Field Scientific Report

Participatory Processing Diagnosis for Gari/Eba in Nigeria

Understanding the Drivers of Trait Preferences and the Development of Multi-user RTB Product Profiles, WP1, Step 3

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Ethics: The activities, which led to the production of this document, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing practices. When external participants were involved in an activity, they were priorly informed about the objective of the activity and explained that their participation was entirely voluntary, that they could stop the interview at any point and that their responses would be anonymous and securely stored by the research team for research purposes. Written consent (signature) was systematically sought from sensory panelists and from consumers participating in activities.

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ABSTRACT

Farmers-processors cassava roots and products qualities identified through participatory processing methods in two states in Nigeria

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Cassava is a major staple food among rural and urban dwellers in Nigeria. It serves as food security and source of income for cassava value chain stakeholders. This study was conducted to ascertain desired cassava root and food qualities to assist breeders to develop variety that meet the needs of cassava end users. This study was conducted in Osun and Benue states Nigeria with 3 champion' cassava farmers-processors in each state to select cassava with preferred roots and food qualities. Freshly harvested roots of four cassava genotypes with contrasting characteristics were presented to 3 champions' farmers-processors to process into gari and eba to illicit information on desired roots and food qualities of cassava. Fresh roots, gari and eba were evaluated. The produced quantities of food products were used to carry out consumer testing in rural and urban areas. The results of this consumer testing are covered in a separate report. Structured questionnaires were used to illicit information from the three champions' processors on preferred qualities of cassava fresh roots and products (gari, eba). Fresh roots and its products were ranked by the processors. The preferred cassava fresh root qualities identified were:root weight (29%), marketable root size (26%), quality and quantity of products that can derived from the roots (23%), less water in the root pulp (14%), root colour (9%), preferred gari qualities identified were granule size (24%), weight (16%), colour (16%), taste (14%), well-cooked (14%), loose on fingers (11%) and crunchiness (5%) while smoothness (24%), moldability (18%), drawability (18%), colour/shininess (15%), taste (9%), easy to swallow (9%), softness (3%) and moderately hard (3%) were eba qualities identified. The local variety in Benue state was rated as the best but portrayed the highest weight of chaff to be removed per unit of fresh roots. An improved variety TMS14F1278P0003 also had high chaff weight but was nevertheless very well appreciated by the processors. Apparently chaff weights per unit of fresh root were not in the range that they became very remarkable to processors. Given the time and effort to remove chaff this aspect has to be closely monitored within breeding programs. Breeding cassava with end users preferred roots and food qualities will enhance adoption rate, increase income, productivity and as well generate more revenue for the government through multi-uses of cassava for domestic and industrial purposes.

Key Words: Cassava, participatory processing, gari, eba, processing diagnosis, local processing methods, Nigeria

HIGHLIGHTS

- Elicited important characteristics of fresh roots were: root weight (29%), root size (26%), quality and quantity of products that can derived from the roots (23%), less water in the root pulp (14%), root colour (9%),
- Elicited important gari qualities were: granule size (24%), weight/density (16%), colour (16%), taste (14%), well-cooked (14%), loose on fingers (11%) and crunchiness (5%)
- Elicited important eba qualities were: smoothness (24%), moldability (18%), drawability (18%), colour (15%), taste (9%), easy to swallow (9%), softness (3%) and moderately hard (3%) were eba qualities identified.
- The local varieties in both Benue and Osun state were rated as the best but portrayed the highest weight of chaff to be removed per unit of fresh roots. An improved variety TMS14F1278P0003 also had relatively high chaff weight but was nevertheless very well appreciated by the processors and consistently ranked second for gari quality and ranked first during the pretest.
- The improved variety 14F1022P0003 provided the highest product (gari) yield but was clearly rated lowest for gari quality (in the pretest and final testing) mainly because of dull appearance/colour, stressing the importance of colour/appearance.
- As expected, the biofortified low dry matter cassava variety IITA-IBA011412 provided the lowest product yield and by far the longest peeling time due to irregular root shape (water content was high so should have provided shorter peeling time) and was not well appreciated in Osun state while its gari was better appreciated in Benue (where people are more used to yellow gari) although it got remarks that it was powdery and light in hand.
- The good gari and eba quality evaluated earlier at the breeding unit for variety TMS14F1195P0005 (reason why the variety was included in the pretest) appeared to be the worst variety when evaluated during the pretest in this study. This urges for good realistic protocols on food product quality assessment.

1 STUDY CONTEXT AND GENERAL OBJECTIVES

The main objective of RTB foods is to deploy cassava varieties that meet user-preferred quality traits to increase the adoption and impact of improved cassava varieties in sub-Saharan Africa (SSA). To do so, the project is working to (1) Define the key user-preferred quality traits for a range of RTB food products (cassava) through surveys with end-users (product profiles); (2) Link these product profiles with biophysical and functional properties of RTB food products (cassava), and develop laboratory-based methods to assess these properties in a quantitative manner; (3) Develop high-throughput phenotyping protocols (HTPP) for rapid screening of user-preferred quality traits in new RTB varieties; (4) Integrate key user traits into breeding and variety deployment programs.

Varietal preferences start with the demand from a range of users, such as producers, processors, retailers and consumers along the food chain. User's varietal choices are informed by the preferences they have for certain characteristics of the crop (characteristics preferred) that can be linked to traits. Preferences for characteristics, are in turn, influenced by the products, and their variations, that users make (e.g. gari/fufu in Nigeria), and for what purpose (e.g. urban or rural markets, household consumption). Users often have several specific characteristics that they prefer and/or have 'non-negotiable' sets of characteristics, such as, for producers, that the crop is high yielding or disease resistant. These different interests culminate into trait packages that can help explain the drivers of varietal acceptance.

However, there is a gap in knowledge of preferences for cassava among different user groups, particularly food processors, retailers and consumers, and diversity within user groups, as breeding programmes have historically focused on production related characteristics at the expense of post-harvest and consumer preferences. In addition, information on characteristics is often overly-simplified by not including information on the optimal range or description that would help breeders be able to meet user needs.

The WP1 approach uses interdisciplinary methods and lines of inquiry (food science, gender and economics) to collect evidence on the preferences of RTB product characteristics for different user groups in the product chain and identify the factors that influence these preferences for men, women and other social segments, and how they may be prioritised differently (e.g. labour requirements and storability may be prioritised more for women, over yield characteristics). The delivery of the information is expected to support the capacity of RTB breeding programmes to be more demand-led.

The general objective of WP1 – Step 3 is to conduct participatory processing/preparation of intermediate product (gari) and final product (eba) with champion/expertise processors for selected cassava varieties to understand processors' and consumers' demand for quality characteristics of products such as gari, and eba.

Specifically, activities in period 4 will be to:

- propose a large variability of cassava varieties through farmers/processors, expert and field team opinions to champion processors
- identify key processing steps/operations important in the quality of intermediate product like gari and final product like eba,
- prepare eba or fufu with different quality characteristics and sensory properties that will be part of the Step 4 consumer tests.

2 METHODOLOGY

2.1 Study area

The study area for RTB foods Step 3 is in a small town Ilupeju (Iwo railroad station), Aiyedire Local Government Area (LGA) in Osun state and Tyomu community Makurdi LGA in Benue state, Nigeria (figure 1). These two communities were selected based on the active participation and expertise of cassava farmers/processors in several surveys, FGDs and participatory trials engagements over the years within the scope of the RTB foods and Nextgen cassava projects. Results of the cassava monitoring survey (CMS) by Wossen *et al.* (2017) also informed the selection of Osun and Benue as states among the highest cassava producing and consuming states of Nigeria to represent, simultaneously, two different agro-ecological zones and two different gari producing cultures.

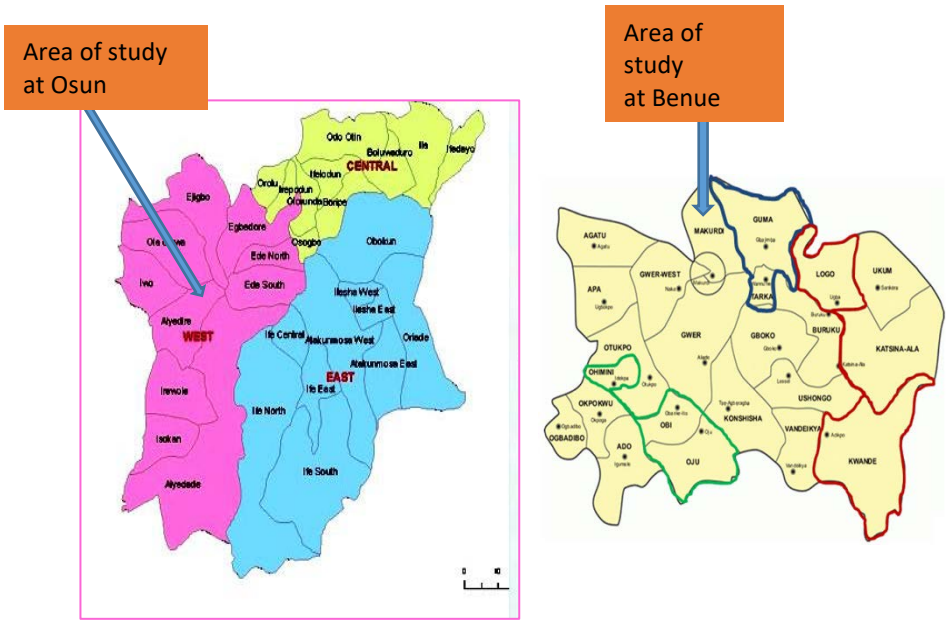

Figure 1: Study areas are indicated with arrow (local government areas where the study were conducted)

2.2 Raw material choice

A total of eight (8) varieties were meticulously selected with expert opinions (Nextgen cassava breeders) in consultation with the Field/Research team. Table 1 shows the nine contrasting cassava clones/varieties selected using the important criteria identified in Step 2 analysis results such as color (brightness, dullness or no discolouration during processing), dry matter content, root weight and shape and gari/eba qualities. The nine selected cassava varieties consisted of a breeders' check, two breeders best with very good food quality, one with medium score in food quality, one with clear over-all complaint in food quality, one biofortified (vit. A) variety with complaints on low dry matter content and local farmer preferred varieties.

Table 1: Varieties chosen for pretest to make contrast for consumer testing at Osun and Benue state

S/N	Varieties	Food quality Class	Average DM 2017/18	Gari Yield	Remark
1	IITA-TMS-IBA000070	Best	32.8	High	breeders check, extremely good in food quality evaluation
2	TMS14F1195P0005	Best	33.5	High	Very good in food quality evaluation
3	TMS14F1022P0003	Mediocre	34	High	Medium scores on food product quality and complaints about the colour (brownish)
4	TMS13F1304P0003	Mediocre	36.2	High	Breeders' best in relation to Fresh Yield, Dry Matter, Gari and fufu yield and other breeder parameters combined. Not good in food quality evaluation.
5	TMS14F1278P0003	Bad	34.9	Medium/ high	Clear overall complaints of crude fibers (woody filaments)
6	4(2)1425	Mediocre	around 30	Medium/ high	This is an old released cassava variety with moderate dry matter. This variety was used to replace the proposed low dry matter, yellow and biofortified TMS-IITA-IBA011412, which was not accessible during pretest.
7	Local 1_Osun(Atu)	Good	around 32	Medium	Among local best
8	Local 2_Osun	Good	around 32	Medium	Among local best

2.3 Gari and Eba processing (Description of the experimentation conducted)

PRETEST/PILOT ACTIVITIES

Four gari/eba champion processors /experts were identified and engaged at Ilupeju community, Railway station, Iwo, Osun state for participatory processing. Prior to the processors' engagement, the facilitating team had brief them of the objectives of the project, their expected activities and remunerations, which they consented to verbally and on paper. The champion processors (mainly women) were consulted in the choice of local varieties that reflect different characteristics as identified in Step 2. Thereafter the team arranged with cassava breeders to source for cassava genotypes to use for this study. Agronomic data were taken from selected cassava genotypes before harvesting and immediately after harvesting.

Fresh cassava roots were harvested and processed to gari by the 4 champions' processors. Cassava was heaped and peeled by Champion processors in-group at Osun state after which peeled roots were washed, grated and left for fermentation and dewatering. After pressing, pressed cake was shared into three equal parts and processed into gari by each processor. Gari made by each processor was later bulked. Eba was made from gari produced from the eight varieties. The four processors evaluated fresh cassava roots, gari and eba. Data were taken from harvest to final

products evaluation. Only 3 processors participated in the toasting of gari while the fourth person assisted in sieving of gari and other petty activities. Quantitative data collected during pre-test study is stated in Table 2 while feedbacks on gari and eba ranking, desired qualities of cassava fresh roots, gari and eba are in Table 3, 4 and 5. Figures 2 and 3 show some of the contrasting color elements obtained within the 8 varieties. Cassava was proc using traditional method of *gari* processing (Abass *et al*, 2012). After completion of pilot test, 4 most contrasting cassava varieties were selected for WP1 Step 3. The variety TMS14F1195P0005 that was evaluated as very good on gari and eba quality earlier at the breeding unit (reason why the variety was included in the pretest) appeared to be the worst variety when evaluated during the pretest in this study. This urges for good realistic protocols on food product quality assessment.

Table 2: Performance of 8 cassava varieties used for WP1 Step 3 pre-test study evaluated by 3 champion processors at Ilupeju Community, Station-Iwo, Osun state

Varieties/ clones	Initial wt. (kg)	Peeling time (min:sec)	Peeled root Wt. (kg)	Peel Wt. (kg)	Grated Mash Wt. (kg)	Pressed cake Wt. (kg)	Gari Wt. (kg)	Chaff Wt. (g)	% root loss to peeling	% water Loss during dewatering	Garification (%)
TMS14F1195P0005	12	16.2	9.0	3.0	8.5	4.5	2.0	192	25.0	47.1	16.7
IBA000070	12	8.3	8.5	3.5	8.0	5.0	2.0	250	29.2	37.5	16.7
TMS14F1022P0003	12	9.2	8.5	3.5	8.0	5.0	2.5	130	29.2	37.5	20.8
TMS13F1304P0003	12	13.2	9.0	3.0	8.5	4.4	2.5	138	25.0	48.2	20.8
TMS14F1278P0003	12	10.5	9.5	2.5	8.0	5.5	2.5	240	20.8	31.3	20.8
4(2)1425	12	12.3	8.5	3.5	7.5	5.0	2.0	306	29.2	33.3	16.7
Local 1_Osun(Atu)	12	13.3	9.0	3.0	8.5	6.0	3.0	208	25.0	29.4	25.0
Local 2_Osun	12	5.7	10.0	2.0	9.5	5.0	2.5	104	16.7	47.4	20.8
mean	12	11.1	9.0	3.0	8.3	5.1	2.4	196.0	25.0	39.0	19.8
SD		2.93	0.47	0.47	0.52	0.45	0.31	60.8	3.9	6.74	2.60
CV (%)		26.5	5.2	15.7	6.30	8.95	13.1	31.0	15.8	17.3	13.1

Table 3: Champion processors ranking of gari and eba produced from 8 cassava varieties used for WP1_Step 3 pre-test study at Osun state

	GARI rank								**EBA rank**							
Champion Processors	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1 Mrs. Paulina	5*	1	7	6	8	4	3	2	7	1	6	4	8	5	2	3
2 Mrs. Elizabeth	5	6	1	7	8	4	3	2	8	7	6	5	4	1	3	2
3 Mrs. Sarah	5	1	8	6	7	3	4	2	7	6	1	8	5	4	2	3
4 Mrs. Teressa	1	5	7	6	8	4	3	2								

*These indicate the variety numbers as defined in Table 1

Figure 2. Ranked gari in pilot pre-testing in Osun state (see table 3 above): Rank 1 in upper left top corner reading down to rank 8 in bottom right corner. It clearly shows the preference for a bright coloured gari and the dislike of dull / brown/ darker coloured gari.

Figure 3. Ranked *eba* in pilot testing in Osun state (see table 3 above) for processor Teressa: Rank 1 on the left up to rank 8 in the right clearly showing the preference for light 'butter' coloured eba and the dislike of dark or brown coloured *eba*.

Table 4: Champion processors feedback from fresh roots evaluation during pilot pre-test study of 8 cassava genotypes to select four (4) contrasting cassava genotypes to use for WP1 Step 4 consumer testing at Iwo-Railway station, Osun state, Nigeria

Farmers/ Processors	7. Among the selected varieties you will process for that participatory study, which variety is your favourite for making the (product under study)? Why?	8. What are the characteristics of that favourite variety that you notice when you look at the raw material? Are they similar to the characteristics of the variety you normally use for making this (product under study)	9. Please, kindly give the name of other varieties that make a high quality (product under study) that you like. Why do you like these varieties? How do you recognize them (visually, by tasting them)? What is essential for you	10. Which variety do you dislike the most dislike among the selected varieties you will process for that processing demonstration? Why? What are these characteristics when you look at it (Please collect the local name of the variety called by the processor and if possible scientific name)	11. How do you assess the poor quality of the (crop under study) (raw material) for making the (product under study)	12. Which variety would you never buy (or use) to make (the product under study)? Why? Who buys that variety? Why?
1 Paulina Odey	The varieties I preferred most is variety 4, followed by variety 7 and 2. I like variety 4 because its roots have weight, it will give more gari after processing and its gari will be white	It has weight, it will swell after processing and will give more food products. It will have less water after grating, the roots are hard to touch and heavy on hand	It produces numerous roots, heavy in hand, will give high product yield after processing. It gives butter colour gari. I recognize it by root outer colour, fresh root weight before processing	Variety 6 , it has small root size, the root outer colour is lie that of potato (light cream), it is light when carry in hand	It has less weight, its gari will be light without appealing colour	We buy all kind of roots in market but we pay less for roots with low quality characteristics, such low quality roots will show signs of streaks on root flesh and its pulp will not fresh and shows deterioration

Farmers/ Processors	7. Among the selected varieties you will process for that participatory study, which variety is your favourite for making the (product under study)? Why?	8. What are the characteristics of that favourite variety that you notice when you look at the raw material? Are they similar to the characteristics of the variety you normally use for making this (product under study)	9. Please, kindly give the name of other varieties that make a high quality (product under study) that you like. Why do you like these varieties? How do you recognize them (visually, by tasting them)? What is essential for you	10. Which variety do you dislike the most dislike among the selected varieties you will process for that processing demonstration? Why? What are these characteristics when you look at it (Please collect the local name of the variety called by the processor and if possible scientific name)	11. How do you assess the poor quality of the (crop under study) (raw material) for making the (product under study)	12. Which variety would you never buy (or use) to make (the product under study)? Why? Who buys that variety? Why?
2 Elizabeth John	I like variety 8, followed by varieties 3 and 5 because of their big roots, the root yield is high, roots are heavy in hand when carry, such roots will give more product yield after processing. The roots after processing will give preferred product colour (cream/butter colour).	The roots are big, heavy in hand, will give more product yield after processing which are the characteristics we look for in roots that can give good eba	Variety 3 and 5. They have big roots, roots are heavy in hand, the mesh give out less water after grating	Variety 6, the roots have less weight, it has started deterioration compared to other varieties, this will affect colour of gari after processing	Root flesh colour will not fine, it will has high water content, it will be light when carry	Light weight roots, roots that its flesh pulp has started turning black shortly after harvesting, this has effect on quality of food product that will be produced from such roots
3 Sarah	I like variety 7, followed by variety 4, 2 and 5. i like variety 7 because it has less water, big, its eba will swells and draw	The roots are big, has less water, heavy in hand, will give more product yield and swells after processing which are the characteristics we look for in roots that can give draw eba	Variety 7 (Atu). They have big roots, roots are heavy in hand. It has less water after grating. It gives good gari, sour, swells, with butter colour.	Variety 6. It's the roots are small and has less weight, and not attractive.	When cassava roots have small sizes and has lesser weight and will give light gari that can easily float in water and affect the swelling of eba.	We buy all kind of roots in market but we pay less for roots with low quality characteristics, such low quality roots will show signs of streaks on

Farmers/ Processors	7. Among the selected varieties you will process for that participatory study, which variety is your favourite for making the (product under study)? Why?	8. What are the characteristics of that favourite variety that you notice when you look at the raw material? Are they similar to the characteristics of the variety you normally use for making this (product under study)	9. Please, kindly give the name of other varieties that make a high quality (product under study) that you like. Why do you like these varieties? How do you recognize them (visually, by tasting them)? What is essential for you	10. Which variety do you dislike the most dislike among the selected varieties you will process for that processing demonstration? Why? What are these characteristics when you look at it (Please collect the local name of the variety called by the processor and if possible scientific name)	11. How do you assess the poor quality of the (crop under study) (raw material) for making the (product under study)	12. Which variety would you never buy (or use) to make (the product under study)? Why? Who buys that variety? Why?
						root flesh and its pulp will not fresh and shows deterioration
4 Teressa Odey	I like variety 8, followed by varieties 4 and 3 and because of their big roots, the root yield is high, roots are heavy in hand, such roots will give more product yield after processing. The roots after processing will have high gari yield and swell very well.	The roots are big, heavy in hand, will give plenty gari after processing which are the characteristics we look for in roots that can give eba that swells well.	Variety 8 and 4. This is because variety 8 has big roots, that heavy in hand and will give plenty gari. Variety 4 has less water after grating. Its gari will swells, and give draw gari.	Variety 6 because the roots are small and does not have weight, and not attractive.	It has small root sizes with lesser weight. It will give light gari. Its gari will float in water and will not give good eba.	Light weight, small root size, and rotten root because these will affect the quantity and quality of food product after processing.

Table 5: Champion processors feedback from cassava product(s) evaluation during pilot study of 8 cassava genotypes to select four (4) contrasting cassava genotypes to use for WP1 Step 4 consumer testing at Iwo-Railway station, Osun state, Nigeria

	Gari evaluation **20. What is your opinion of the first (product under study)? What is your first impression just by looking at it? Do you like it? Please explain why, what are the characteristics you like, the characteristics you don't like?**	**21. When you touch that (product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (between fingers) that you like? The characteristics you don't like?**	**22. When you taste (that product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (in mouth) that you like? The characteristics you don't like? What about the taste, the texture in mouth.....**	**23. Among these (products under study) which one is your favourite? What are the reasons for this? Rank in order of importance, 1=most importance**	**24. Among these (products under study) which one do you like least? What are the reasons for this? Rank in order of importance, 1=most importance**
1 Paulina Odey	Variety 5, it has smooth fine granules with attractive butter colour, I like everything about this gari	It has weight, heavy in hand when fetched and its granules loose on fingers	Its well-cooked, crunchy with sugar taste, it give smooth fine texture in mouth when chewed	Variety 5, It has smooth granules, heavy in hand with butter colour	Variety 2, It has dull appearance which may be due to processing step (or improper dewatering) or variety used to produce gari
2 Elizabeth John)	Variety 5, I was attracted by its fine smooth granules with butter colour, its eba will be fine. I like everything about it	It's crunchy, heavy in hand with smooth granules. Its granules roll freely on fingers	Its well-cooked, sour with sweet taste, this variety of cassava is good	Variety 5, is my favourite, it has fine granules, well appealing colour, with smooth granules and sour, its eba will be lie semovita	Variety 2, its granules are not shiny but dull in appearance. The granules size are not even, it has lumps, the dull colour is likely to be as a result of processing steps but most likely the variety used to produce the gari
3 Sarah	I like variety 5, I was fascinated by its colour, it's well cooked with fine smooth granules, I like everything about it.	Its well-cooked, it loose within fingers	Its sour, well dried, it gives sound of pulp corn when chewed, it gives characteristic sound of good gari	Variety 5, is my favourite, it has fine granules, well appealing colour, with smooth granules and sour	Variety 2 is the worst, it has dull colour which is not bright as others. Its dull colour maybe due to variety bad characteristics or improper processing
4 Teressa Odey	Variety 1, its heavy in hand, has butter colour, and will give good eba after turning, I like everything about this gari	It has weight, heavy in hand and its granules did not leave powdery stain after rubbing within fingers, it means the granules has fine smooth well crunched particles	Its well-cooked, sour moderately which I most preferred with sweet taste, its heavy in mouth as it last longer when chewed	Variety 1, I have mentioned all the characteristics I like about it previously	Variety2, it is dull, not shiny like others
	Evaluation of Eba				

	Gari evaluation **20. What is your opinion of the first (product under study)? What is your first impression just by looking at it? Do you like it? Please explain why, what are the characteristics you like, the characteristics you don't like?**	**21. When you touch that (product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (between fingers) that you like? The characteristics you don't like?**	**22. When you taste (that product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (in mouth) that you like? The characteristics you don't like? What about the taste, the texture in mouth.....**	**23. Among these (products under study) which one is your favourite? What are the reasons for this? Rank in order of importance, 1=most importance**	**24. Among these (products under study) which one do you like least? What are the reasons for this? Rank in order of importance, 1=most importance**
	20. What is your opinion of the first (product under study)? What is your impression just by looking at it? Do you like it? Please explain why. What are the characteristics you like, the characteristics you don't like?	**21. When you touch that (product under study), explain your impressing. Do you like it? Describe the way it feels between fingers. What are the characteristics (between fingers) that you like? The characteristics you don't like?**	**22. When you taste that (product under study), explain your impression. Do you like it? Describe the way it feels in mouth. What are the characteristics (in mouth) that you like? The characteristics you don't like?**	**23. Among these (products under study) which one is your favourite? What are the reason for this? Rank in order of importance, 1= most important.**	**24. Among these (products under study), which one do you like the least? What are the reasons for this? Rank in order of importance, 1=most important.**
1 Paulina Odey	I like variety 1, 4, 5, 6, 7 and 8 because they have attractive colour. Variety 4 have yellow-colour while varieties 1, 5, 6, 7 and 8 have butter color.	When I touch all the samples with the fingers, all the varieties are moderately soft, smooth, moldable and easily draw well.	When tasted, varieties 1, 2, 6 and 8 are slightly sour while varieties 3, 4, 5, 7 are sweet. They are all-smooth and easily swallow.	Variety 7, 1, 6, 4, 8, followed by 5 are my favourite, they smooth when touch, they have butter colour, moldable very well and draw very well.	Variety 3 and 2, they are dull and dark in color. Not attractive at all. I like variety 5 small because is appearance is not too bright, followed by variety 8, 4, 6, 1, 7.
2 Elizabeth John	I like variety 1, 4, 5, 6, 7 and 8 because they all have attractive colour. Varieties 1, 6, 7, and 8 have butter color while variety 4 and 5 are creamy-white in color	When I touch all the samples with the fingers, all the varieties are smooth, moldable and easily draw well except variety 5 which are moderately hard	When tasted, varieties 6, 1 and 8 are very sour. Variety 2, 5 and 7 are slightly sour while varieties 3, 4 are sweet. They are all smooth and easy to swallow and go on well.	Variety 8, 7, 6, 5, 4, followed by 1 are my favourite, they smooth when touch, they have butter colour, moldable and draw well.	Variety 2 and 3, they are dull and dark in color. Not attractive at all, followed by variety 1, 4, 5, 6, 7,8.
3 Sarah Clement	I like variety 1, 4, 5, 6, 7 and 8 because they have attractive colour. Varieties 1, 5, have milk colour. Varieties 6, 7 and 8 are butter color. Variety 4 is yellowish/ cream color.	When I touch all the samples with the fingers, all the varieties are smooth, they absorbed water and moldable and easily draw	When tasted, varieties 6 are very sour. Variety 1, 2, 3, 4, 5, 7 and 8 are slightly sour. They are all smooth and easy to swallow and go on well.	I like variety 7 because it has butter color, draw well and easy to mold. Followed by variety 6, 1, 8, 5, and variety 4.	Variety 3 and 2, they are dull and dark in color. Not attractive and looking good. This is followed by variety 4, 5, 8, 1, 6 and 7.

Participatory Processing in Osun and Benue state
Fresh roots of four contrasting cassava varieties selected from pilot study were presented to 3 champions' processors at Ilupeju communities, Railway station, Iwo, Osun state for evaluation of fresh roots and processing of roots into gari. The four contrasting cassava genotypes selected for the study were TMS-IITA-IBA011412, TMS14F1278P0003, TMS14F1022P0003 and Osun Local 1_Atu. TMS-IITA-IBA011412 has low dry matter and starch content, poor texture and cohesion (Olaosebikan et. al., 2019). Each processor evaluated the fresh roots before they jointly peeled the roots. After dewatering, pressed cake from each genotype was shared equally between the three processors to process into gari. Gari produced were bulked after the exercise. Data were taken from harvest to final products. Harvest and processing data of Step 3 conducted at Osun and Benue are presented in Table 6. The gari ranking and qualitative feedback from Osun and Benue champion processors on four contrasting cassava varieties is stated in Table 7, 8, 9 while Fig.2 shows eba weight of 100g gari produced from five cassava genotypes used for WP1 Step 3 study. Annex 5.2 shows the dominant remarks in relation to each variety with regards to fresh roots, gari and eba products.

Benue state
Only the preferred local cassava variety (Barnada) was processed into gari by 3 champion processors at Tyomu community, Benue state. Gari prepared in Osun from the three varieties TMS-IITA-IBA011412, TMS14F1278P0003, TMS14F1022P0003 was used along with gari from the variety Benue local (Barnada) for evaluation with processors in Benue and for the consumer testing (Step 4) at Benue.

POST HARVEST ACTIVITIES:

Pulverization: Pressed wet cake was grinded with motorized cassava grating machine in Osun while processors at Benue used locally made wooden sieve for sieving pressed cake to remove fibre and lumps before toasting, each processor used the same sieve.

Production of *eba*
Four cassava varieties (IBA011412, 1278PP0003, 1022P0003 and atu/ banada) with contrasting *gari* qualities during pilot test were selected to produce *eba* for consumer's acceptability test. *Gari* was sprinkled into boiled water placed in a bowl using *gari*/water ratio of 1:3 *gari*/water (Osunbade and Adejuyitan (2020) in order to also induce contrasting textures - and covered for few minutes, and then stirred with a turning stick until it is smooth. The team got to community ahead of time to be able to prepare eba. Twenty wraps of about 50g were prepared at each community and two communities were covered in a day in each state. Prepared eba wrapped with transparent white nylon and kept in food warmer to make it hot at the time it was evaluated.

Data Coding and Compilation
Data in Table 8 was compiled from feedbacks of champion processors during WP1 Step 3 pretest and actual activity. A frequecy table was constructed for preferred characteristics by champion processors during evaluation of fresh roots, gari and eba in the pretest and actual Step 3 study conducted at Osun state but only actual ativity 4 study in Benue state. Percentages were calculated from frequency summation. Data presented for fresh roots in (Table 8) below were roots characteristics from champion processors feedback during pretest and actual WP1 Step 3 study at Osun state while products (gari and eba) data in Table 8 were pooled data from feedbacks for qualities of gari and eba during Osun WP1 pretest and actual Step 3 study as well as Benue champion processors during actual WP1 Step 3 study.

3 RESULTS

3.1 Raw material characteristics

Present results of quantitative data collected concerning the raw material for each variety (see example below)

Fresh cassava roots of IITA developed genotypes (TMS-IITA-IBA011412, TMS14F1278P0003, TMS14F1022P0003, TMS-IITA-IBA011412 were harvested from IITA-Ibadan and Agoowu sub-station while Osun Local 1_Atu was sourced from one of the champion processor farm at Ilupeju, Station Iwo, Osun state. Barnada_Benue local was also sourced from farmer farm at Tyomu, Benue state. The three seleted processors peeled the fresh root together, washed after which the roots was grated and left for fermentation. The grated mesh was fermented for 3days before putting on pressing jack on the fourth day and toasted on the fifth day. Pressed cake from each cassava was shared equally into three for the processors to sieve and toast and gari made by the three processors was bulked after toasting. The weight of bulked gari was taken after cooling. The peeling time was taken and peeled roots weight before washing and grating. Chaff weight after sieving was also measured. Table 6 shows the overview of the results. Produced gari was evaluated by each processor. The results of the ranking are presented in table 7.

Peeling Yield: The root loss to peeling varies from 17 to 19 %, there is no significant difference in peeling lost between the 5 genotypes used for final consumer testing study.

Peeling time: Peeling time varies from 1911 to 2880 seconds per 100kg roots. Processors constraints to peeling include constrictions on the roots, small root size, irregular root shape, over-grown/very long roots. Not much variation in peeling time was observed (CV=17%) although IITA-IBA011412 had by far the longest peeling time. Given the high water content of this variety this might be related to the irregular root shape. Processors were disturbed when harvested roots had one or more of peeling difficulties as this take more time costlier. At times they may not get labour especially at the period when many people harvest their farms.

Gari yield (garification)

Gari Yield did not differ much only IBA011412 had a lower gari yield than all the others as was expected based on the low dry matter and high moisture/water content for this variety

Observed chaff in pressed cake

For the observed chaff weight per 100 kg of root and and per kg of pressed cake (%) there were large differences between varieties (CV=66 and 62 respectively). The local variety from Osun and IBA011412 showed clearly lower chaff weights and lower chaff weights per kg of pressed cake (%). The local variety in Benue showed the highest chaff weight and percentage of chaff

Weight of the eba from 100 g gari

Fig 4 shows the weight of the eba made from 100 grams of gari. Eba was made once from each variety. It clearly shows that IBA011412 and the local variety from Benue swelled the least while the local variety was still evaluated the best by people in Benue. This indicates that in Benue people seem to accept varieties that swell less. However the variety IBA011412 was only ranked as high as 2nd by only one processor (the others ranked it 3rd), which is however a little better than in Osun where it was ranked 3rd for all processors.

Ranking of the gari made from the varieties for overall quality

The best 3 cassava genotype as ranked by champion processors were Local 1 (Atu), Local 2

(Barnada) and TMS14F1278P0003 while the worst genotype was TMS14F1022P0003 (table 7)

Table 6: Processing performance of five cassava varieties processed by champion processors at Osun and Benue (Local Benue variety – Barnada-only) state (Scaled values are put beside the real values for easy comparism)

Varieties	Initial Weight (kg)		Peeling Time (s)		Peeled root wt. (kg)		Peel wt. (kg)		Grated mash wt. (kg)		Pressed Cake wt. (kg)		Gari wt. (kg)		Chaff (woody filaments) wt. (kg)		% Chaff per pressed cake	peeling loss (%)	pressing water loss (%)	Garification (%)
		Scaled		Scaled		Scaled		Scaled		Scaled		Scaled		Scaled		Scaled				
14F1022P0003	87	100	1663	1911	72.3	83.1	14.7	16.9	71.8	82.5	50.8	58.4	25.5	29.3	1.5	1.7	3.0	**16.9**	29.25	29.31
14F1278P0003	187	100	3352	1793	146	77.8	41.5	22.2	142.8	76.4	94.6	50.6	46.2	24.7	3.3	1.8	3.5	22.19	33.75	24.71
IITA-IBA011412	250	100	7200	2880	172	68.9	77.8	31.1	162	64.8	103	41.0	26.4	10.6	0.6	0.2	0.6	31.12	36.67	**10.56**
Local 1_Osun	88	100	2032	2309	69.6	79.1	18.4	20.9	66.2	75.2	42.9	48.8	22.4	25.5	0.3	0.3	0.7	20.91	35.2	25.45
Local_Benue	90.8	100	2103	2316	73.1	80.5	17.7	19.4	72.5	79.8	52.8	58.1	23.67	26.1	2.2	2.4	4.2	19.49	27.17	26.07
Mean		100		2242		78		22		76		51		23		1.3	2.4	22.12	32.41	23.22
SD		0		381.7		4.8		4.8		6.1		6.5		6.5		0.86	1.47	4.83	3.61	6.52
CV (%)		0		17		6		22		8		13		28		**66**	**62**	2.16	1.61	2.92

Table 7: Overall ranking of gari used for RTBFoods WP1 Step 3 by champion processors at Benue and Osun state.

Champion Processors	Benue				Osun			
	Rank				Rank			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
P1	Local_ Benue	1278P0003	IBA011412	1022P0003	Local1_ Osun	1278P0003	IBA011412	1022P0003
P2	Local_ Benue	IBA011412	1278P0003	1022P0003	Local1_ Osun	1278P0003	IBA011412	1022P0003
P3	Local_ Benue	1278P0003	IBA011412	1022P0003	Local1_ Osun	1278P0003	IBA011412	1022P0003

Table 8: Analysis of qualitative data of fresh roots, gari and eba during WP1 pretest and actual Step 3 study at Osun and Benue state

Fresh roots attributes and preference in brackets	freq	%
Root weight (height weight)	10	28.6
Root size (big root)	9	25.7
quality and quantity of products (amount of product derived with expected values)	8	22.9
Water in the root pulp (should be little)	5	14.3
Root pulp colour (should be white)	3	8.6
	35	100
Gari attributes		
Regular granule size (fine but not powdery)	9	24.3
Colour (shiny, butter, not brown, not dark, not dull/gray)	6	16.2
gari weight (should be high)	6	16.2
taste (good taste, little sweet, not bland)	5	13.5
Well cooked	5	13.5
Looseness of granules on fingers (should be loose)	4	10.8
Crunchiness (should be crunchy)	2	5.4
	37	100
Eba attributes		
Smoothness (should be smooth)	8	24.2
Mouldability (should be well mouldable)	6	18.2
Strechability (should stretch)	6	18.2
Colour (light, butter, not dark, not brown, not dull)	5	15.2
Good taste (not bland)	3	9.1
Easily swallowed	3	9.1
Softness (should be soft)	1	3.0
Hardness/firm (should hold shape)	1	3.0
	33	100

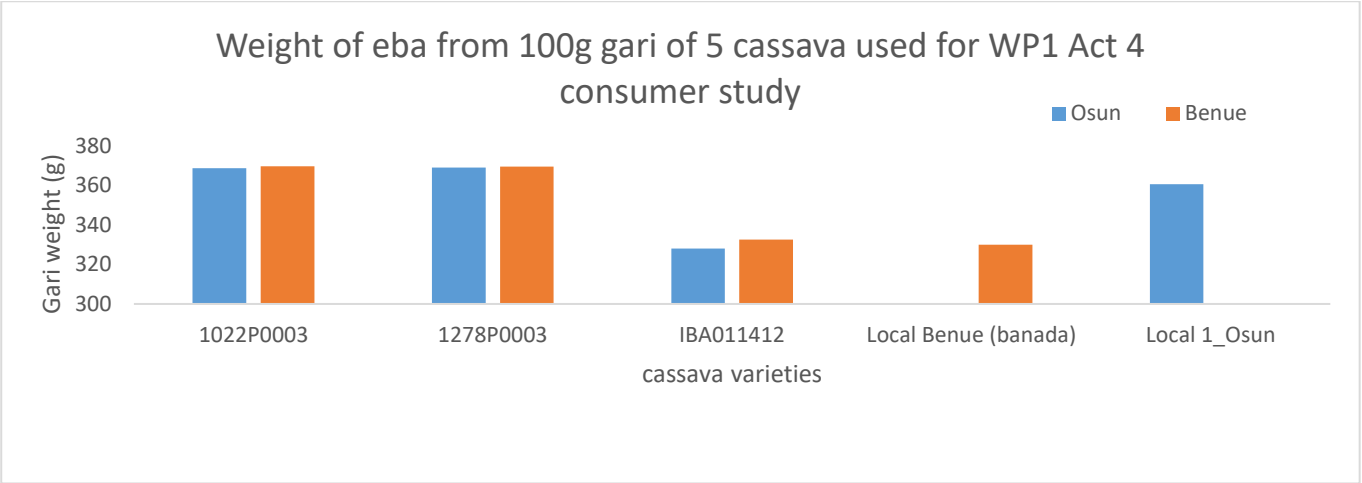

Fig. 4: Weight of eba made from100g of gari of 5 cassava genotypes used for consumer testing study at Osun and Benue state, Nigeria (one assessment , no replications)

3.1.1 Qualitative information collected on the raw material

Raw material, qualitative information obtained from the questionnaire interview during processing

Table 9: Feedback from 3 Champion Processors on evaluation of Fresh roots used for WP1 Step 3 study at Osun state

Farmers/ Processors	7. Among the selected varieties you will process for that participatory study, which variety is your favourite for making the (product under study)? Why?	8. What are the characteristics of that favourite variety that you notice when you look at the raw material? Are they similar to the characteristics of the variety you normally use for making this (product under study)	9. Please, kindly give the name of other varieties that make a high quality (product under study) that you like. Why do you like these varieties? How do you recognize them (visually, by tasting them)? What is essential for you	10. Which variety do you dislike the most dislike among the selected varieties you will process for that processing demonstration? Why? What are these characteristics when you look at it (Please collect the local name of the variety called by the processor and if possible scientific name)	11. How do you assess the poor quality of the (crop under study) (raw material) for making the (product under study)	12. Which variety would you never buy (or use) to make (the product under study)? Why? Who buys that variety? Why?
1) Paulina Odey	Variety 5 is my favourite because is heavy and has weight and big. It will give high yield of gari	It looks big and heavy. It also straight and have the same characteristics of the variety we normally use.	Atu is the name of other variety that make a high quality of gari I like. They are heavy and have less water.	I don't like variety 6 because it is reddish when looking at, it is tiny and not heavy	Poor quality of cassava is tiny and will give light gari with lesser weight and produce yellow colour	I will not buy variety 6 because it is tiny and not heavy. It will give light gari.
2) Elizabeth John	Variety 5 is my favourite for gari because it is big and heavy.	It is big in size and will give smooth gari, butter coloured gari.	Atu gari do have cream colour, swell and will give high yield of gari after gari processing.	I don't like variety 6 because of its yellow color, it has a lot of water, it won't get dewater quickly. This variety will not give good gari, I will not buy these varieties at the normal price.	Poor quality of cassava are small in size, tiny and will give light gari with lesser weight and produce yellow colour	I will not buy variety 6 with normal price because it is tiny and not heavy. It will give light gari. I will buy big size tuber/ big long tuber to spray them.

Farmers/ Processors	7. Among the selected varieties you will process for that participatory study, which variety is your favourite for making the (product under study)? Why?	8. What are the characteristics of that favourite variety that you notice when you look at the raw material? Are they similar to the characteristics of the variety you normally use for making this (product under study)	9. Please, kindly give the name of other varieties that make a high quality (product under study) that you like. Why do you like these varieties? How do you recognize them (visually, by tasting them)? What is essential for you	10. Which variety do you dislike the most dislike among the selected varieties you will process for that processing demonstration? Why? What are these characteristics when you look at it (Please collect the local name of the variety called by the processor and if possible scientific name)	11. How do you assess the poor quality of the (crop under study) (raw material) for making the (product under study)	12. Which variety would you never buy (or use) to make (the product under study)? Why? Who buys that variety? Why?
3) Serah Clement	Variety 5 is my favourite for gari because it is fine appearance, heavy and will give plenty gari.	It is heavy and big in size and will give smooth gari, butter coloured gari.	Atu gari produce cream colour, swell and will give high yield of gari	I don't like variety 6 because of its yellow color, it has a lot of water, it will not give more gari quantity.	Poor quality of cassava is tiny and will give light gari with lesser weight and produce yellow colour	I will not buy variety 6 because it is small and not heavy. It will give light gari.

3.2 Product profile process description

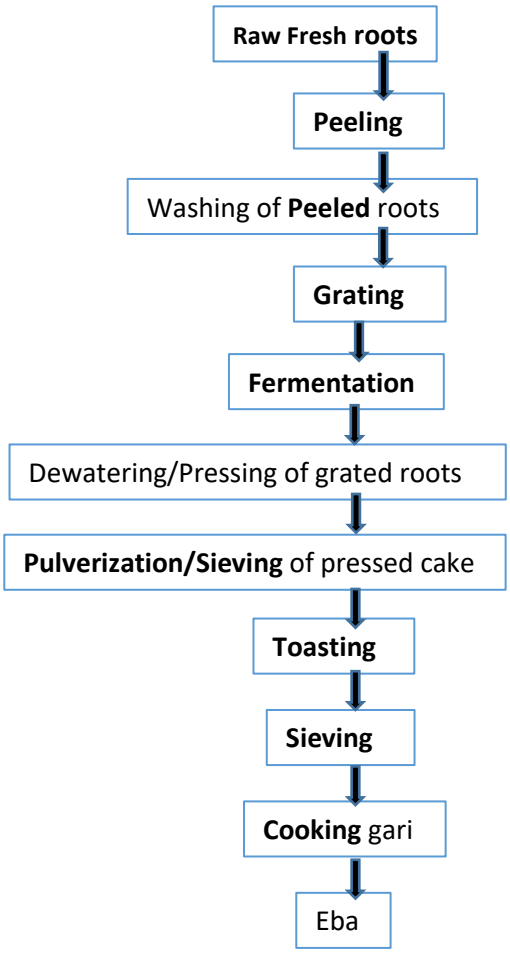

Fig 5: Flow diagram for gari-eba process

3.3 Processors' appreciation of end-product

Results of the processors evaluation of the ready to eat end-product

Table 10: **Champions Processors evaluation of gari produced from 4 contrasting cassava varieties used for WP1_Step 3 study at Osun and Benue State**

Processors (1,2,3)	20) What is your opinion of the first (product under study)? What is your first impression just by looking at it? Do you like it? Please explain why, what are the characteristics you like, the characteristics you don't like?	21). When you touch that (product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (between fingers) that you like? The characteristics you don't like?	22). when you taste (that product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (in mouth) that you like? The characteristics you don't like? What about the taste, the texture in mouth....	23). Among these (products under study) which one is your favourite? What are the reasons for this? Rank in order of importance, 1=most importance	24). Among these (products under study) which one do you like least? What are the reasons for this? Rank in order of importance, 1=most importance
1) Mrs. Paulina Odey	Appearance of varieties 3 is not good, very dull colour, variety 5 has dull colour too but has fine granules. Variety 6 has yellow colour, fine granules and i like it. Variety 7 has cream colour, dry and fine granules. I like the colour of variety 7 but don't like yellow colour of variety 6 and colour of variety 3 is dark.	Varieties 3 is light in hand and mouth, I will sell it for a very low price. Variety 5 is free in between fingers and dry, it has no dusty powder stain. Variety 6 has no dusty powder stain on hand	When tasting variety 3, it feels very light in mouth, variety 5, 6 and 7 also have a sweet taste. Variety 7 has fine granules when touched. It is weighty and has cream colour.	Variety 7 is my best favourite because it is dry, has fine granular, sweet, bright colour, or cream colour and has weight in hand. By ranking, variety 7 is 1st, followed by 5, 6 and 3.	I like variety 3 least because is light in hand, the appearance is not good, very dull. Followed by 6, 5 and 7
2) Elizabeth John	Colour of variety 3 is dull, variety 7 is bright, its eba will be fine. Variety 5 is cream and 6 is yellow. I like colour of variety 7, 5 and 6 but I dislike colour of variety 3.	Step 2 is light in hand and will not be marketable. Variety 5 is dry and heavy in hand, free between fingers, variety 6 and 7 are also heavy in hand and i like it very much but don't like variety 3 at all because the colour is dull and dark.	Variety 3 is not sour in when tasted, and I don't like it. Variety 5 is sour and dry, likewise, variety 6 and 7 are dry and sour when tasted.	Variety 7 is my best favourite because it is dry, has fine granular, sweet, bright colour, or cream colour and has weight in hand. By ranking, variety 7	I like variety 3 least because is light in hand, the appearance is not good, very dull. Followed by 6, 5 and 7

Processors (1,2,3)	20) What is your opinion of the first (product under study)? What is your first impression just by looking at it? Do you like it? Please explain why, what are the characteristics you like, the characteristics you don't like?	21). When you touch that (product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (between fingers) that you like? The characteristics you don't like?	22). when you taste (that product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (in mouth) that you like? The characteristics you don't like? What about the taste, the texture in mouth....	23). Among these (products under study) which one is your favourite? What are the reasons for this? Rank in order of importance, 1=most importance	24). Among these (products under study) which one do you like least? What are the reasons for this? Rank in order of importance, 1=most importance
				is 1st, followed by 5, 6 and 3.	
3) Serah Clement	Appearance of varieties 3 is not good, very dull colour, variety 5 cream colour but has fine granules. Variety 6 has fine granules, yellow colour and i don't like colour yellow. Variety 7 has dry and fine granules,	Variety 3 is light in hand and mouth, I will sell it for a very low price. Variety 5 is heavy in hand and free in between fingers and dry. Variety 6 is also heavy in hand, variety 7 is heavy in hand too and mouth- full.	Variety 3 is light in mouth, while variety 5 is sweet in when tasted, variety 6 has good taste and dry but I don't like the yellow colour.	Variety 7 is my favourite because it is dry, sour and have good colour, it has fine granular, sweet, bright colour, or cream colour and has weight in hand. By ranking, variety 7 is 1st, followed by 5, 6 and 3.	I like variety 3 least because is light in hand, the appearance is not attractive, the colour is not good and very dull. Followed by 6, 5 and 7
Benue Champions Processors evaluation of gari					
Mr. comfort Biem (processor 1)	Variety 8 (Barnada) has white colour, dry and fine granules. I like the colour of variety 8, it is not sour and i like gari that is not sour, and I also prefer yellow colour of variety 6 but the colour of variety 3 is dark. Appearance of varieties 3 is not good, very dull colour, variety 5 has dull colour too but has fine granules. Variety 6 has yellow	Gari produced from varieties 3 is too light in hand and mouth, Variety 5 is not stain hands, free between fingers and dry, it has no dusty powder stain. Variety 6 has no dusty powder stain on their hand too. Variety 8 (banada) is white, smooth and is the best.	Variety 8 (Barnada) is slightly sour and I love it like this. Variety 3 tasted very light in mouth and variety 5, 6 are sour than what I like. Variety 8 has slightly sour taste, fine granules when touched. It is has white colour too.	variety 8 (banada) is my best favourite because it is slightly sour, dry, has smooth granular, sweet, white colour, and has weight in hand. By ranking, variety 8 (banada) is 1st, followed by 5, 6 and 3.	I like variety 3 least because is light in hand, the appearance is dull/ brown and dark, followed by 6, 5 and 8

Processors (1,2,3)	20) What is your opinion of the first (product under study)? What is your first impression just by looking at it? Do you like it? Please explain why, what are the characteristics you like, the characteristics you don't like?	21). When you touch that (product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (between fingers) that you like? The characteristics you don't like?	22). when you taste (that product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (in mouth) that you like? The characteristics you don't like? What about the taste, the texture in mouth....	23). Among these (products under study) which one is your favourite? What are the reasons for this? Rank in order of importance, 1=most importance	24). Among these (products under study) which one do you like least? What are the reasons for this? Rank in order of importance, 1=most importance
	colour, fine granules and I like it. .				
Mrs. Terso Kumba (Processor 2)	Variety 8 (banada) has white colour, dry and very smooth texture. I like the white colour of variety 8, it is slightly sour and i like gari that is not too sour, and I also prefer yellow colour of variety 6 and the colour of variety 3 is too dark for my liking. Appearance of varieties 3 is not good, very dull and dark colour, variety 5 has dull colour too but has smooth granules. Variety 6 has yellow colour, smooth granules and I also like variety 6, followed by variety 5.	Variety 3 is light in hand. Variety 5 is dry and heavy in hand, free between fingers. Variety 6 and 8 (Barnada) is heavy in hand and I like it very much but don't like variety 3 at all because the colour is dull and dark.	Variety 3 is too sour when tasted, and I don't like it. I prefer variety 8 followed by variety 5 because is sour slightly and dry, likewise variety 6.	variety 8 (banada) is my best favourite because it is white, dry, slightly sour, has fine granular, sweet and has weight in hand. By ranking, variety 8 (Barnada) is 1st, followed by 5, 6 and 3.	I like variety 3 least because is light in hand, the appearance is dull/ brown and dark, followed by 6, 5 and 8
Mrs. Adah Gabriel (processor 3)	Appearance of varieties 3 is not good, very dull colour, variety 5 cream colour but has smooth texture. Variety 6 has smooth and smooth particles, yellow colour and I do eat yellow gari.	Variety 8 (banada) is heavy in hand and mouthful. Variety3 is light in hand and mouth. Variety 5 is heavy in hand and free in between fingers and dry. Variety 6 is also heavy in hand.	Variety 8 (Barnada) is slightly sour and I love it like this. Variety 3 tasted very light in mouth, sour, variety 5, 6 are sour than what I like. Variety 8 has slightly sour taste, fine granules when touched. It is has white colour too.	Variety 8 (banada) is my favourite because it is very white in colour, it is not sour, and i like not sour gari, dry. It has fine granular, sweet, and has weight in hand.	I like variety 3 least because is light in hand, the appearance is not attractive, the colour is not good and very dull, followed by 6, 5 and 8

Processors (1,2,3)	20) What is your opinion of the first (product under study)? What is your first impression just by looking at it? Do you like it? Please explain why, what are the characteristics you like, the characteristics you don't like?	21). When you touch that (product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (between fingers) that you like? The characteristics you don't like?	22). when you taste (that product under study) explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (in mouth) that you like? The characteristics you don't like? What about the taste, the texture in mouth....	23). Among these (products under study) which one is your favourite? What are the reasons for this? Rank in order of importance, 1=most importance	24). Among these (products under study) which one do you like least? What are the reasons for this? Rank in order of importance, 1=most importance
	Variety 8 (banada) is very white in colour, dry and fine particles,			By ranking, variety 8 (Banada) is 1st, followed by 5, 6 and 3.	

3.4 Preferred and non-preferred varieties

From quantitative and qualitative data collated during this pilot study, the preferred cassava with appropriate root qualities that will produce quality gari and eba during the study, Local1_Osun (Atu), Local_Benue (Barnada) and TMS14F1278P0003. The non-preferred variety was TMS14F1022P0003

4 DISCUSSION AND CONCLUSION

There is consistency in desired fresh roots and products qualities by processors at Benue and Osun state. Farmers-processors dislike small, light roots with signs of discolouration during processing. These findings corroborate with or Activty 3 survey work and Olaniyi 1994 who reported that post-harvest age of roots, formation time and quality of equipment are factors controlling gari quality. This study also revealed that granule size, gari weight, dryness, colour (cream/white) and taste (sour/sweet) are key qualities that consumers desire in gari, this corresponds with findings of Oduro et.al., 2000, Ojo and Akande 2013, Sanni et. al., 2016 and Oyeyinka et.al., 2019, that reported that good particle size, colour, taste, aroma and texture are key sensory parameters for composite gari samples. Smoothness, mouldability, Strechability (drawability) and colour are important qualities of eba revealed in this study. Especially colour of the gari and eba appeared to be very important in the ranking of varieties as the lowest ranked variety TMS14F1022P0003 clearly had a dull colour. Also, the colour gradient from light coloured to darker colored could be clearly observed during the pretest. These findings also align with findings by Teeken et al. 2020 and Ndjouenkeu et al. 2020 that also found that these characteristics are crucial and color/appearance/shininess and darkening in particular.

Roots with many constrictions were clearly identified to increase peeling time and effort. The peeling time measured for the biofortified cassava variety TMS-IITA-IBA011412 was by far the longest and given that this variety had the highest water content which was also indicated by the processors and which would normally reduce peeling time as the knife slices more easily through high water content roots, this stresses even more the increased drudgery caused by roots with many constrictions,

Local cassava varieties (Barnada and Atu) had the best root qualities that can produce good gari and eba followed by newly bred genotype TMS14F1278P0003

The variety TMS14F1195P0005 that was evaluated as very good on gari and eba quality earlier at the breeding unit (reason why the variety was included in the pretest) appeared to be the worst variety when evaluated during the pretest in this study. This urges for good realistic protocols on food product quality assessment.

The complaints about fiber on TMS14F1278P0003 that motivated us to include the variety in this study appeared not to be that bad for processors as the variety was overall well rated. Table 6 showed that indeed chaff per kg of fresh roots and per kg of pressed pulp were rather high but not higher than the chaff for the local variety from Benue that was evaluated the best in Benue and had the highest chaff content. More study on the disadvantage and possible significantly more drudgery involved in removing chaff from the pressed pulp should inform about the tradeoff of this aspect. Standards on the maximal acceptable chaff weight per unit of fresh roots and per unit of gari yield should be determined because it seems that the higher amount of chaff produced per pressed pulp and kg of fresh roots for the Local variety from Benue and the improved one was not remarked by processors.

Breeders must work along with food scientist and social scientist to develop varieties with desired roots and food qualities preferred by cassava users to enhance adoption and utilization of released varieties.

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6 APPENDICES

6.1 Annex 1: Summary Table of Quantitative Data

	Raw material characteristics			Processing quantitative data									
				Peeling unit operation		Cutting unit operation		Cooking unit operation*			End-products	Global process yield	
Varieties	Weight (g)	Length (cm)	Dry matter (%)	Yield (%)	Productivity (kg/h/op)	Piece size (w)	Productivity (kg/h/op)	Ratio [Qw/Qy]	Cooking time (min)	Yield (%)	Dry matter (%)	Yield (w.b)	Yield (d.b)
Mean Value													

^{a,b,c,d} *indicates membership in significantly different value groups with a P value < 0.05*

6.2 Annex 2: Overview of Quality Traits of Raw Cassava, During processing, Gari and Eba

Name of variety	Raw product			
	Agronomical characteristics	Technological characteristics at each step of the process		
		Peeling	*washing*	*Example*
14F1022P0003	Small root size, less weight,			
14F1278P0003	Big long roots, roots are straight, less water in the roots pulp,			
IITA-IBA011412	Irregular root shape, more water in the root pulp, unattractive outer root colour, not heavy/light in hand			
Local 1_Osun (Atu)	Heaviness, less water in the pulp, white pulp colour, big, long and straight roots			
Local_Benue (Barnada)	Heaviness Big roots Straight and long roots No constriction in the roots Less water in root pulp			

	Sensory characteristics gari					
Name of variety	**When you look at**	**Texture when you touch**	**When you smell**	**Taste (In mouth)**	**Texture when you chew**	**After-taste**
14F1022P0003	Dull colour	Light in hand	Smell nice	Light in mouth		
14F1278P0003	white	Heavy in hand and free between fingers, fine granules but not powdery	Good odour	Sweet and sour	Crispy, well dried	
IITA-IBA011412	Yellow colour	Light in hand, granules are powdery	Good odour	Light in mouth	Well cooked	
Local 1_Osun (Atu)	White/cream colour	Heavy in hand,	Good odour	Sweet and sour taste	Mouth full, well dried	
Local_Benue (Barnada)	White colour	Heavy in hand, smooth granules	Fine odour	Not sour	Well dried	

	Sensory characteristics eba					
Name of variety	**When you look at**	**Texture when you touch**	**When you smell**	**Taste (In mouth)**	**Texture when you chew**	**After-taste**
14F1022P0003	dull	Mould well	sweet	sweet	smooth	
14F1278P0003	Cream	mouldable	sweet	sweet	crispy	
IITA-IBA011412	yellow	soft	Slightly sour	sour	Smooth and soft	
Local 1_Osun (Atu)	Butter colour/white	Well binded	sweet	sweet	Well cooked	
Local_Benue (Barnada)	white	Well binded	sweet	sweet	Well cooked	

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