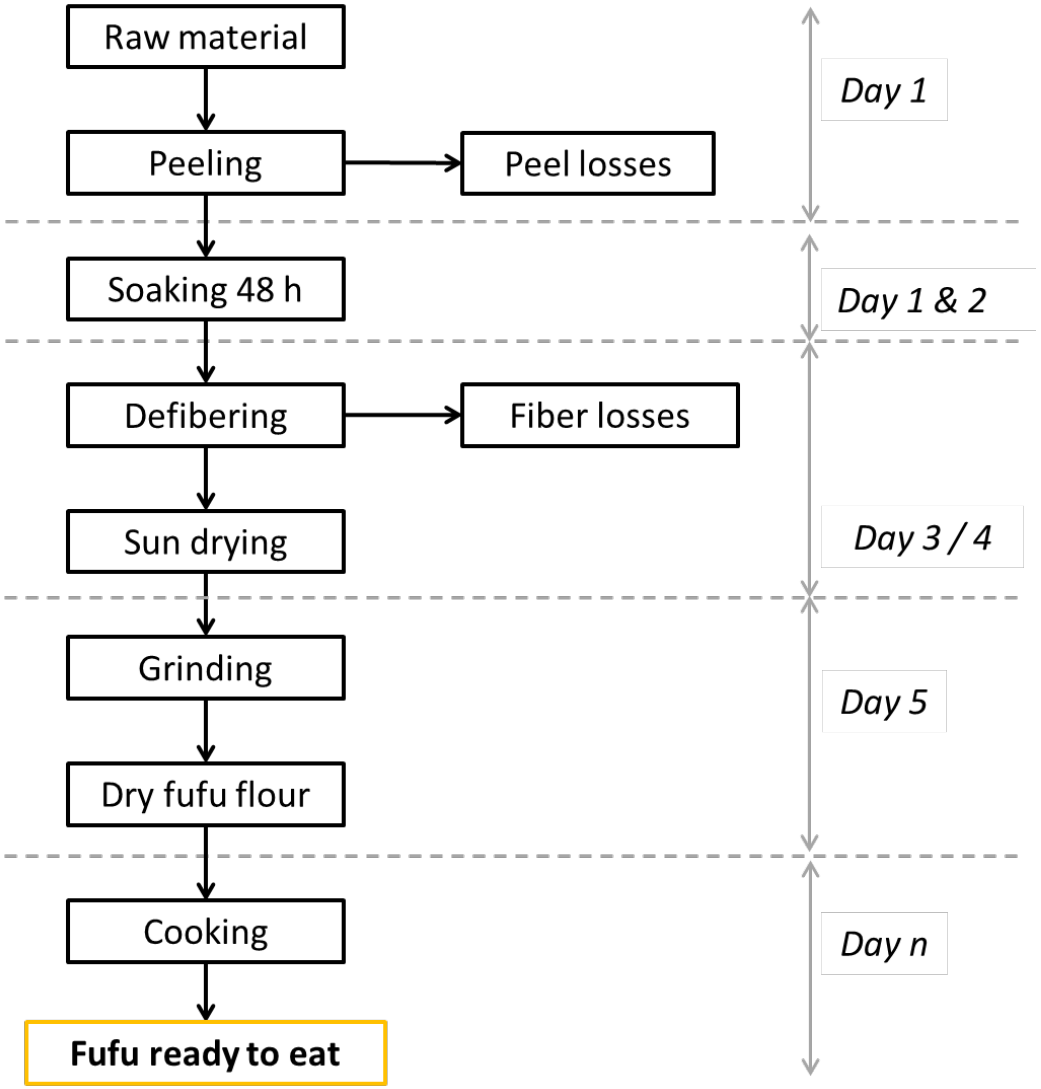

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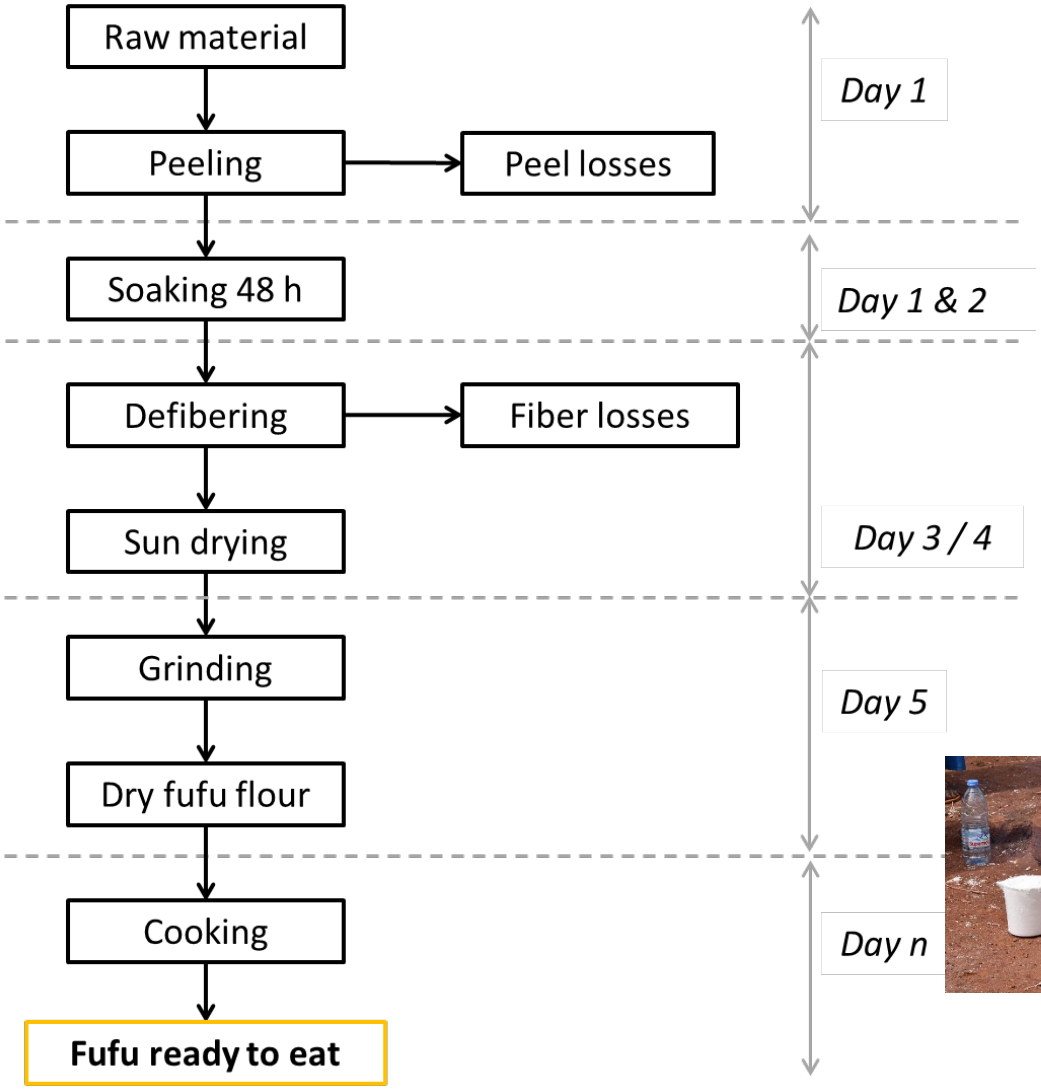

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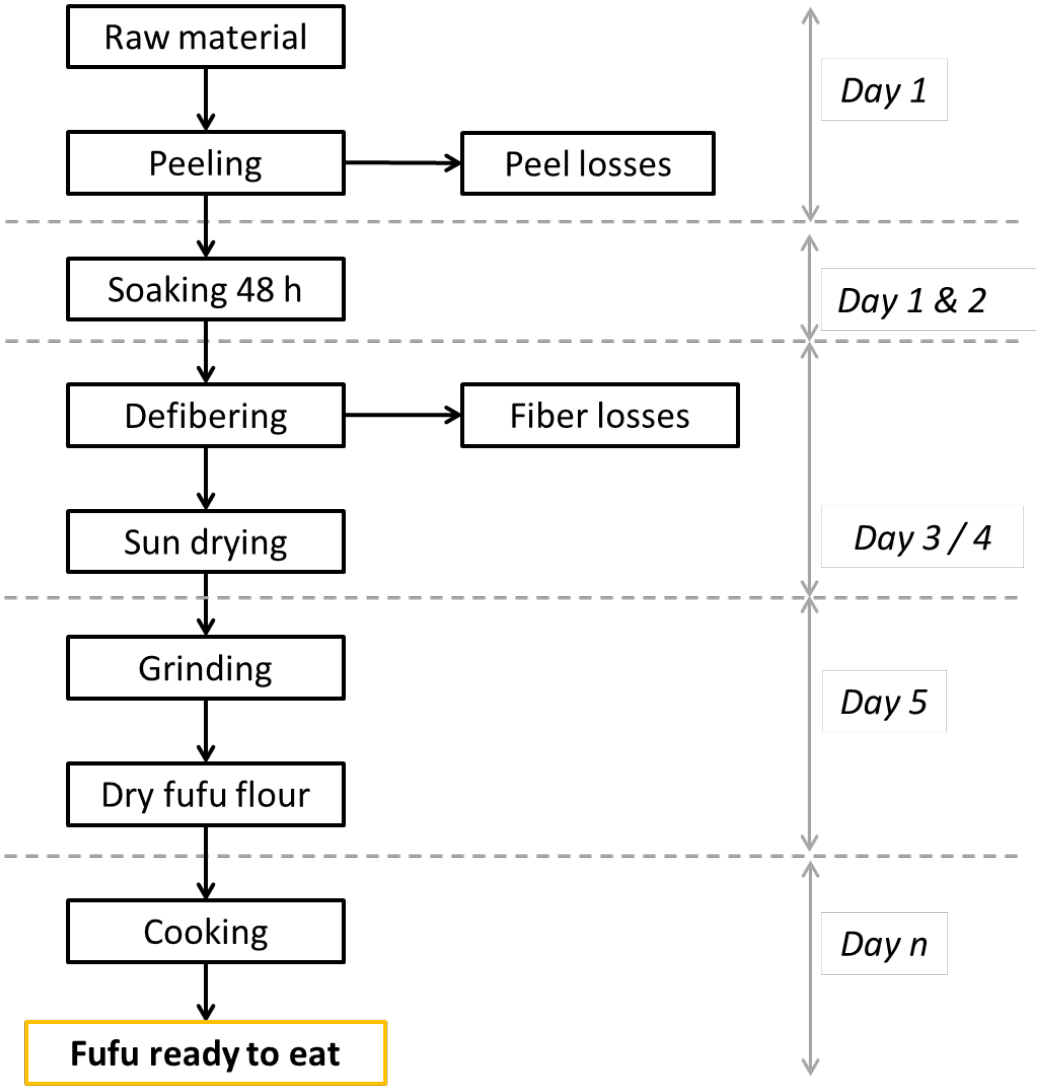


Characterization of Cooking/Processing Ability

- SOP for Preparation of fufu from dried flour

Quantity of flour :Data collected with processors for each genotype

1

Weigh the flour (g)

Quantity of water: fixed parameter

2

Heat water to boiling point (500 ml)

Mixing time: fixed parameter

3

Mix the flour and water for 30 sec

Standardization of the mixing pattern

4

Knead in Kitchen aid using the hook tool

5

Store in oven at 45°C until Texture Test

Storage conditions: fixed parameter (reproducing cool box used by people to store product during the night)

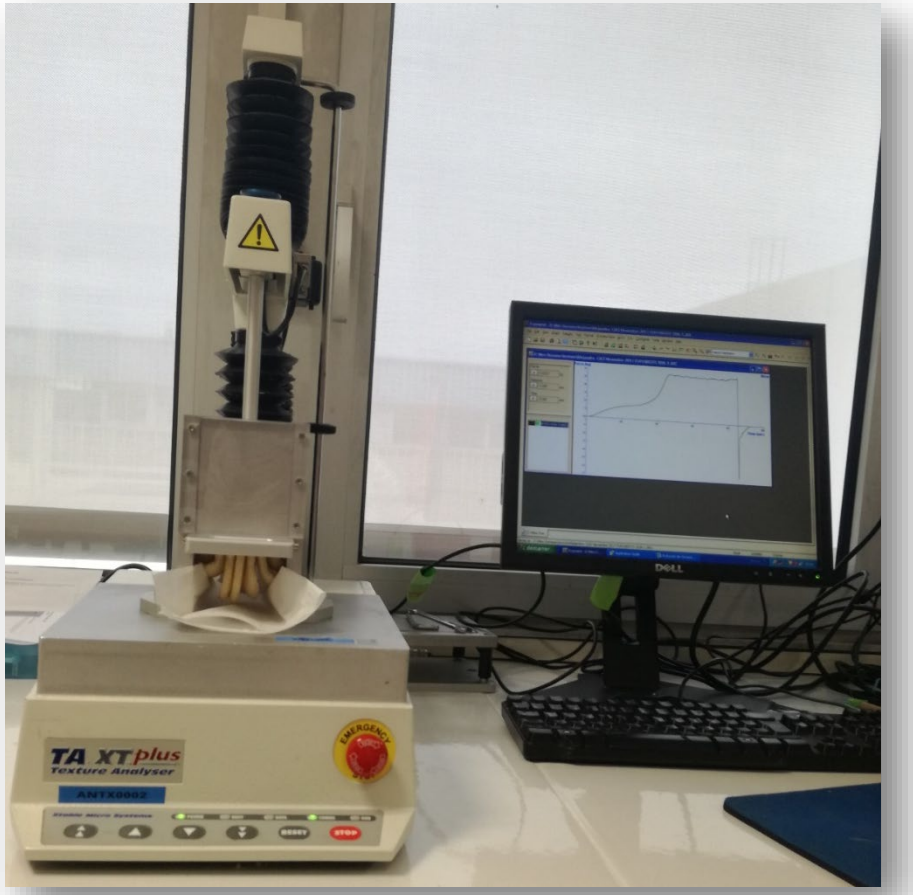
Fufu process – Bertoua - Cameroon

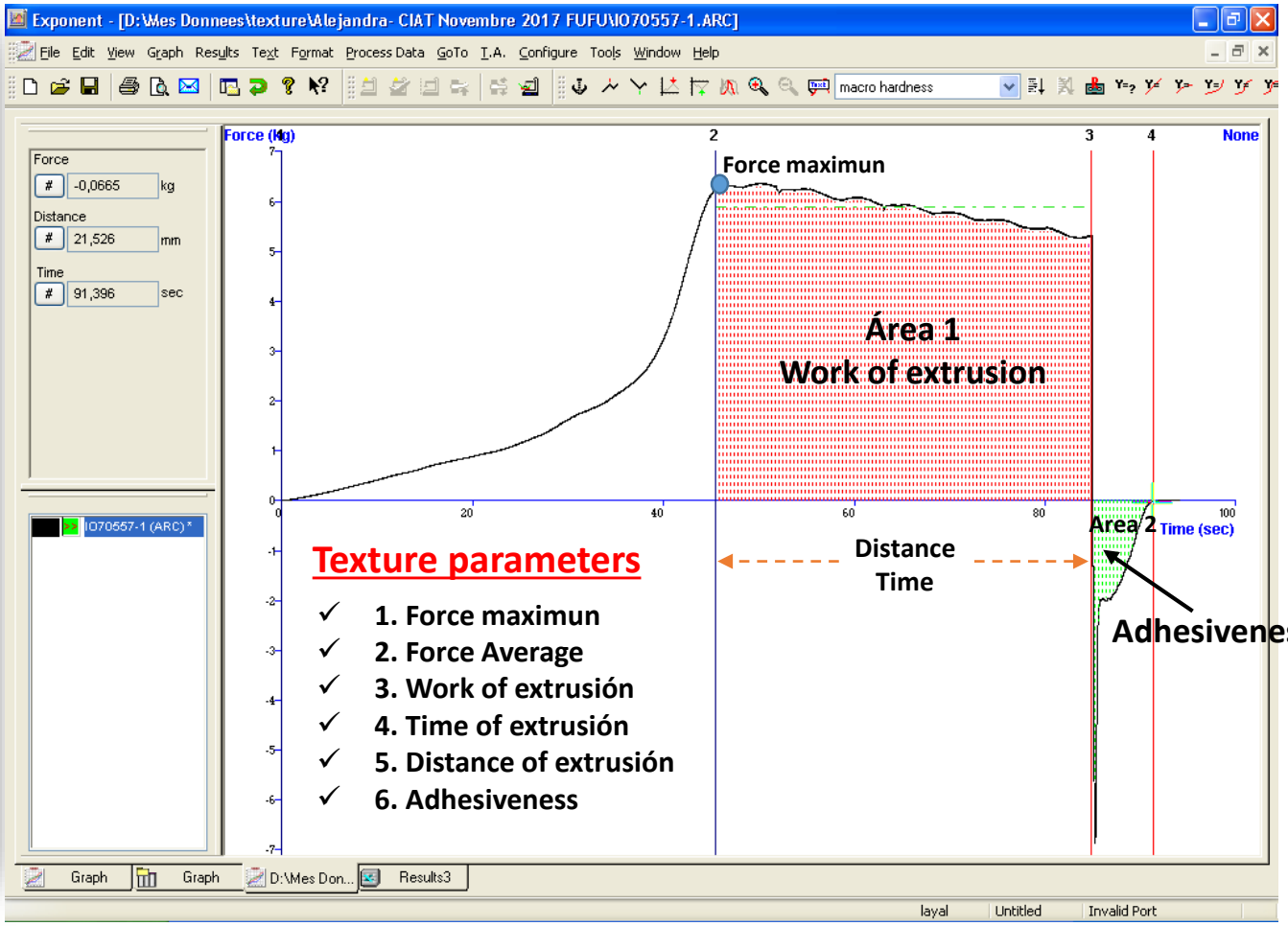
Fufu ready to eat with significant differences in term of :

- color from brown to yellow
- textural properties / behaviour: from firm to « sticky-viscous »

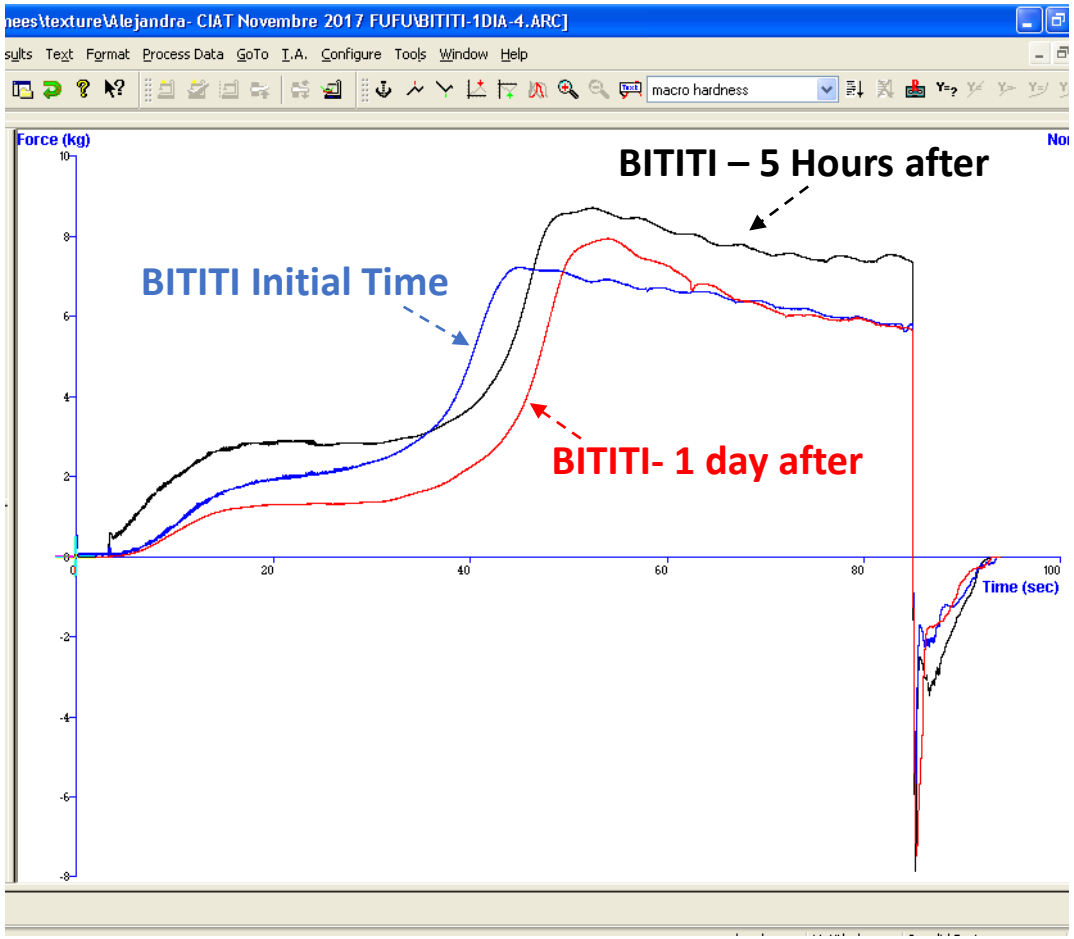
Fufu texture measurement

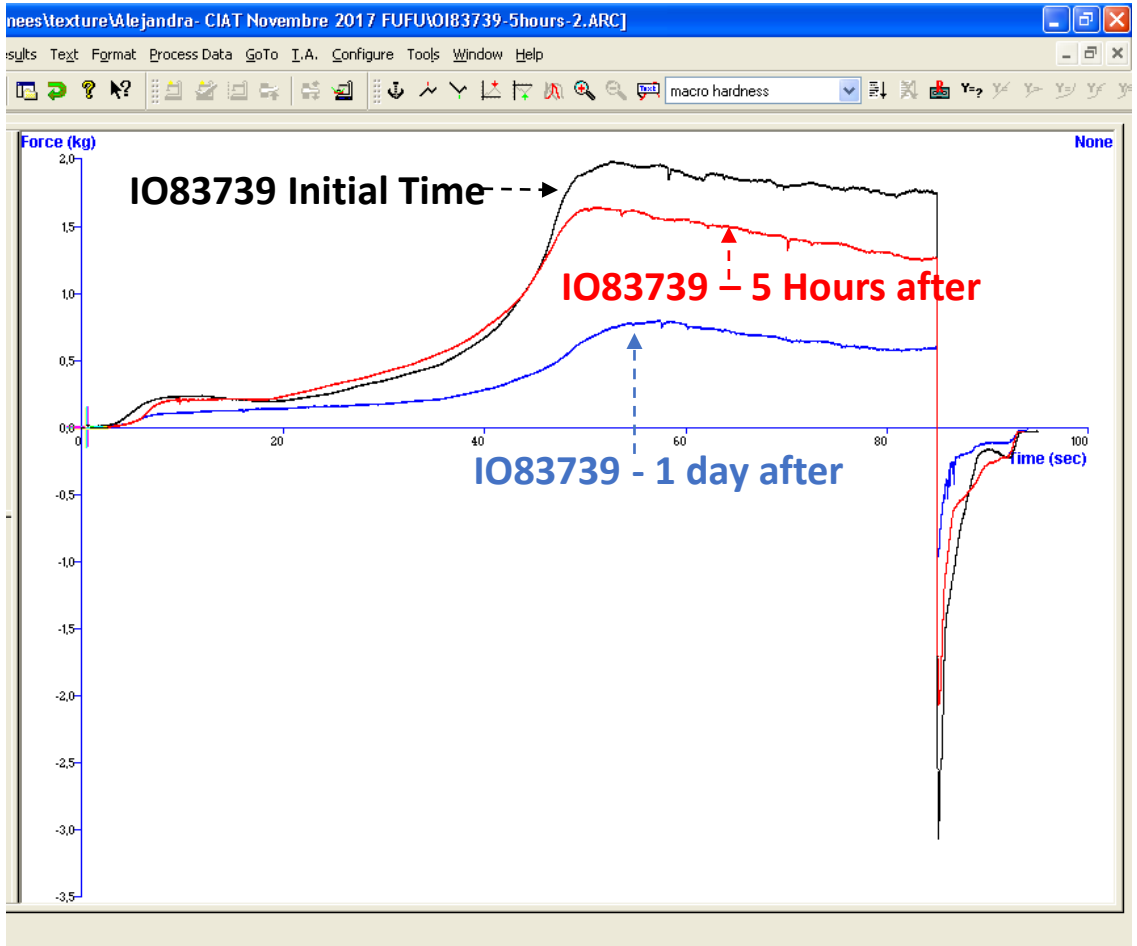
Development of a texture test using an extrusion cell





Fufu textural behaviour (preliminary results)





Local variety with a stable textural beahaviour ***vs*** *new genotype with « collapsing » behaviour after 5 and 24 hours*

Characterization of Cooking/Processing Ability

- SOP for Preparation of fufu from mash

RATIO OF FUFU MASH : WATER MUST BE 2:1

1

Pregelatinization temperature is fixed: The mantle of the yam pounder to 93^{0}C

2

3

***Smoothness of dough**: The partially gelatinized dough must be stirred intermittently during the first pounding to achieve a smooth lump free dough.*

4

To achieve a final gelatinization, the dough must be cooked for 5mins

5

The dough must not be over cooked to avoid a glassy dough.

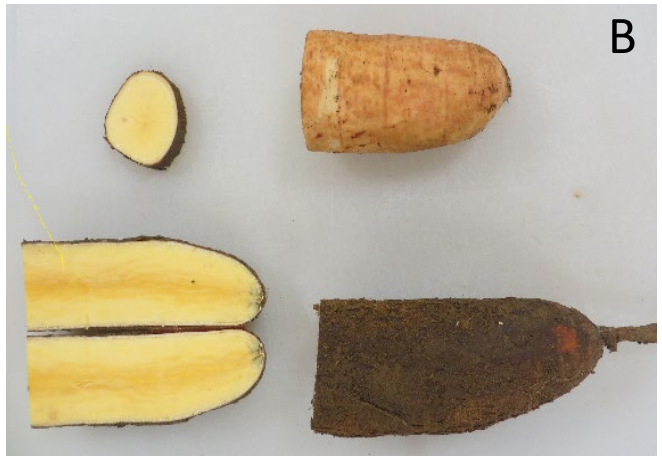
Traits Dissection to Explore/Explain Biophysical Quality Characteristics

Id	Flesh color
I090616	White
92/0326	
LMR	
I090590	
Local variety	

Id	Flesh color
01/0040-27	Yellow
I011412	
01/1797	
I071026	
I070593	
I082264	

Table 1: Core collection of cassava genotypes used in this study

Traits Dissection to Explore/Explain Biophysical Quality Characteristics



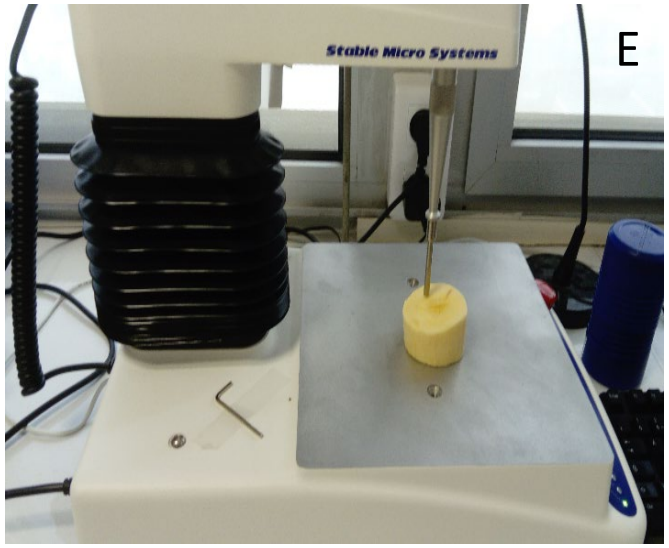
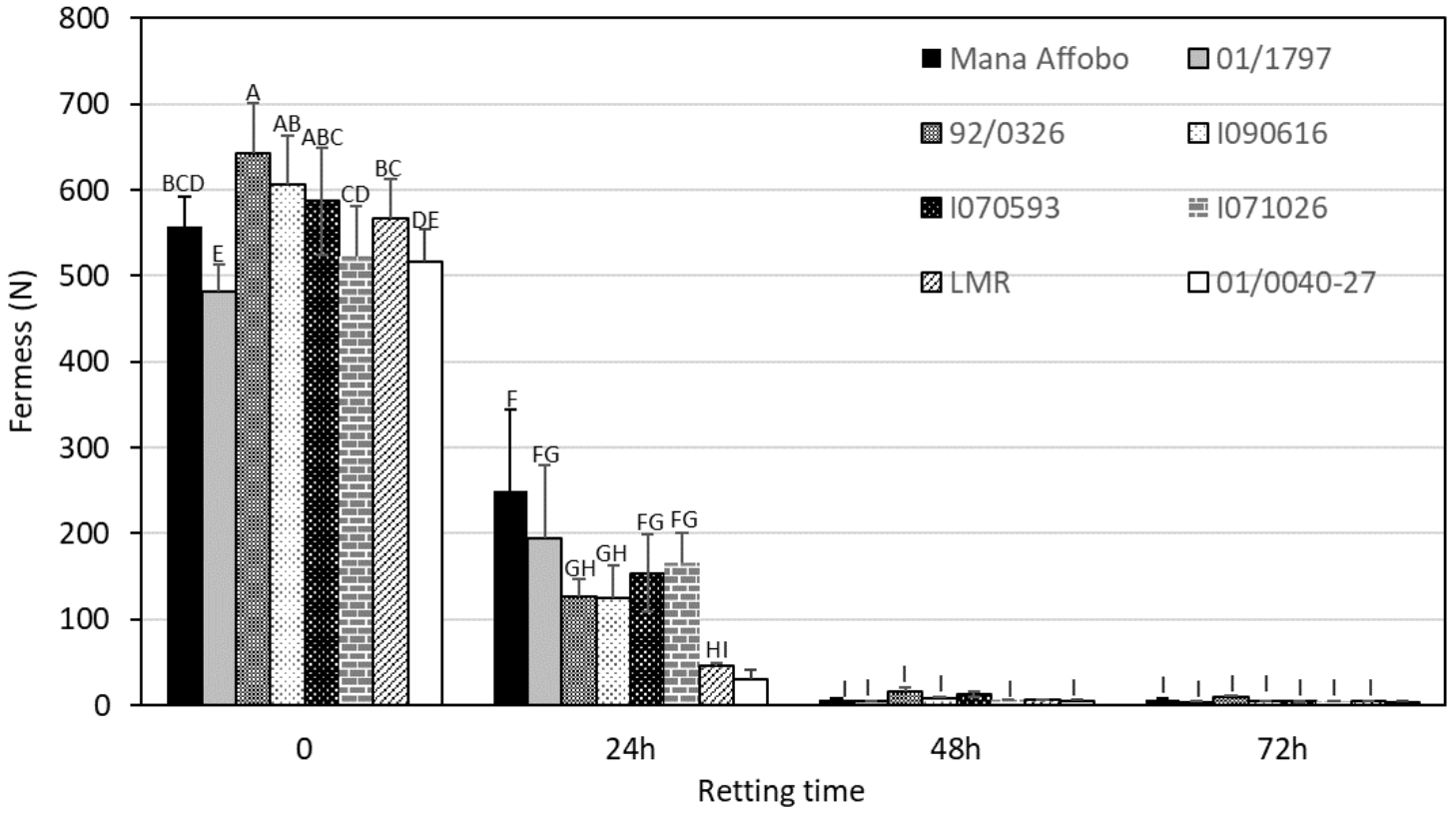


Figure 1: Experimental scheme including harvest (A), peeling (B), retting (C) and sampling (D) and firmness analysis (E).

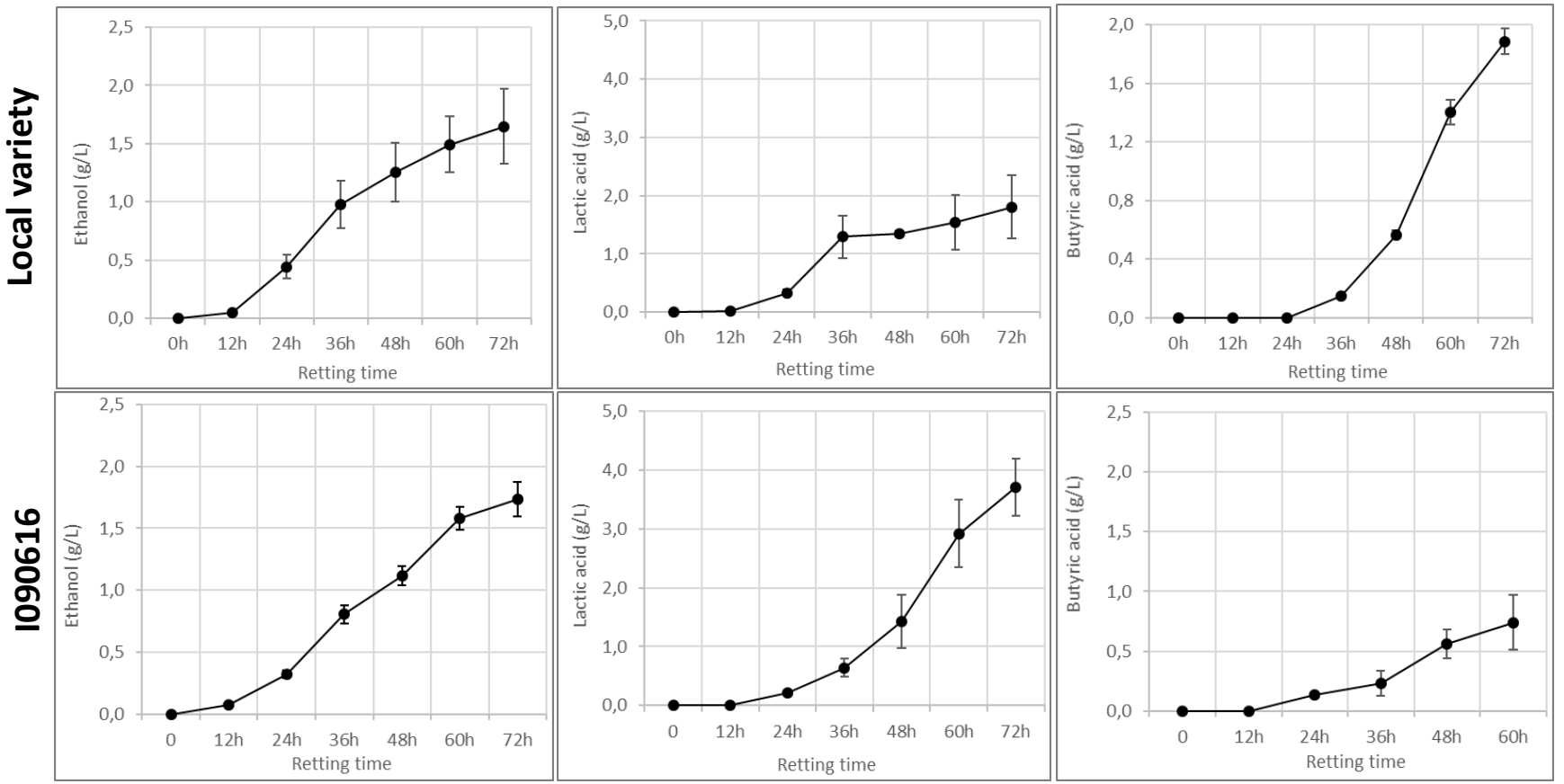
Traits Dissection to Explore/Explain Biophysical Quality Characteristics



Changes of root softening during retting process of a set of cassava genotypes

Root softening, a measurable physical indicator of cassava retting process

Traits Dissection to Explore/Explain Biophysical Quality Characteristics



Changes of biochemical component of soaking water during retting process of two cassava genotypes

Biochemical compounds of soaking water, additional measurable indicator of cassava retting process

Traits Dissection to Explore/Explain Biophysical Quality Characteristics

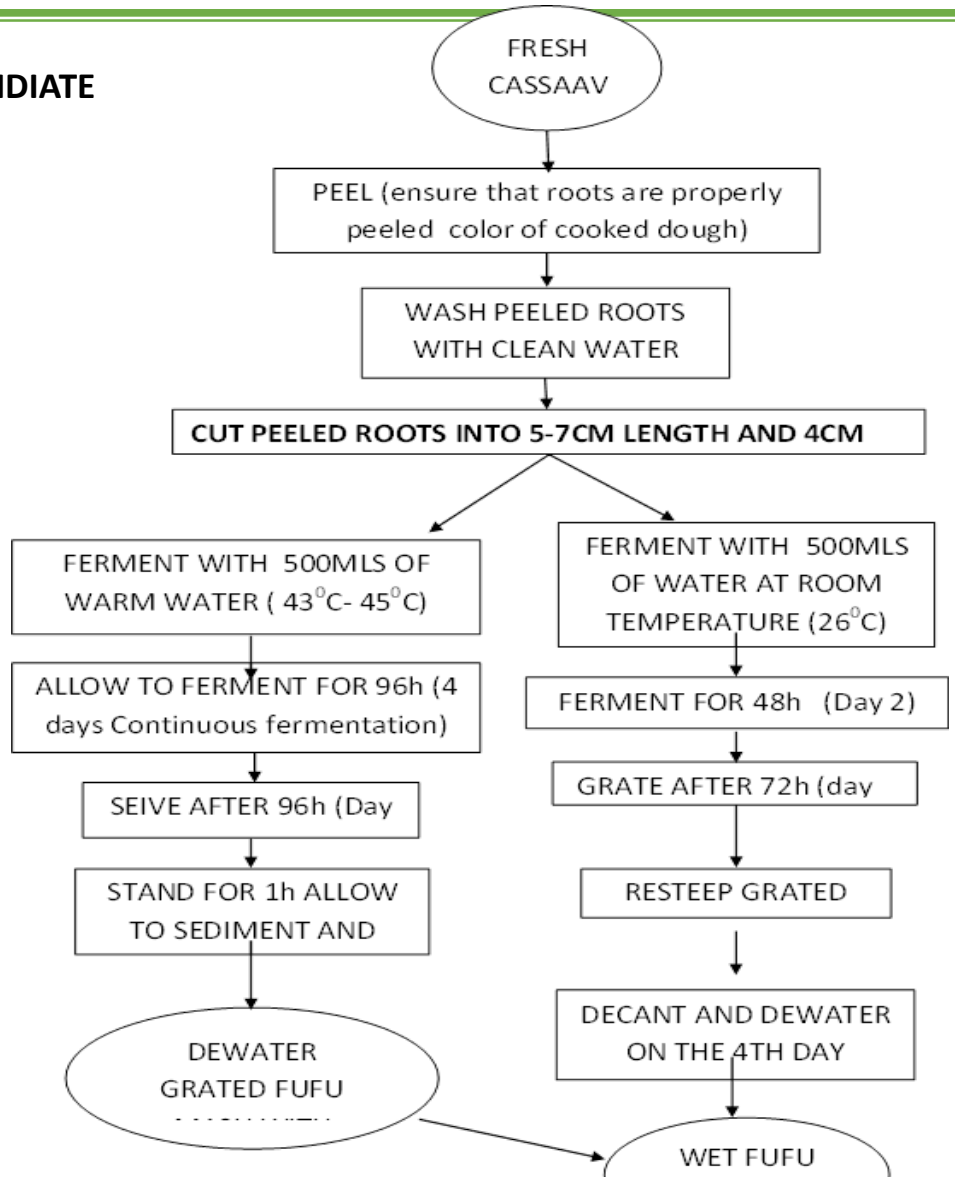
NCRP TRIAL
TMS13F1160P0004
NR130124
IITA-TMS-IBA30572
TMS13F1122P0005
TMS13F1153P0001
TMS13F1053P0015
TMEB419
NR14B-218
NR1741
IITA-TMS-IBA000070
TMS13F1343P0022
TMS13F1307P0016
TMS13F2110P0008
NR095F
NR130022
NR292D
Nwaibibi
TMS13F1343P0044

- **Table 1: Core collection of cassava genotypes used in this study**

Fufu processing – Abia and Imo-NIGERIA

(U.CHIJOKE, A. OGUNKA, S. OSADEKE, U.IRO)

SOP FOR PROCESSING INTERMIDIATE FUFU PRODUCT



Traits Dissection to Explore/Explain Biophysical Quality Characteristics

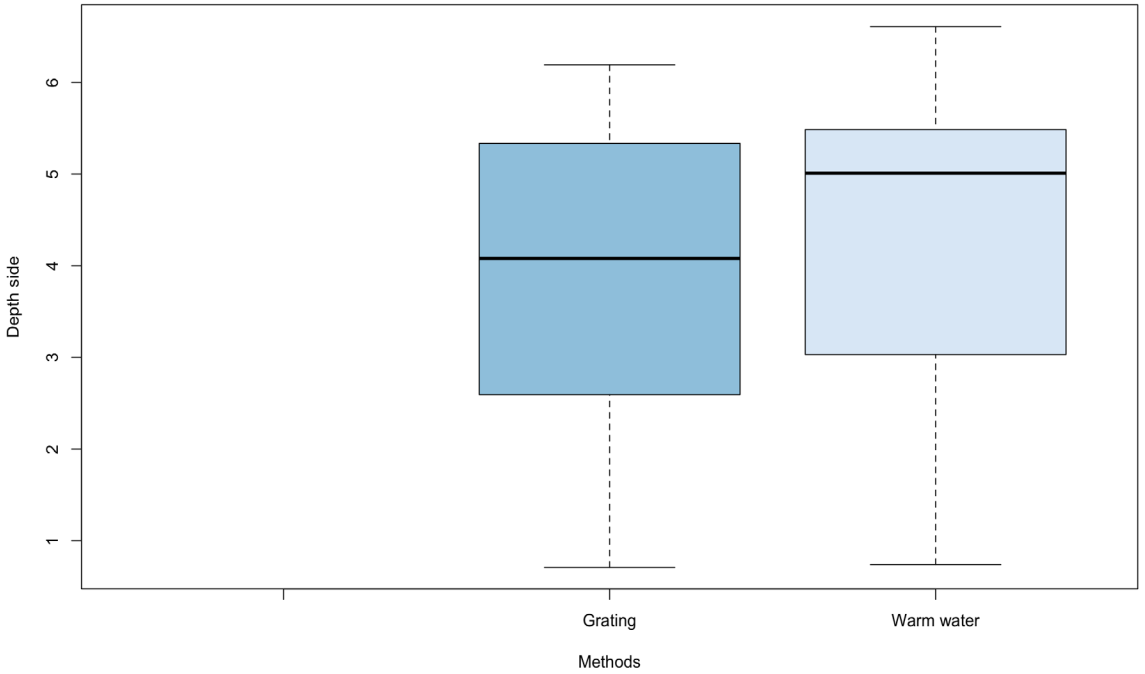
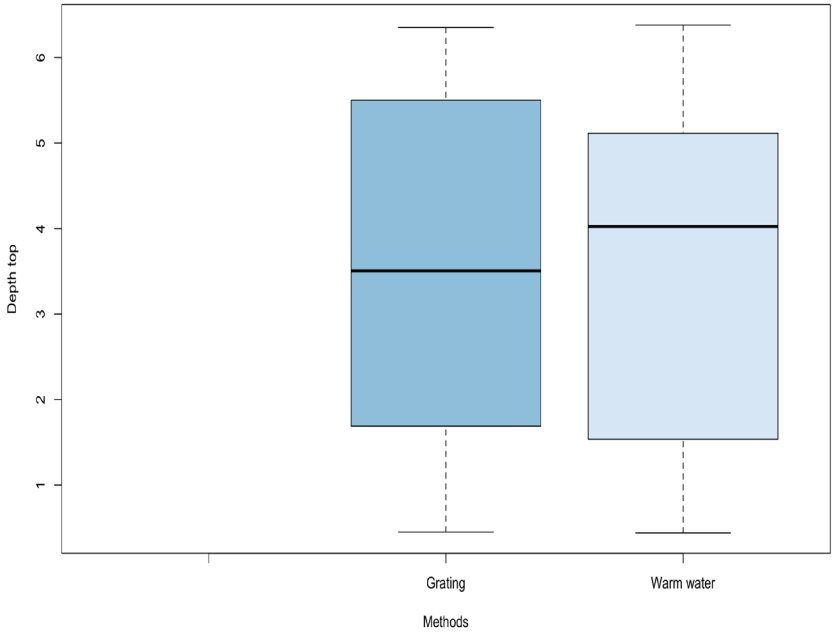


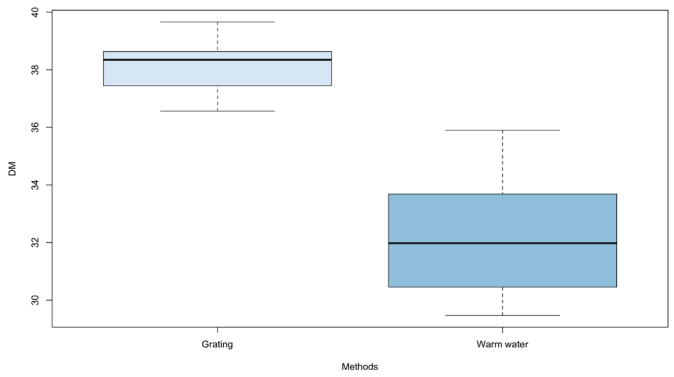
Fig 1:softening ability of outer/side region some cassava genotypes



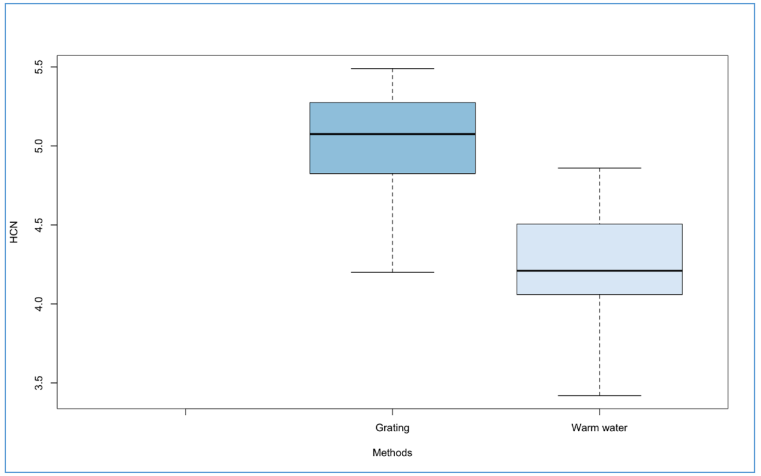
Softening ability of Top region some cassava genotypes

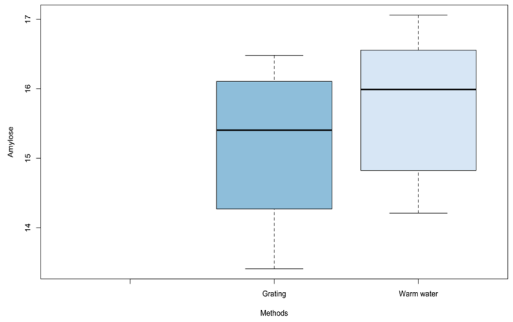
Root softening, a measurable physical indicator of cassava retting process

Traits Dissection to Explore/Explain Biophysical Quality Characteristics



Dry matter content of intermediate fufu product





Amylose content intermediate fufu product

HCN content of intermediate fufu product

Biochemical content of intermidate fufu samples from two different Fermentation methods

Sensory Profiling of Varieties

- ✓ List of Descriptors
- Nb of Varieties profiled
- Correlations with Instrumenta

	Sensory Attributes	Description
COLOUR	White	As white as a flip chart paper
	Off- white	As white as soy milk colour
	Cream colour	cream in colour, e.g liquid peak milk
	Light yellow	Colour of an egg yolk
	Yellow	Colour of of a yellow maize
TEXTURAL QUALITY	**Smoothness**	
	Fibrous	Three leaf yams
	lumpy	Forming tiny balls inside Dough
	No lumps	Very smooth like a plain
	Softness	
	Slightly soft	e.g very ripe Pawpaw
	Soft	Agidi
	Very soft	Very very easy to press
	Strecthability	Chewing gum
	Not strechable	
	Slightly strechable	
	Strechable	
	Sticky	
	MOUDABILITY	
	Not Moudble	
	Slighly Mouldable	Dough that can be moulded like clay
	Moudable	

Sensory Profiling of Varieties

- ✓ List of Descriptors
- Nb of Varieties profiled
- Correlations with Instrumental M

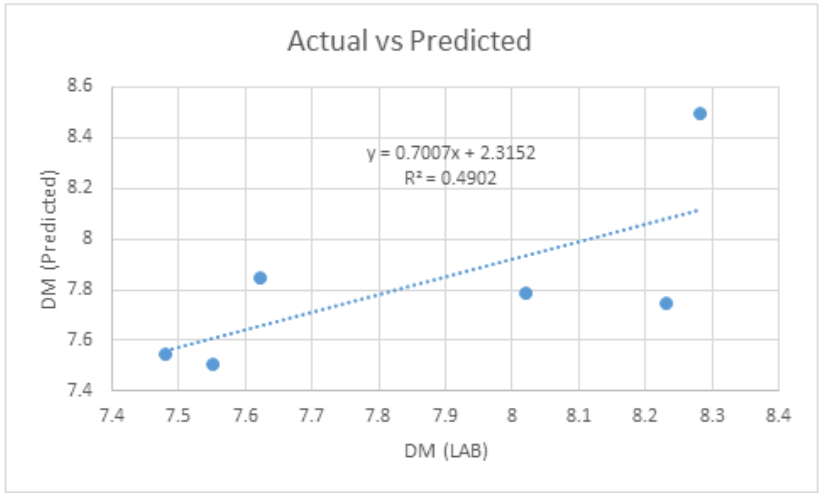
	Sensory Attributes	Description
STICKINESS	Not Sticky	Dough that can be gummy to the hand
	Slightly Sticky	
	Very Sticky	
ODOUR	Odourless(Bland)	Dough has no Odour like semovita
	Slightly Odourless	
	Sour	Dough that has the smell of fermented fufu products
	Very Sour	Fufu that can be slappy on the cheeks
SOFTNESS/HARDINESS	Hard	Like Garri
	Very Soft	Easy to press
	Soft	
	Slightly Soft	
	Slightly Hard	
	Very Hard	
SMOOTHNESS	Fibrous	Homogenous in appearance and handfeel does not have fibre
	No Fibre	
	Big lumps	
	Small lumps	
	No lumps	

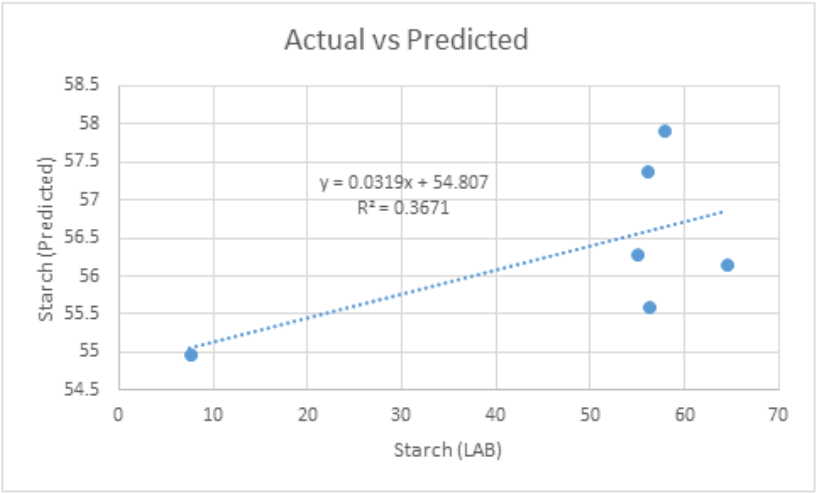
roduct / Activity Picture

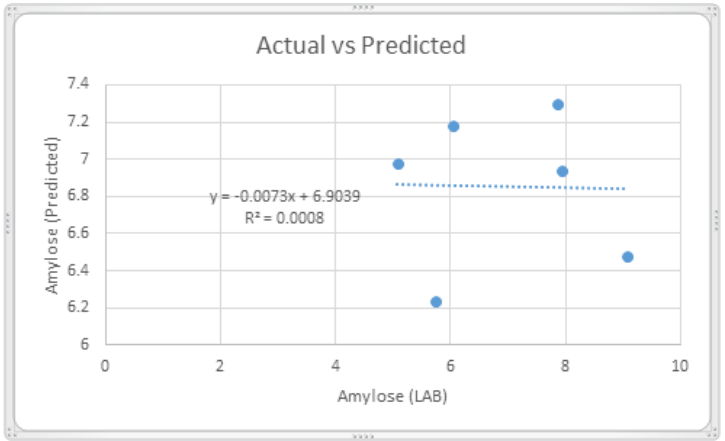
WP3

Development of Calibrations to Predict Quality Traits

- Quality Traits for which a Calibration is being developed (+)
- Product presentation to be mentioned (fresh raw, fresh raw ground, raw dried ground, cooked dried, etc.)
- **Traits to be Calibrated**
- DM, starch, amylose and moisture content,
- Nb of spectra used, with reference data
- **SAMPLE PREPARATION FOR INTERMIDIATE FUFU PRODUCT**
- The intermediate Fufu samples were sampled in two forms;**wet dewatered mash and dried milled fufu flour.**
- **Three (**3) quartz sampling cups were used to fill the mashes and spectra captured on them for each clone, thereby making a total number of 9 spectra per clone.
- I.e. 3 cups X 3 spectra = 9 spectra per clon


Actual vs Predicted
y = 0.7007x + 2.3152
R² = 0.4902
DM (Predicted)
DM (LAB)
8.6
8.4
8.2
8
7.8
7.6
7.4
7.4
7.5
7.6
7.7
7.8
7.9
8
8.1
8.2
8.3
8.4


Actual vs Predicted
y = 0.0319x + 54.807
R² = 0.3671
Starch (Predicted)
Starch (LAB)
58.5
58
57.5
57
56.5
56
55.5
55
54.5
0
10
20
30
40
50
60
70


Actual vs Predicted
y = -0.0073x + 6.9039
R² = 0.0008
Amylose (Predicted)
Amylose (LAB)
7.4
7.2
7
6.8
6.6
6.4
6.2
6
0
2
4
6
8
10

WP4

Key Progress in Cassava Breeding for Quality

- Major activities were executed under WP4:
- a) harvesting and NIRS spectra collection from roots of the NextGen C2 CET at Ubiaja.
- b) undertake a GxE study using the NextGen C2 population comprising 250 individuals currently established at Ubiaja and Umudike
- c) harvesting and evaluation of C1a UYT and C1b AYT for NIRS and dry matter parameters

Table : Description of the phenotypic dataset generated in 2019.

Location	Description	No. of clones	No. of reps	Traits measured/In progress
Umudike	C1 UYT	18	3	Dry matter, starch yield and content, amylose, fibre, HCN, swelling power, solubility, RVA
Umudike	C1 AYT	51	3	Dry matter, starch yield and content, amylose, fibre, HCN, swelling power, solubility, RVA
Ubiaja	CET C2. WACCI PhD study for starch. Trials now planted in 2 locations.	250	1	NIRS spectra reads from roots. RVA starch analysis ongoing.
Umudike/Igbariam /Otobi	WACCI PhD study for mealiness.	150	2	NIRS spectra from 2 locations. Penetrometer used for softness. Taste panel evaluation of boiled roots for mealiness.

Traits Dissection to Explore/Explain Biophysical Quality Characteristics

UYT TRIALS
NR8082
NR15C1aF44P002
IITA-TMS-IBA00070
TMEB7
NR15C1aF4P007
NR15C1aF23P003
NR15C1aF68P007
NR15C1aF116P001
NR15C1aF24R26P01
NR15C1aF9P002
NR15C1aF24P001
IITA-TMS-IBA30572
NR15C1aF28R13P01
NR15C1aF99P006
NR15C1aF4R22P01
NR15C1aF93P001
NR15C1aF100P001
NR15C1aF25P001
NR15C1aF3P017
TMEB419

Table : Core collection of cassava genotypes used in this study

MATERIALS AND METHOD

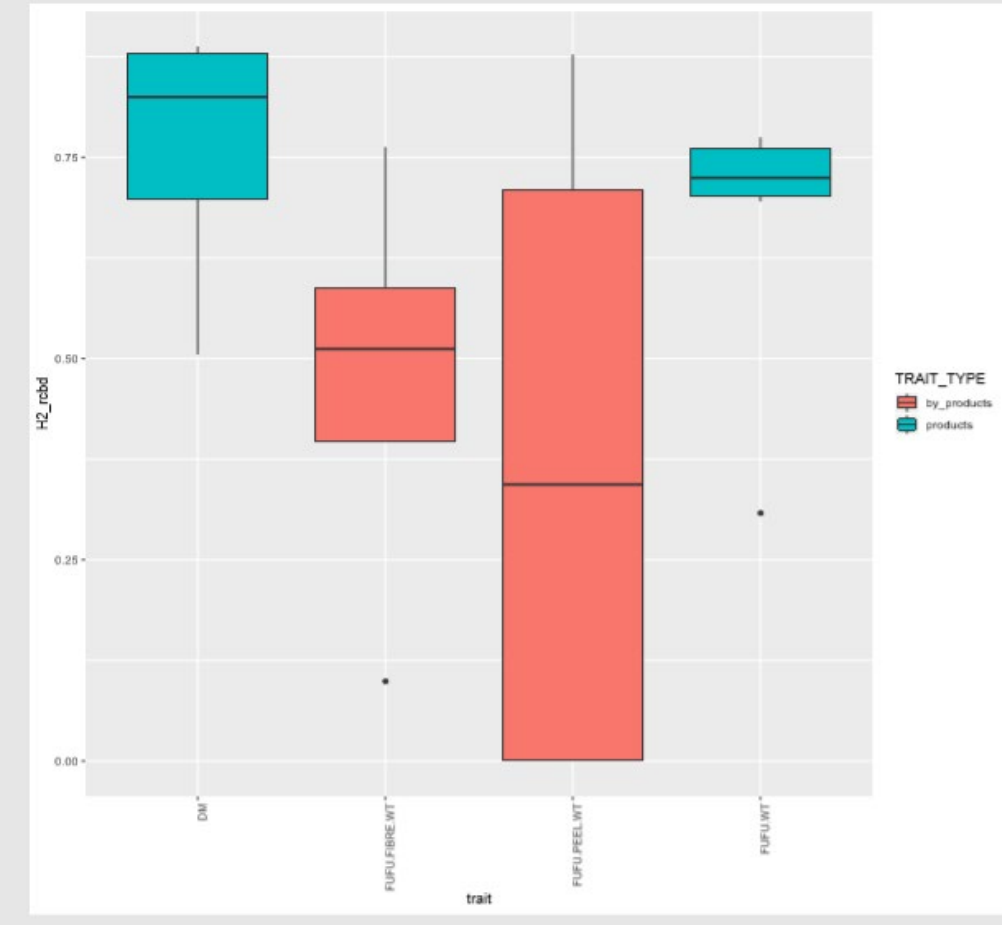
- 20clones of cassava at UYT stage were harvested in Umudike and Otobi locations respectively
- 5kg of root per clone were peeled using a knife, the weight of the peel and peeled tubers were weighed on a scale.
- The roots were washed with clean water and soaked for 4 days before sieving and dewatering to get the wet fufu mash.
- Dry matter content, starch content and yield, bulk density and amylose was determined using standard methods
- Statistical analysis was done using SPSS and GENSTAT

TABLE 4: ANOVA of processing parameters and some biophysical properties of FUFU from UYT Cassava clones in two locations within South-east Agro-ecology in Nigeria

TRIAT	DF	SUM OF SQ	MEAN SQ	F VALUE	Pr>f
PEEL LOSS	35	30328.19	86.52	1.12	0.365
CHAFF LOSS	35	2552.72	729.42	2.86	0.001
%YIELD	35	5405.07	154.43	2.04	0.018
MC(DRY WEIGHT)	35	870.81	24.88	4.84	<0.0001
MC(WET WEIGHT)	35	22615.711	6.46.16	4.02	<0.0001
AMYLOSE (DRY WT)	35	33976.23	970.75	5.81	<0.0001
AMYLOSE (WET WT)	35	30129.26	860.81	4.48	<0.0001
STARCH (DRY WT)	35	21370.57	610.59	171.34	<0.0001
STARCH WET WT)	35	24440.17	698.29	4.29	<0.0001
DM	35	22261.39	636.04	29.02	<0.001

TABLE 5: Pair- wise Correlation analysis for FUFU processing parameters of UYT clones in different locations

	Peel loss	Chaff loss	%yield	DM(Dry wt)	Starch (dry wt)
PEEL LOSS	1.0000				
CHAFF LOSS	0.3361*	1.0000			
% YIELD	0.0526	-0.5828*	1.0000		
DM(DRY WT)	-0.2924*	-0.3001*	0.2012	1.0000	
STARCH (DRY WT)	0.3181*		-0.2953*	-0.8807*	1.0000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0.50
0.25
0.00
DM
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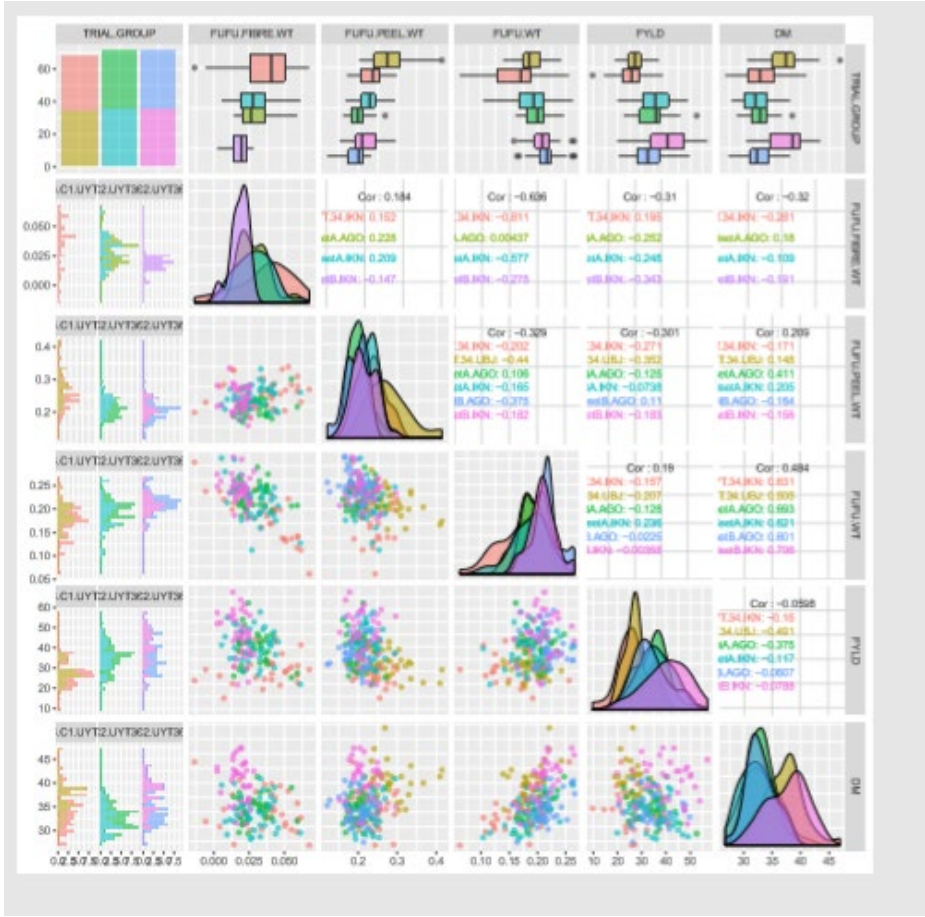
FUFU.PEEL.WT
FUFU.WT
trait
TRAIT_TYPE
by_products
products


TRIAL.GROUP
FUFU.FIBRE.WT
FUFU.PEEL.WT
FUFU.WT
FYLD
DM

Insert Crop / Product / Activity Picture

WP5

On-Farm Trials & Evaluation of Advanced Material

- On-farm / Advanced Trials
- Examples of Participatory Evaluations of Pre-released Material

Conclusion on Perspectives for all WPs

- WP1 Activity 4 & 5 Data Analysis – Consolidation of Final Product Profile
- Interactions WP1 / WP2: GOOD
- Definition of Quality Traits to inform Crop Ontologies (by WP2) -ONGOING
- New Spectral Calibrations to be dvped for Quality traits (by WP3)-ON-GOING
- IJFST Publication:
- …

- NEXT LEVEL
- FINAL REPORT ON ACTIVITES 4 AND 5
- SENSORY PROFILING STUDIES
- IMPROVE SOP ON SAMPLING AND PREDICTION OF FUFU QUALITY TRAIT WITH ASD QUALITY TREC
- TEXTURAL ANALYSIS STUDY

- THANK YOU