

Consumer Testing of Eba in Rural and Urban Areas in Nigeria

Understanding the Drivers of Trait Preferences and the Development of Multi-user RTB Product Profiles, WP1, Step 4

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Ethics: The activities, which led to the production of this manual, 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 panellists and from consumers participating in activities.

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ABSTRACT

Nigeria is a multi-ethnic country with diverse eating habits and preferences for food characteristics can be influenced by factors such as socio-economic status, household size, culture, health perceptions etc. The objective of this study is to study cassava stakeholders' quality characteristics for consumption of the well-known West-African food dough-like cassava product called *Eba*. We are aiming to better understand the relationships between overall liking and quality characteristics identified during activity 3 gendered food mapping and activity 4 participatory processing under WP1 RTB Foods. A hedonic, a Check-All-That-Applies and Just-about-right tests were conducted with 301 consumers at eight locations (4 villages, 2 major towns and 2 cities) in Osun and Benue state in Nigeria using *Eba* made from two commonly cultivated, two improved and one biofortified cassava varieties.

There were significant differences between states for the mean overall liking of the four *Eba* samples ($p \leq 0.05$) but there was no strong significant difference by men and women.

The study revealed differences in consumers' overall liking for *Eba* samples. The JAR and CATA test results confirmed that colour-appearance, texture, odour, and granule size affected overall liking of *Eba*. Desired characteristics of *eba* identified in the study are 'white' or 'cream colour' 'mouldable', 'good odour', 'neat' and 'good taste' while consumers described 'bad' *eba* as 'dull/dark/brown', 'too sticky', 'too soft', 'not stretchy', and 'tasteless' 'with fibres'.

Breeders need to incorporate sensory testing and consumer acceptability of food products in cassava breeding evaluation activities to identify cassava that meet stakeholders' consumption needs and preferences. Breeding of cassava with desired food qualities along with the best agronomic traits will enhance adoption and utilization by cassava end-users.

Key Words: cassava, eba, check-all-that-applies, just-about-right, consumer acceptability, gender, location, Nigeria, Osun state, Benue state

1 STUDY CONTEXT AND GENERAL OBJECTIVES

This report is part of the RTB foods project, Work Package (WP) 1. The main objective of RTBFoods is to deploy RTB varieties that meet user-preferred quality traits in order to increase the adoption and impact of improved RTB varieties in sub-Saharan Africa (SSA). To do so, the project is working to provide evidence base for users' quality characteristics for the selected products that are the focus of the RTB foods project. WP 1 includes five activities namely:

Activity 1: State of Knowledge review

Activity 2: Capacity strengthening and sharing

Activity 3: Gendered product mapping

Activity 4: Community-based RTB Food processing/preparation diagnosis

Activity 5: Consumer tasting in rural and urban areas

This report presents the findings for Activity 5, Consumer testing in rural and urban areas.

The food product under focus in this report is called *Eba*. *Eba* is made from *Gari* mixed or poured into a boiled water, allowed to seamer or cook, stirred until smooth and served with sauce. *Gari* is the intermediate product processed from cassava roots with varying and adjustable processing procedures such as the fermentation period. *Gari* processing includes peeling cassava tubers, grating into mash, fermenting (with varying time), dewatering or pressing, sieving, and roasting.

The main aim of this Activity 5 "Consumer testing" is to understand the consumers' demand for the quality characteristics of *Eba* products.

Another aim is to provide WP2 with a clear and visual mapping of the most liked *Eba* product samples associated with high quality characteristics and high overall liking scores, and of the least liked *Eba* product samples associated with low quality characteristics and low overall liking scores.

The practical activity consists in testing 4 *Eba* samples from carefully selected cassava varieties with different quality characteristics as a pre-test during Activity 4.

2 METHODOLOGY

2.1 Sampling

The WP1 methodology uses interdisciplinary approach (food science, gender, and economics) to collect evidence on the RTB quality characteristics for different user groups in the product chain and identify the factors that may influence these quality characteristics, such as gender or location factors.

For Activity 5, a food scientist consultant who was involved in Activities 3 and 4, led the team to conduct consumer testing with the procedure stated in the methodological report (Fliedel et al., 2018).

Prior to the selection of the four contrasting varieties, a pre-test processing and evaluation were conducted with eight (8) varieties selected based on expert opinions (Nextgen cassava breeders) and in consultation with the Field/Research team. The eight contrasting cassava clones/varieties were selected using the important *Eba* quality criteria identified in Activity 3 analysis results such as colour (brightness, dullness or no discolouration of cassava roots during processing), dry matter content ('heaviness of roots'), root weight and shape, smoothness, mouldability, sweet/sourness and non-stickiness of *Eba*. The eight selected cassava varieties consisted of a breeders' check, two of the best varieties (with very good known food quality), one with medium score in food quality, one with clear over-all complaint in food quality and one biofortified (vit. A) variety with complaints on low dry matter content, and three local farmer preferred varieties.

The pre-test *Gari* (Figure 1) and *Eba* (Figure 2) gave very clear result with regards to appearance/colour, which co-informed the selection of four contrasting varieties for Activity 5.



Figure 1 Ranked Gari in pilot pre-testing in Osun state -Rank 1 (letter A) in upper left top corner reading down to rank 8 in top right corner (letter H).

The preliminary results clearly showed preference for a bright coloured *Gari* and a dislike of dull/brown/ darker coloured *Gari* products



Figure 2 Ranked Eba in pilot testing in Osun state for one of the champion processors

Rank 1 (letter A) on the left up to rank 8 in the right (letter H) clearly showing the preference for light 'butter' coloured *Eba* (letter A, B, C) and the dislike of dark or brown coloured *Eba* (letter F, G, H).

The four contrasting cassava varieties selected for Activity 5 in Benue and Osun states These varieties are IITA-TMSIBA011412 (a biofortified variety which has low dry matter -around 25%- and starch content, poor texture and cohesion in its *Eba*), IITA-TMS14F1278P0003, IITA-TMS14F1022P0003 (two recently developed clones from uniform yield trials) and the local varieties Atu and Barnada very common in Osun and Benue states, respectively. All varieties were processed into *Gari* in Osun except for the variety Barnada that was processed in Benue. The *Gari* samples were processed according to the way processors in the communities in Osun process their *Gari* which mainly differs from the Benue with regards to the fermentation time, which is 2 days longer in Osun. The boiled water and *Gari* used in the preparation of *Eba* from the different varieties selected was standardised as described in the Activity 4 “processing diagnosis” report (Bello et al. 2020). A standardised ratio of 1:3 (100g of *Gari* to 300g of boiled water) was used in the preparation of the four *Eba* samples, as usually done by the respondents in the communities in Osun and Benue.

The four *Eba* samples were tested by 301 consumers in 4 villages, 1 small town and 1 city in each of Osun (South-west region) and Benue states (North-central region) (Table 1). The villages and cities were selected using the same criteria as used for the preceding Activity 3 survey work: high involvement into cassava production, processing and food product consumption.

Table 1 Number of consumers interviewed in the rural and urban areas of the two regions.

	Total	Region 1- North central (Benue State)						Region 2- South west (Osun State)					
		Village 1	Village 2	Village 3	Village 4	Small town	Makurdi city	Village 1	Village 2	Village 3	Village 4	Small town	Oso city
Number of consumers	301	15	15	15	15	30	60	15	15	15	15	30	61
Women	150	8	7	7	7	14	31	8	7	8	8	15	27
Men	151	7	8	8	8	16	29	7	8	7	7	15	34

In Benue, villages (1-4) selected are Tyomu, Sangevya-Ikyo, Nyam II, Al'Okete, respectively; small town is Aliade and city is Makurdi. The names of the villages (1-4) in Osun states are Wasimi, Oyan, Ago-owu farm settlement and Aba-gbooro Elefon, respectively; the small town is Iwo and the city is Osogbo.

2.2 Consumer testing

A hedonic test, a Just-About-Right (JAR) test, and a Check-All-That-Apply (CATA) test were used. Consumers (n = 301) from the different locations in rural and urban areas were asked individually to look, touch, smell, taste each *Eba* sample, one after the other, in random order.

First, the consumers were asked to score the overall liking using a nine-point hedonic scale (from 1. “dislike extremely, to 9. “like extremely”). Consumers were also asked to assess how they perceived the intensity of three most important characteristics using the 3-point JAR “Just About Right” scale (1 = “Too low, too weak, not enough” 2= “Just About Right” and 3 = “Too high, too strong, too much”) respectively for each of the *Eba* samples. The three characteristics were identified as important in the previous Activities 3 & 4: Smoothness (“Not smooth enough”, JAR, “too smooth”), Colour (“too

bright", JAR, "too dull") and Sourness ("Not sour enough", JAR, "too sour"). Consumers were then asked to select the quality characteristics that better describe each *Eba* sample, among a list of 27 sensory characteristics: the most liked and the least liked collected during the previous Activities 3 and 4 (Table 2). Finally, consumers were invited to give their opinion and preferences on the *Eba* samples in relation to *Eba* they usually consume.

Table 2 Quality characteristics identified during the previous Activities 3 & 4 and selected for building the CATA table

	Quality characteristics of the <i>eba</i> product	Identified during Activity 3	Identified during Activity 4	Identified during both Activities 3 & 4 and used in CATA test
List of the most liked characteristics	Appearance			
	1. Neat	X		
	2. cream, yellow colour	X	X	X
	Aroma			
	3. good/fresh aroma	X		
	4. cooked aroma	X		
	Texture when touching			
	5. mouldable	X	X	X
	6. stretchy	X	X	X
	7. smooth	X	X	X
	8. moderately soft			
	Taste			
List of the least liked characteristics	9. good taste	X	X	X
	10. bland	X		
	11. sour	X		
	Texture in mouth			
	12. moderately soft	X	X	X
	Appearance			
	13. dull/dark/brown colour	X	X	X
	Odour			
	14. offensive	X		
	15. fermented	X		
	Texture when Touching			
	16. too sticky	X	X	X
	17. not mouldable	X	X	X
	18. not stretchy	X		
	19. too hard			
	Taste			
	20. no taste	X	X	X
	21. not sour			
	Texture in mouth			
	22. too hard	X	X	X
	23. too soft			
	Others			
	24. fibres	X		X
	25. impurities			

2.3 Data analysis

Analysis of variance (one-way ANOVA) was carried out to identify significant differences in the overall liking scores between the 4 *Eba* samples as tested by the consumers (n=301). The effect of region and gender was studied as well as other sociodemographic parameters using a Chi-square test on cluster groups. Multiple comparisons were made using the Tukey test, with a confidence interval of 95% at $p < 0.05$ (n=301 consumers). An Agglomerative Hierarchical Clustering (AHC) analysis was used to organize consumers into similar groups of overall liking. For each *Eba* sample, the number of consumers who judged each specific characteristic either 'Just About Right' (JAR),

'too weak' or 'too strong' was counted, and the percentage of consumers (out of 301) was determined. A Principal Component Analysis (PCA) was conducted on the count of citations for all the CATA quality characteristics, with Eba samples as the observation labels, and the mean overall liking for each sample as a supplementary quantitative variable. All statistical analyses were computed using XLSTAT 2019 software (Addinsoft).

3 RESULTS

3.1 Overall liking of the product samples

This study was conducted with 301 respondents in two states namely Benue (150 respondents (83 women; 67 men)) and Osun (151 respondents (75 women; 76 men)). This corresponds to 52.5% of women to 47.5% of men.

The overall liking of the *Eba* product significantly differed between the four *Eba* samples at a significant level of $p < 0.05$ (one-way ANOVA) (Table 1).

The combined results across the two states showed that the four *Eba* samples significantly differ with respect to liking ($p < 0.05$). The most liked *Eba* samples were the local or commonly cultivated varieties (Atu and Barnada) and IITA-TMS14F1278P0003 with a mean overall liking score close to 7-8 ('like moderately' to 'like very much'). The least liked was the IITA-TMS14F1022P0003 sample with a mean overall liking score close to 4 (dislike slightly). The IITA-TMS14F1278P0003 sample got an appreciable score close to 6 (like slightly).

The higher acceptability of yellow gari in Benue and some appreciation for a less starchy food product (Olaosebikan *et al.* 2019) can explain the better score for IITA-TMS-IBA011412 there. Sample IITA-TMS-14F1022P0003 was rated low across the two states.

The Tables below indicates overall liking of eba samples tested by 301 consumers at Benue (150) and Osun (151) states respectively.

Table 3 Mean overall liking scores for the four *Eba* samples tested in Osun

Eba samples	Mean Overall liking scores (n=151 consumers)	Groups
TMS14F1022P0003	4.2	A
TMS14F1278P0003	6.9	B
IITA-TMS-IBA011412	7.4	C
Atu	7.7	C

*Overall liking was rated on a nine-point scale from 1 = dislike extremely, to 9 = like extremely.

**Different letters correspond to the *Eba* samples when they are significantly different. Tukey test ($p < 0.05$).

*Atu: Local commonly cultivated variety in Osun

In Osun, the mean Overall liking of *Eba* samples significantly differed between the four varieties at a significant level of $p < 0.05$ (one-way ANOVA) (Table 3). The most liked was the *Eba* sample made from Atu and IITA-TMS-IBA011412 varieties with a mean Overall liking score of 7.7 (close to 8 or 'like very much') and 7.4 (close to 7 or 'like moderately') respectively. There were no significant differences in the average scores for Atu and IITA-TMS-IBA011412. The least liked was TMS14F1022P0003 clone with a mean Overall liking score of 4.2 (close to 4, 'dislike slightly'). TMS14F1278P0003 got a mean score of 6.9 ('like moderately') but appeared significantly different from IITA-TMS-IBA011412, and can be considered as an intermediate "liked product" among the four samples. Overall liking in Benue is presented in Table 4.

Table 4 Mean overall liking scores for the four Eba samples tested in Benue

Eba samples	Mean Overall liking scores (n = 150 consumers)	Groups		
TMS14F1022P0003	4.1	A		
TMS14F1278P0003	5.6		B	
IITA-TMS-IBA011412	6.3			C
Barnada	7.2			D

*Overall liking was rated on a nine-point scale from 1 = dislike extremely, to 9 = like extremely.

**Different letters correspond to the Eba samples when they are significantly different. Tukey test ($p < 0.05$).

*Barnada: long released improved variety in Benue

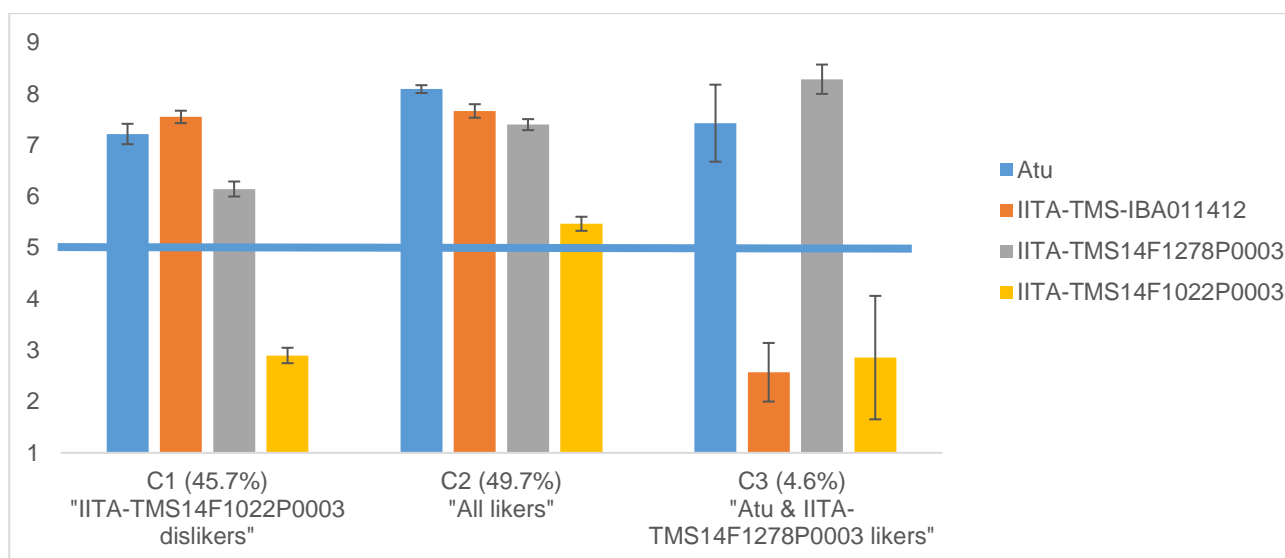
In Benue, the mean Overall overall liking of *Eba* samples significantly differed between the four varieties at a significant level of $p < 0.05$ (one-way ANOVA) (Table 4). The most liked was the *Eba* sample made from Barnada, a local variety, with a mean Overall liking score of 7.2 (close to 7 or 'like moderately'). The least liked was also TMS14F1022P0003 clone with a mean overall liking score of 4.1 (close to 4, 'dislike slightly'). TMS14F1278P0003 and IITA-TMS-IBA011412 got a mean score of 5.6 and 6.3 (close to 6, 'like slightly') respectively. However, these two clones appeared significantly different and can be considered as two intermediate "liked products" among the four samples.

Across the two states, the *Eba* sample TMS14F1278P0003 was rated higher by the consumers in Osun state with a mean Overall liking score of 6.9 compared to 5.6. The same for the *Eba* sample IITA-TMS-IBA011412 scored 7.4 in Osun and 6.3 in Benue. Even for the two local varieties Atu and Barnada, the score was higher for Atu in Osun (7.7) compared to the score obtained by Barnada in Benue (7.2).

3.2 Segmentation of consumers into groups of similar overall liking

The aim of an Agglomerative Hierarchical Clustering (AHC) analysis is to create homogeneous clusters of consumers who have similar overall liking scores. It is useful to classify consumers who have been interviewed randomly, into similar groups.

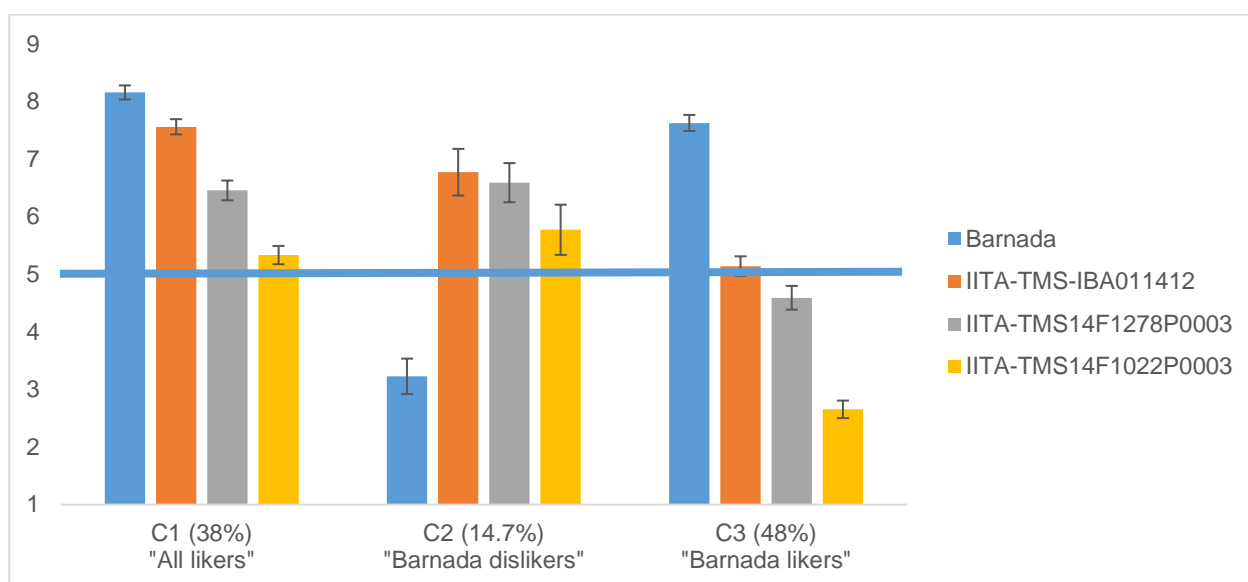
In Osun state (Figure 3), an Agglomerative Hierarchical Clustering analysis of the mean overall liking scores classified the consumers into three groups: "IITA-TMS14F1022P0003 dislikers" (C1), "all likers" (C2) and "Atu & TMS14F1278P0003 likers" (C3). These three clusters contained 45.7%, 49.7% and 4.6% of 151 consumers interviewed. Local (Atu) and improved (IITA-TMS14F1278P0003) varieties fulfilled the hedonic expectations of all consumer groups. IITA-TMS-IBA11412 dislikers only represented was disliked 4.6% of the respondents



Where: error bars represent the standard error.

Figure 3 Mean overall liking of the Eba samples by consumer cluster type (%) in Osun state

In Benue state, an Agglomerative Hierarchical Clustering analysis of the mean overall liking scores classified the consumers into three groups: "all likers" (C1), "Barnada dislikers" (C2) and "Barnada likers" (C3). These three clusters respectively contained 38%, 14.7% and 48% of 150 consumers interviewed. The traditional variety Barnada was not acceptable for consumers in C2, this was however only presenting 14.7% of the respondents. This is in contrast with Osun state where the traditional variety Atu was always highly acceptable. This shows that there are differences in acceptability between the traditional varieties in those two states. This could point to a more progressive attitude in Benue where farmers are more familiar with changing varieties and a more active seed system exists (Bentley et al. 2020).



Where: error bars represent the standard error.

Figure 4 Mean overall liking of the Eba samples by consumer cluster type (%) in Benue state

3.2.1 Demographic data of the consumers interviewed

Among the 301 consumers interviewed, 52.5% were women and 47.5% were men (Table 5).

Table 5 Demographic differences of the consumers with respect to cluster division for Osun and Benue states (in percent of the total consumers in each region)

Consumers	Benue State (n=150)					Osun State (n=151)				
	C1	C2	C3	sum	Chi-square test (p)	C1	C2	C3	sum	Chi-square test (p)
	57	22	71	150		69	75	7	151	
Female	36	10	37	83	0.275	37	35	3	75	0.660
Male	21	12	34	67		32	40	4	76	
Nigerian	57	22	71	150		69	75	7	151	
Yoruba	0	0	0	0	<0.0001*	61	70	5	136	0.102
Igbo	0	0	0	0		5	1	.	6	
Ibira	0	0	0	0		2	3	.	5	
Igede	0	0	0	0		1	1	1	3	
Tiv	53	15	68	136		0	0	0	0	
Idoma	4	7	3	14		0	0	0	0	
18-25	15	7	18	40	0.873	3	5	1	9	0.458
26-35	20	9	19	48		16	20	1	37	
36-45	13	4	19	36		27	27		54	
46-55	6	1	10	17		12	13	3	28	
56 & above	3	1	5	9		11	10	2	23	
Student	10	2	6	18	0.375	6	2		8	0.254
Artisanship	8	6	6	20		4	10		14	
Civil service	2		6	8		7	5	1	13	
Trading business	9	4	13	26		24	29	1	54	
Employed	0	0	2	2		3	5		8	
Unemployed	2	1	5	8		20	21	3	44	
Farming	26	9	33	68		5	3	2	10	
Other	0	0	0	0		0	0	0	0	
Primary	7	5	18	30	0.111	12	17	1	30	0.360
Secondary	33	15	30	78		20	25	3	48	
Tertiary	15	1	20	36		16	17		33	
No formal education	1	1	3	5		11	8	3	22	
Single	16	9	13	38	0.302	6	8		14	0.846
Married	38	13	55	106		62	65	7	134	
Widower	3		2	5		1	2	0	3	
Other			1	1		0	0	0	0	
Every day	15	3	16	34	0.556	27	31	1	59	0.888
Several times a week	30	13	35	78		35	34	5	74	
Once a week	10	4	10	24		4	5	1	10	
Several times a month	1		4	5		2	3		5	
Once a month	1	2	6	9		1	2		3	
PPI (average)	54.1	48.6	55.1	53.8	0.126 ^{&}	55.6	53.7	50.1	54.4	

[&]Using ANOVA because Poverty Probability Index (PPI) is a continuous variable

* Significant at $p < 0.05$

The sociodemographic description of the consumers interviewed over the two states shows that the majority of respondents were in the working class 18-45 year-old. Most respondent engaged in farming (37%), trading (26%), artisanship (11%) civil servant (7%) and students (9%). Most of the consumers belong to Tiv (45%) and Yoruba (45%) ethnic group with few consumers from Idoma (5%), Igbo (2%), Ibira (2%) and Igede (1%). About 80% of the respondents that participated in the consumer testing had formal education (primary, secondary and tertiary) with only 20% had no formal education. Half of the respondents consumed *Eba* several times a week and 31% consumed *Eba* every day. In Osun and Benue state the percentage of female and male respondents were (49.7% and 50.3%) and (55% and 45%) respectively. Respondents in Benue were Tiv dominated with few Idoma while Osun comprises of majorly Yoruba speaking respondents with few from Igbo, Ibira and Igede ethnic groups. There were less respondents in Benue state without formal education compared to Osun state.

Results show that ethnicity had a significant influence on segmentation and therefore on consumer preference in Benue state ($p < 0.05$) but this was not the case in Osun state. There were proportionally more Tiv people in C2 (Barnada dislikers) as compared to Idoma. This would mean that more people from Tiv ethnical background would dislike Barnaba. However, because of the small size of the cluster 2 (15 Tiv and 7 Idoma people), this conclusion may be biased. Other sociodemographic results including gender were non significant in terms of cluster group.

3.2.2 Consumption attitudes

Out of 301 consumers, interviewed 30% consume *Eba* daily, 51% consume *Eba* several times a week, 11% consumed *Eba* once a week and 7% consumed *Eba* once or several times a month. Both Osun and Benue state had higher proportion of respondents consuming *Eba* daily (39%, 23%) and several times a week (49%, 52%), once a week (7%, 16%) as well as once or several times in a month (5%, 9%) respectively.

Figures 5 and 6 show the proportion of men and women as segmented in the different clusters in Osun and Benue states.

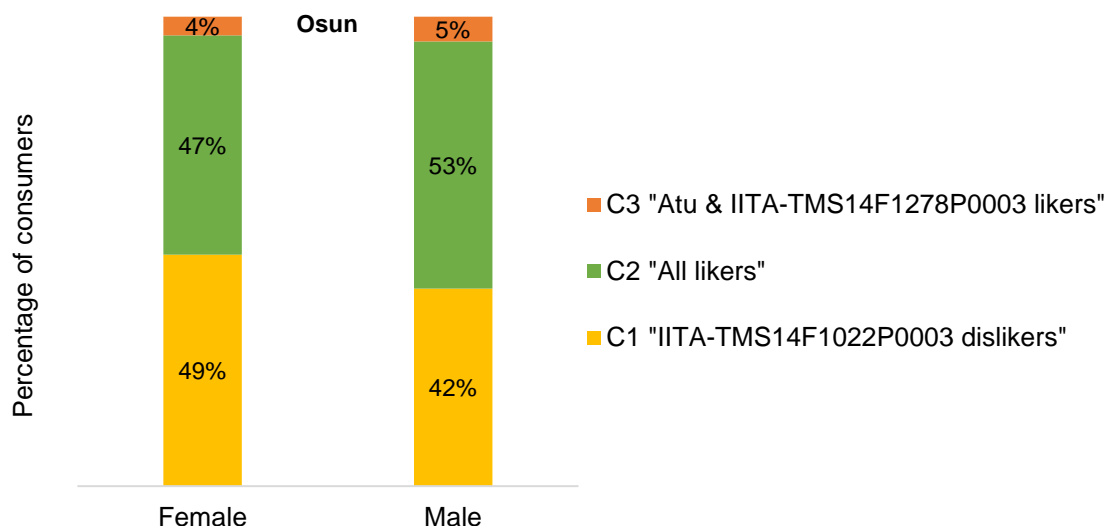


Figure 5 Percentage of consumer cluster type by gender at Osun state

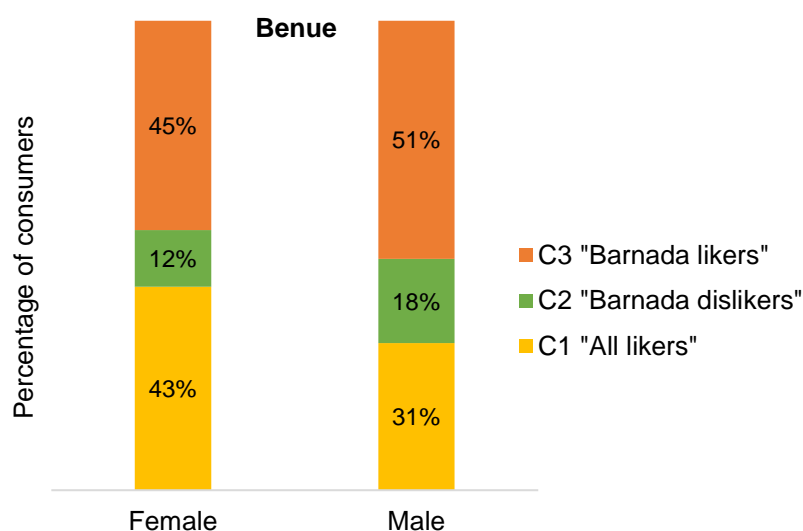


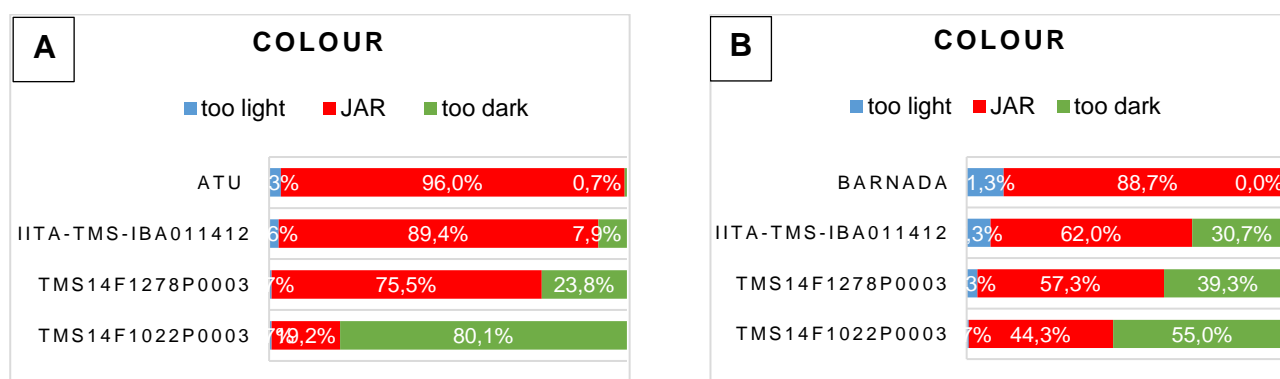
Figure 6 Percentage of consumer cluster type by gender at Benue state

Higher proportion of men and women are “All likers” in Osun (53% and 47% respectively) compared to Benue state (31% and 43% respectively). Overall there was no strong statistical difference in preference between men and women ($p = 0.06$ – see appendix 1) but it was shown that more women disliked IITA-TMS14F1022P0003 in Osun. This may be that there are more women in the cluster that of ‘TMS14F1022P0003 dislikers’ and this could be interpreted as women being stronger against the overall disliked variety indicating that men are more forgiving when confronted with a variety that is different and less liked and it could reflect women’s higher hands on experience and thus expertise in processing *Gari* and preparing *Eba*. It could also indicate that men are more keen to appreciate something that they do not normally eat.

3.3 A Just About Right test (JAR)

Just about right (JAR) scale was used to determine the optimum level of intensity as perceived by the consumers for some important sensory quality characteristics of the *Eba* samples. Such “descriptor’s diagnostic” may help understand why consumers like or dislike specific *Eba* samples.

Consumers were asked to give their perception of the colour, smoothness and sourness of each *Eba* sample, by using a 3-point JAR scale (1 = “Too low, too weak, not enough”, 2= “Just About Right” and 3 = “Too high, too strong, too much”).



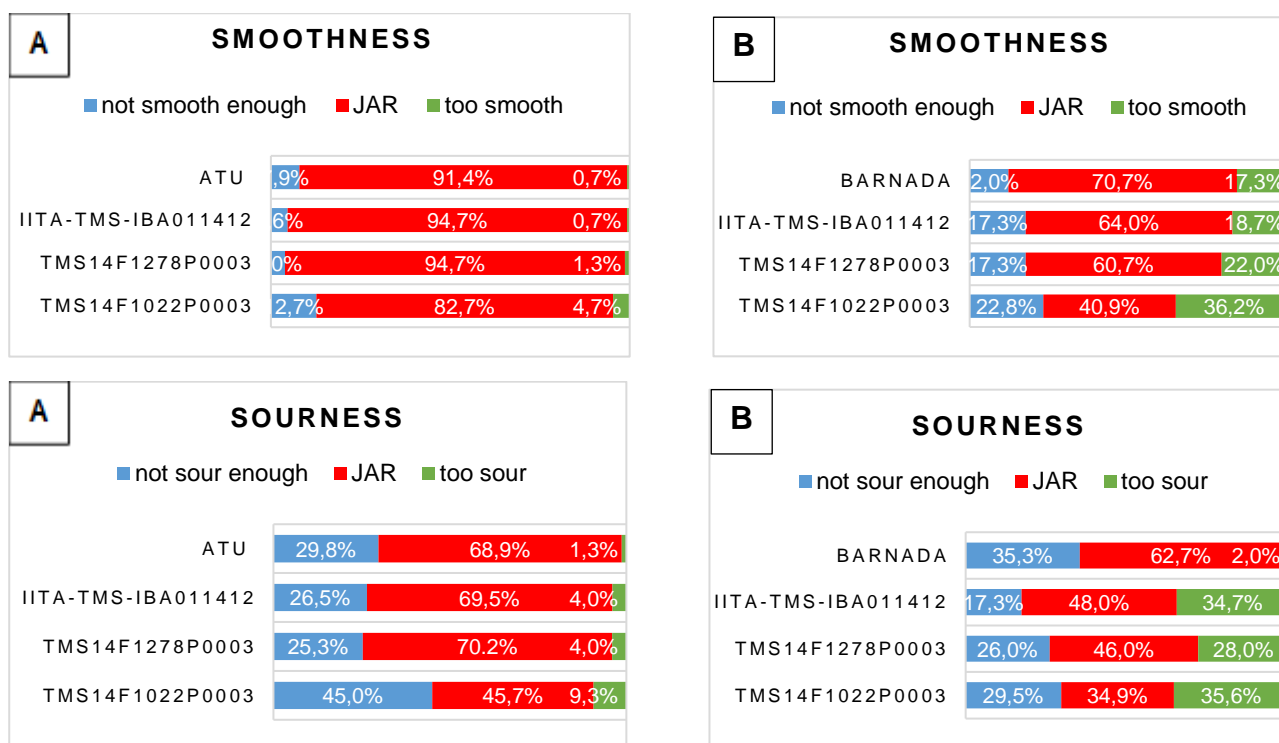


Figure 7 Percentage of consumers who scored the three specific quality characteristics at Osun (A) and Benue (B) states

In Osun state, most consumers were satisfied with the three sensory characteristics of the local variety (Atu), IITA-TMS-IBA011412 and IITA-TMS14F1278P0003 *Eba* samples in term of colour, smoothness and sourness (Figure 7A). Colour was scored “Just About Right” (JAR) by 96, 89.4 and 75.5% of consumers, respectively. Smoothness was scored JAR by 91.4, 94.7 and 94.7% of consumers respectively, and Sourness was also scored JAR by 68.9, 69.5 and 70.2% of consumers respectively. IITA-TMS14F1022P0003 was also perceived JAR by 82.7% of consumers for its smoothness, but by only 45.7% of consumers for its sourness. This *Eba* sample was found “too dark” and “not sour enough” by 80.1% and 45.0% of consumers. The three other *Eba* samples were also perceived “not sour enough” by 25.3 to 29.8% of consumers, and IITA-TMS14F1278P0003 “too dark” by 23.8% of consumers. Consequently, darkness of IITA-TMS14F1022P0003 can explain the lower score in overall liking.

In Benue, Barnada, IITA-TMS-IBA011412 and IITA-TMS14F1278P0003 *Eba* samples were found JAR for their colour (88.7, 62.0 and 57.3% of consumers respectively) and smoothness (70.7, 64.0 and 60.7% of consumers respectively) (Figure 7B). Sourness was scored JAR by more than 50% of consumers (62.7%) for only Barnada *Eba* sample. IITA-TMS14F1022P0003 was scored “too dark” by more than 50% of consumers (55.0%), and IITA-TMS-IBA011412 and IITA-TMS14F1278P0003 by 30.7 and 39.3% of consumers respectively. A higher percentage of consumers scored also “too smooth” (18.7, 22.0, and 36.2%) and “too sour” (34.7, 28.0, and 35.6%) the *Eba* samples IITA-TMS-IBA011412, IITA-TMS14F1278P0003 and IITA-TMS14F1022P0003 respectively, contrary to a lower percentage of consumers in Osun. This can again be attributed to a longer fermentation during cassava processing into *Gari* in Osun state compared to the one used in Benue. Benue consumers are used to *Gari/Eba* with big granule size and sweet taste fermented for lesser time/days compared to Osun where processors ferment for longer time/days resulting into smoother granules and sour *Eba*. The data also indicate that longer fermentation of *Gari* affects the colour because more consumers in Benue state indicated that the all the samples except their local one for which the *Gari* was made following standard procedures in Benue, were “too dark”.

There were differences in sensory perception of the *Eba* samples across the two states. Consumers in Osun state were overall more satisfied with the *Eba* samples - including the traditional variety Atu- than consumers in Benue state. That may be explained by the fact that all except the Barnada *Gari*

samples were processed in Osun state where fermentation time is longer, apparently affecting the sourness and the colour of the *Eba* products in Benue.

3.4 Check All That Apply (CATA) test

The objective of the CATA test is to show the relationships between hedonic overall liking scores for each *Eba* sample and the frequencies of citation of each CATA sensory characteristic by all the consumers.

After scoring the overall liking and the perception of some specific sensory characteristics, consumers were invited to choose the most appropriate terms among the 27 sensory characteristics that better describe each *Eba* sample.

The count of citations given by the consumers in Osun and Benue States to describe each *Eba* sample were shown in Table 6. The sensory characteristics with high count of citations by the consumers are considered the best for describing *Eba* products.

These include “mouldable”, “good aroma”, “smooth”, “good taste”, “neat”, “moderately soft” in both states, and “stretchy” and “sour” in Osun, with a count of citation between 410 and 580. The least used terms were “impurities”, “fibres” and “too soft” in Osun and “too hard” in Benue.

Atu and Barnada *Eba* samples representing local varieties were described with a high number of citations (between 110 and 150) by the same characteristics than above. Only Barnada sample was not described in Benue as “sour” (11 citations) but was described as “white” (127 citations).

We observed the same for the characteristics used by the consumers to describe IITA-TMS-IBA011412 and TMS14F1278P0003 *Eba* samples with a count of citations between 100 and 150. Only IITA-TMS-IBA011412 was described as “yellow” (147 citations).

Yellow colour of IITA-TMS-IBA011412 *Eba* sample stand out from other *Eba* tested and this gave it high citation at both states as the consumers in the study can differentiates colour of *Eba* samples tested.

The TMS14F1022P0003 *Eba* sample was qualified in Osun as “dull/dark brown”, “moderately soft” and “good aroma” (100 to 150 citations), but also “too sticky”, “not stretchy”, “not mouldable” (55-60 citations) However, it was also perceived “mouldable” (96 citations). In Benue, it was also described as “dull/dark brown”, “moderately soft”, “mouldable”, but also “smooth”, with “fermented odour” (105 to 145 citations).

Table 6 Count of citations of each quality characteristic by consumers in Osun and Benue State

Characteristics	OSUN					BENUE				
	IITA-TMS 14F1 022P 0003	IITA-TMS 14F1 278P 0003	IITA-TMS- IBA0 1141 2	ATU	Sum	IITA-TMS14F 1022P0 003	IITA-TMS 14F1 278P 0003	IITA-TMS- IBA0 1141 2	Barna da	Sum
Butter colour	2	77	0	13	92	14	62	48	3	127
Cream colour	2	43	0	100	145	30	40	10	21	101
Dull/dark brown	129	32	1	0	162	142	78	46	4	270
Fermented odour	58	63	59	64	244	106	99	101	79	385
Fibres	1	0	1	3	5	42	34	26	11	113
Good aroma	102	137	139	140	518	83	112	114	138	447
Good taste	76	129	139	141	485	78	113	113	143	447
Impurities	0	0	0	2	2	60	38	23	3	124
Less lump	27	33	32	31	123	60	51	54	60	225
Moderately soft	115	115	126	127	483	128	132	139	116	515
Mouldable	96	146	149	150	541	143	145	149	140	577

Characteristics	OSUN					BENUE				
	IITA-TMS 14F1 022P 0003	IITA-TMS 14F1 278P 0003	IITA-TMS- IBA0 1141 2	ATU	Sum	IITA-TMS14F 1022P0 003	IITA-TMS 14F1 278P 0003	IITA-TMS- IBA0 1141 2	Barna da	Sum
Neat	81	109	147	148	485	93	117	126	146	482
No taste	13	3	3	6	25	27	20	17	17	81
Not mouldable	55	2	5	0	62	8	3	0	15	26
Not sour	21	6	3	3	33	34	34	21	78	167
Not stretchy	59	8	3	4	74	93	85	88	12	278
Offensive odour	17	1	1	3	22	39	22	15	2	78
Smooth	88	138	143	140	509	128	136	146	140	550
Sour	85	103	110	116	414	96	96	120	11	323
Stretchy	66	125	137	133	461	49	55	56	137	297
Sweet	14	33	35	32	114	12	30	26	66	134
Swelled	73	77	72	80	302	50	51	51	50	202
Too hard	8	25	13	16	62	4	2	1	0	7
Too soft	7	1	2	0	10	37	27	16	32	112
Too sticky	59	16	6	4	85	38	26	21	50	135
White	0	0	0	39	39	0	0	0	127	127
Yellow	0	0	147	1	148	2	4	101	0	107

3.5 Sensory mapping of the sensory characteristics

Principal component analysis (PCA) was used to summarize the relationships between CATA sensory characteristics, *Eba* samples, and mean overall liking of each product scored by all the consumers in Osun and in Benue states.

In Osun, the PCA plot explained 92.21% of the variance of the sensory characteristics, the first and second axes accounting for 61.44% and 30.77% respectively. Most of the variance was explained by the first axis (Figure 10).

The loading of sensory characteristics on PCA plan showed that axis 1 (x) was mainly explained positively by the terms “dull/dark brown”, “not sour”, “too sticky”, “not stretchy”, “offensive odour”, “not mouldable”, “no taste” and “too soft” (here on the right part of the PCA plan) associated to the least liked *Eba* sample (TMS14F1022P0003) and a lower overall liking (score of 4.2, dislike slightly). Negatively, axis 1 was explained by the terms “stretchy”, “good taste”, “smooth”, “mouldable”, “good aroma”, “sweet”, “sour”, “neat”, and “less lumps” which are highly related to a high overall liking (here on the left part of the PCA plan).

Axis 2 (y) was mainly explained positively with the terms “Yellow”, related to IITA-TMS-IBA011412 *Eba* sample, and negatively by the terms such as “swelled”, “fermented odour” and “cream colour” related to Atu *Eba* sample.

Axis 3 (not represented here) (7.79% of the variance) was explained positively by the term “butter colour” related to TMS14F1278P0003 *Eba* sample, and negatively by “fibres”.

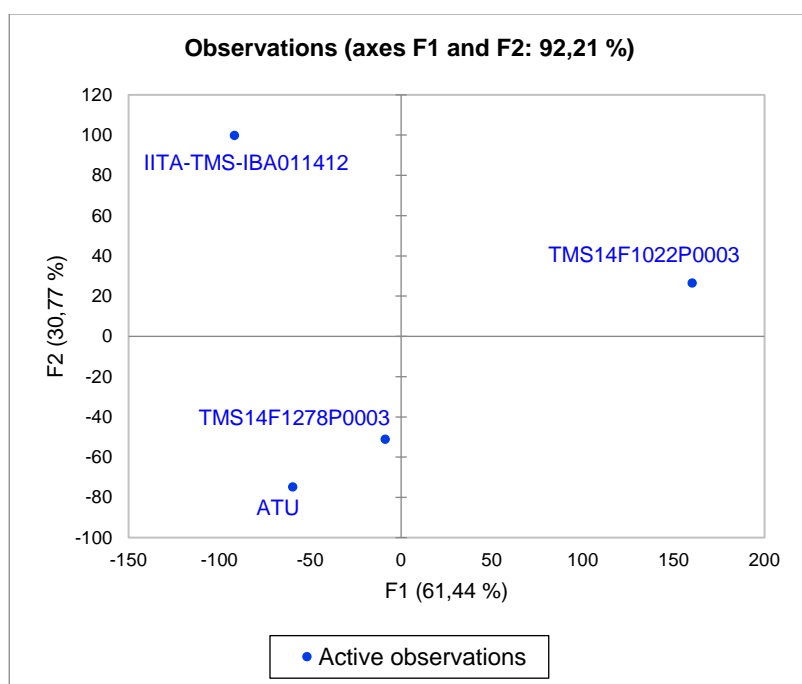
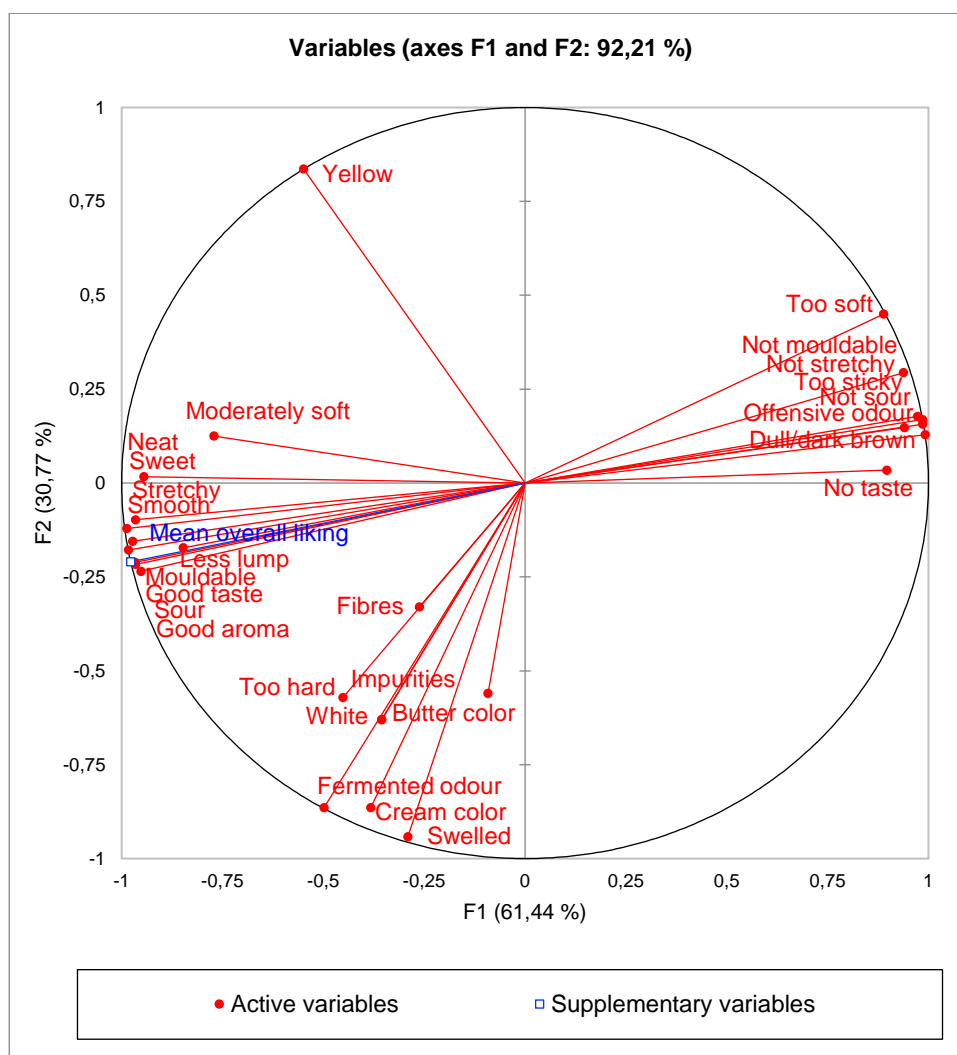
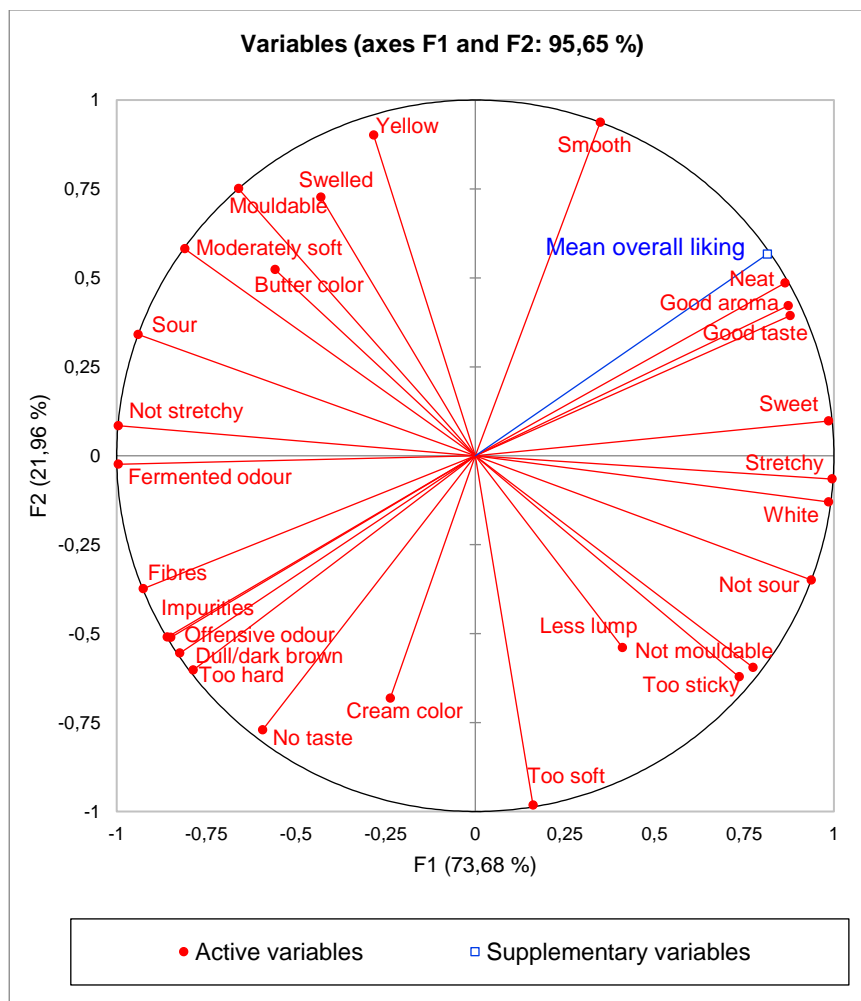


Figure 8 Mapping (Principal Component analysis) of the sensory characteristics and the overall liking of the product samples by consumers at Osun state

In Benue, the PCA plot explained 95.65% of the variance of the sensory characteristics, the first and second axes accounting for 73.68% and 21.96% respectively. Most of the variance was explained by the first axis (Figure 11).

The loading of sensory characteristics on PCA plan showed that axis 1 was mainly explained positively by the terms “stretchy”, “white”, “sweet”, “not sour”, “good taste”, “good aroma”, “neat” (here on the right part of the PCA plan) associated to the most liked *Eba* sample Barnada and a higher overall liking (score of 7.2, like moderately). Negatively, axis 1 was explained by the terms “fermented odour”, “not stretchy”, “sour”, “fibres”, “impurities”, “offensive odour”, “dull/dark brown”, “moderately soft”, “too hard” (here on the left part of the PCA plan) which are slightly related to TMS14F1022P0003 and TMS14F1278P0003 *Eba* samples, and a lower overall liking (scores of 4.1, dislike slightly and 5.6, like slightly).

Axis 2 was mainly explained positively with the terms “smooth” and “yellow”, related to IITA-TMS-IBA011412 *Eba* sample, and negatively by the term “too soft”.



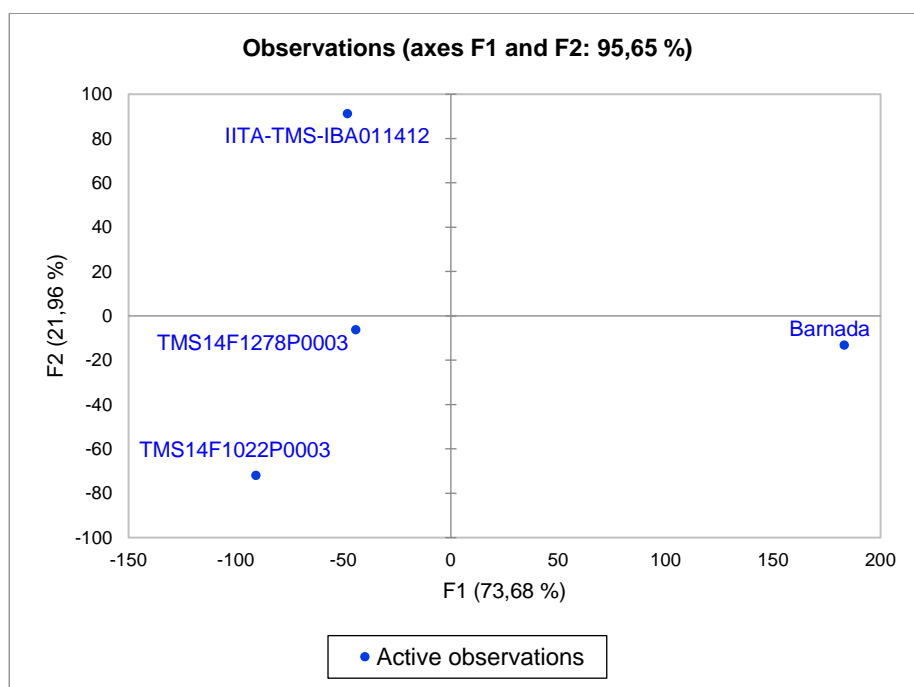


Figure 9 Mapping (Principal component analysis) of the sensory characteristics and the overall liking of the Eba samples among consumers in Benue state

4 DISCUSSION AND CONCLUSION

Apart from the tedious processing work *Gari*, *Eba* can be classified as a fast food because it is fast and easy to prepare for both men and women daily engaged in long working hours. The ethnic groups involved in this study are known for their *Eba* consumption. This indicates results from the study are reliable. *Eba* samples were perceived differently among consumers across states due to cultural, processing and preparation differences in the two localities. Respondents selected for this study were married, educated, engaged in different livelihoods mostly farming, business and artisanship with higher percentage, consuming *Eba* several times within a week. The highest proportion of consumers that participated in the study were in their active age of (26-55) years.

Analysis of variance (ANOVA) shows that *eba* sample TMS14F1022P0003 has the least mean overall liking. About half of the population (29% women, 20% men) engaged in farming and business/trading as livelihoods, disliked this *eba* sample. This group of people know what they need in terms of food qualities.

The JAR test results revealed that *eba* from local/commonly cultivated cassava (Atu and Barnada) in Osun and Benue states has highest score for colour, smoothness and sourness, followed by ITA-TMS-IBA011412 and TMS 14F11278P0003 while TMS 14F1022P0003 had the lowest score.

Scores from Osun on the JAR test for colour; sourness and smoothness for the four *eba* samples were higher compare to Benue. In Benue, consumers the four *eba* samples scored higher for the negative connotations: too dark, too sour and too smooth while the local variety clearly received the least negative connotations. This is related to differences in fermentation practices and processing methods adopted in the two states because all but the local Benue variety Barnada were processed into *gari* in Benue state. Benue processors are also used to adding palm-oil to *Gari*, explaining why the *Eba* made from biofortified *Gari* was more appreciated there (Olaosebikan et al, 2019, Bechoff et al, 2018).

In Benue, consumers found *Eba* sample from TMS 14F1022P0003 variety too smooth and this was contrary to the perception of a few Osun consumers who found *Eba* sample from TMS 14F1022P0003 not smooth enough although less outspoken. This can be explained by the method of *Eba* preparation and granule size of *Gari* preferred by consumers that is different in both states. In Benue longer time between the *Gari* and *Eba* is made resulting into a smoother fully rehydrated

Eba structure, while in Osun less long time of rehydration is practiced resulting in a grainier and less stretchable and less smooth *Eba*. The lowest JAR score for *Eba* sample from TMS 14F1022P0003 indicates that consumers disliked slightly *Eba* made from this variety, this corroborates with findings of Olakunle et. al., 2012 and Teeken et al., 2020 and Ndjouenkeu, 2020 and Awoyale et al. 2020 that colour, taste, odour are the principal sensory characteristics that determine overall acceptability of cassava food product.

CATA results showed that the colour and appearance related characteristics, white, yellow, cream colour and dull/dark brown were important in determining *Eba* quality which corresponds to findings by Teeken *et al.* (2020). It also seems that the unliked darkening goes along with fermentation length as consumers in Benue generally mentioned 'too sour and too dark more often for all varieties in the JAR test, except for the *Eba* from the locally popular variety Barnada for which the *Gari* was processed in Benue and was thus fermented less. The least liked variety seems to be more affected by darkening as a result of fermentation.

Furthermore, 'mouldable', 'good aroma', 'neat', 'good taste', 'sour' and 'smooth' were characteristics that described good *Eba* while 'presence of fibres', 'too soft', 'no taste', 'too sticky', 'not stretchy' and 'not sour' were characteristics of bad *Eba* sample, highly corresponding to the survey findings from RTB foods activity 3 survey work (Ndjouenkeu *et al.* 2020)

Apart from dull/dark coloured *Eba* consumer from both states detested *Eba* with offensive odour and without taste, the other bad qualities of bad *Eba* samples are 'too hard', 'not mouldable', 'presence of impurities and fibres'.

There were no gender differences: men and women preferred *Eba* qualities identified in the study. However, women seemed to be less forgiving when confronted with a less liked variety probably reflecting their hands on processing and preparation experience and/or indicating that men generally are more likely to appreciate a food product quality they are not usually consuming and less discriminative in terms of food quality.

The good characteristics of *Eba* are related to 'good texture', 'good colour', 'moulding' and 'swelling capacity' of *Gari*. This indicates that cassava that can produce good quality *Gari* will produce *Eba* with acceptable attributes and eating quality.

Conclusively, breeders are advised to incorporate sensory testing and product acceptability tests in screening newly developed cassava varieties among diverse consumers before release, and develop ways to select for food products' quality earlier on in the breeding cycle through investigating the relationships between physiochemical properties of the root and the quality of the final food product.

5 REFERENCES

- Awoyale, W., Alamu, E.O., Chijioke, U., Tran, T., Takam Tchuenté, H.N., Ndjouenkeu, R., Kegah, N. and Maziya-Dixon, B. (2021). A review of cassava semolina (gari and eba) end-user preferences and implications for varietal trait evaluation. *Int. J. Food Sci. Technol.* 56: 1206-1222. doi:10.1111/ijfs.14867
- Bechoff A, Chijioke U, Westby A, Tomlins KI (2018) 'Yellow is good for you': Consumer perception and acceptability of fortified and biofortified cassava products. *PLoS ONE* 13(9): e0203421. <https://doi.org/10.1371/journal.pone.0203421>
- Bello, A., Olaosebikan, O., Osunbade, A., Teeken, B. (2020). Participatory processing diagnosis for gari in Nigeria: Community-based RTB Food processing/preparation diagnosis. Ibadan, Nigeria: RTBfoods Project Report.
- Bentley, J.W., Nitturkar, H., Obisesan, D., Friedmann, M. and Thiele, G. (2020). Is there a space for medium-sized cassava seed growers in Nigeria? *Journal of Crop Improvement* 34:6, 842-857. doi:10.1080/15427528.2020.1778149
- Ndjouenkeu, R., Ngoualem Kegah, F., Teeken, B., Okoye, B., Madu, T., Olaosebikan, O.D., Chijioke, U., Bello, A., Oluwaseun Osunbade, A., Owoade, D., Takam-Tchuenté, N.H., Biaton Njeufa, E., NguiaDEM Chomdom, I.L., Forsythe, L., Maziya-Dixon, B. and Flidel, G. (2021), From cassava to gari: mapping of quality characteristics and end-user preferences in Cameroon and Nigeria. *Int. J. Food Sci. Technol.*, 56: 1223-1238. doi: 10.1111/ijfs.14790.
- Olakunle, M.M, Akinwale, S.O., John, O. M. and O. O. Samuel (2012): Comparative Study on Quality Attributes of *Gari* Obtained from Some Processing Centres in South West, Nigeria, *Advanced Journal of Science and Technology*, 4(3):135-140.
- Olaosebikan, O., Abdulrazaq, B., Owoade, D. et al. (2019). Gender-based constraints affecting biofortified cassava production, processing and marketing among men and women adopters in Oyo and Benue States, Nigeria. *Physiological and Molecular Plant Pathology*, 105, 17–27.
- Teeken, B., Agbona, A., Bello, A., Olaosebikan, O., Alamu, E., Adesokan, M., Awoyale, W., Madu, T., Okoye, B., Chijioke, U., Owoade, D., Okoro, M., Bouniol, A., Dufour, D., Hershey, C., Rabbi, I., Maziya-Dixon, B., Egesi, C., Tufan, H. and Kulakow, P. (2021), Understanding cassava varietal preferences through pairwise ranking of gari-eba and fufu prepared by local farmer-processors. *Int. J. Food Sci. Technol.*, 56: 1258-1277. <https://doi.org/10.1111/ijfs.14862>.

6 APPENDIX

Table 7 Combined demographic differences of the consumers with respect to cluster division in Osun and Benue state. *except for PPI (ANOVA test)

Consumers		C1	C2	C3	Total	Chi-square test (p)*
State	Benue (%)	28.57	13.29	7.97	49.83	<0.001*
	Osun (%)	21.26	24.92	3.99	50.17	
Gender	Female (%)	29.24	18.60	4.65	52.49	0.06
	Male (%)	20.60	19.60	7.31	47.51	
Nationality	Nigerian (%)	49.83	38.21	11.96	100.00	
Country of residence	Nigeria (%)	49.83	38.21	11.96	100.00	
Ethnicity	Yoruba (%)	18.60	22.92	3.65	45.18	<0.001*
	Igbo (%)	1.33	0.33	0.33	1.99	
	Ibira (%)	0.66	1.00	0.00	1.66	
	Igede (%)	0.33	0.66	0.00	1.00	
	Tiv (%)	27.57	11.96	5.65	45.18	
	Idoma (%)	1.00	1.33	2.33	4.65	
Age	18-25 (%)	8.31	4.65	3.32	16.28	0.298
	26-35 (%)	12.96	11.30	3.99	28.24	
	36-45 (%)	15.28	11.30	3.32	29.90	
	46-55 (%)	6.98	6.98	1.00	14.95	
	56 & above (%)	6.31	3.99	0.33	10.63	
Occupation	Student (%)	4.32	2.99	1.33	8.64	0.355
	Artisanship (%)	3.99	4.65	2.66	11.30	
	Civil service (%)	4.32	2.66	0.00	6.98	
	Trading business (%)	13.62	11.30	1.66	26.58	
	Employed (%)	1.66	1.33	0.33	3.32	
	Unemployed (%)	1.66	0.66	0.33	2.66	
	Farming (%)	17.94	13.62	5.65	37.21	
	Other (%)	2.33	1.00	0.00	3.32	
Education	Primary (%)	10.63	7.31	1.99	19.93	0.109
	Secondary (%)	18.60	15.61	7.64	41.86	
	Tertiary (%)	11.30	9.97	1.66	22.92	
	No formal education (%)	5.98	2.66	0.33	8.97	
Marital status	Single (%)	7.64	5.65	3.99	17.28	0.107
	Married (%)	40.86	30.90	7.97	79.73	
	Widower (%)	1.00	1.66	0.00	2.66	
	Other (%)	0.33	0.00	0.00	0.33	
Consumption count	Every day (%)	14.62	13.62	2.66	30.90	0.597
	Several times a week (%)	24.25	18.94	7.31	50.50	
	Once a week (%)	6.31	3.65	1.33	11.30	
	Several times a month (%)	2.33	1.00	0.00	3.32	
	Once a month (%)	2.33	1.00	0.66	3.99	
PPI (average)		55.1	54.4	49.2	54.1	0.065



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