

Consumer Testing of Pounded Yam 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 panelists and from consumers participating in activities.

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ABSTRACT

Quality attributes are perceived differently by various individuals, and sensory perceptions can be influenced by consumers' different demographic characteristics. Sensory preference among rural and urban consumers for yam varieties and those varieties made into pounded yam was the focus of this field survey. The aim was to incorporate the best quality attributes into new breeders' lines. Consumption habits of consumers, their form and frequency of consumption as well as their preferences for pounded yam quality were assessed. In order to understand consumers' demand for pounded yam sensory characteristics, a clear and visual mapping of the most liked and least liked pounded yam varieties associated with high and low quality characteristics and high and low overall liking scores, respectively, was examined using statistical analysis (XLSTAT software).

In this field study, 180 consumers were assessed for pounded yam quality preferences using 4 pounded yam samples prepared from identified yam varieties in Iwo, Osun state, Nigeria. Yam varieties which are less preferred by the consumers were classified as less preferred because of their 'not too good' quality pounded yam characteristics and compared favourably with pounded yam from the highly preferred yam varieties.

Good quality pounded yam samples were described as 'stretchable', 'soft', 'smooth', 'mouldable', 'not sticky', 'white/yellow' depending on the yam flesh colour, 'sweet taste' and 'good aroma'. These described pounded yam varieties Lasinrin (269), Gbongi kamilu (386) and Awana (752).

The least liked pounded yam sample was Ewura. Consumers described its pounded yam as 'lumpy', 'not mouldable', 'not stretchable' etc. when touched and perceived it as 'too dark' in appearance and having a 'bitter' taste in the JAR test results.

In conclusion, high quality characteristics related to a high mean overall liking and associated with the most liked pounded yam samples with the terms: 'smooth', 'mouldable', 'good aroma', 'stretchable', 'sweet taste', 'soft'. The most liked varieties were Lasinrin, Awana, and Gbongi Kamilu.

Conversely, the low quality characteristics related to a low mean overall disliking by the consumers and associated to the least liked pounded yam sample, Ewura, which rated as a low quality variety with attributes such as 'grey'/'too dark', 'bitter taste', 'sticky', 'not stretchable', 'lumps', and 'too hard'.

Key Words: Consumer acceptability, hedonic preference, check-all-that-applies, just-about-right, pounded yam, preferred quality characteristics, gender, Nigeria, Osun state

1 STUDY CONTEXT AND GENERAL OBJECTIVES

Understanding the Drivers of Trait Preferences and the Development of Multi-user RTB Product Profiles is the focus of RTBfoods i.e. roots, tubers and banana foods project. This project entails various work packages which includes WP1. WP1 focused on identifying quality characteristics of crops such as yam and the final RTB product such as pounded yam in this field survey, for different user groups. The work package also aimed at providing evidence base for end-user preferences of RTB product – pounded yam characteristics, identify the factors that influence these preferences for men, women, ethnicity and other social segments, and the way they may be prioritized differently. Various activities, 1-5, were carried out in WP1 ranging from the State of Knowledge Review in order to investigate demand trends and consumer segments for selected RTBfoods products as follows: Capacity Strengthening using the multidisciplinary methodology approach (food scientist, gender specialist and economists forming a team); Gendered product mapping and user profiles to evaluate and rank the quality characteristics of RTBfoods crops e.g. yam and selected final products such as pounded yam by gender and region; Participatory processing diagnosis and quality characteristics to find out processing parameters and quality characteristics during processing that may influence the quality of the end product; and Consumer testing in rural and urban user segments respectively.

Activity 5 “Consumer testing” which is the focus of this report is centred on assessing consumer preferences through sensory profiling of final products e.g. pounded yam, with consumers in rural and urban areas in different regions. The main objective is to understand the consumers’ demand for the quality characteristics of Root, Tuber and Banana products, and also provide WP2 with a clear and visual mapping of the most liked pounded yam, associated with high quality characteristics and high overall liking scores, and that of the least liked pounded yam associated with low quality characteristics and low overall liking scores.

In this field study, outcomes from Activity 5 carried out on pounded yam - a popular yam food product - which is the focus for consumer testing, is presented. The activity involved inviting a large number of consumers to test 4 pounded yam samples with variable quality characteristics made from identified yam varieties in the previous processing demonstrations step.

2 METHODOLOGY

2.1 Sampling

Pounded yam samples were prepared from four yam varieties with different quality characteristics, as identified during Activity 4 “Processing diagnosis” by the processors. The 4 cultivars used in this field survey were all landraces from urban and rural areas of Iwo, Osun State, Southwest region, Nigeria and presented below as named by processors.

- Lasinrin,
- Awana,
- Gbongi kamilu
- Ewura

The quality characteristics of the yam varieties used for preparing the pounded yam samples were ranked in the order of being very good to very poor in lasinrin, awana, gbongi kamilu and ewura respectively by the processors. However, these varieties can behave differently when stored.

Samples were tested by rural and urban consumers (n=180) with different demographic characteristics in Iwo, Osun State region, Nigeria. Using the WP1 process for consumer testing, based on willingness, availability and given consent, 180 participants were recruited for this study consisting of 109 females and 65 males as indicated in Table 2, with 6 participants who preferred not to state their gender. The consumer testing was carried out by both rural and urban consumers in Iwo town. These participants were presented with the 4 pounded yam samples prepared from

various yam varieties and assessed for their preferences regarding various sensory quality characteristics in pounded yam such as colour, textural attributes and mouthfeel as identified in previous WP1 activities. The yam varieties used for preparing the 4 pounded yam samples consisted of varieties described by processors as not preferred, less preferred, preferred and highly preferred for pounding as presented in Table 1, because it gives very poor, poor, good, and very good pounded yam quality respectively in terms of colour, textural attributes and mouth-feel.

Table 1: Quality characteristics of the yam varieties used as identified by Processors in Osun




Name	Yam specie	Code	Preferred characteristics	Pounded Yam Quality characteristics rank	Photo (appearance)
Gbongi kamilu	<i>D. rotundata</i>	386	Less preferred	Low/poor	
Awana	<i>D. rotundata</i>	752	Preferred	High/Good	
Ewura	<i>D. alata</i>	410	Not preferred	Very low/very poor	
Lasinrin	<i>D. rotundata</i>	269	Highly preferred	Very high/very good	

Table 2: Number of consumers interviewed in the rural and urban areas of one region

	Total	Region – South West (Osun State)	
		Village 1	Small town
Number of consumers	174	40	134
Women	109	34	75
Men	65	6	59

2.2 Consumer testing

In order to assess the consumer preference of the interviewed participants, a method including a hedonic test, a just-about-right (JAR) test, and a check-all-that-apply (CATA) test was adopted. Consumers (n = 180) from different locations in rural and urban areas were asked individually to look/touch/smell/taste each pounded yam sample, one after the other, in a random order, and 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 6 characteristics identified as important in the previous Activities 3 & 4, using the 3-point JAR “Just-About-Right” scale (1 = “too soft”, “too dark”, “not enough”, 2= “Just-About-Right” and 3 = “too hard”, “too stretchable”, “too sticky”) for each of the pounded yam samples.

Consumers were then asked to select the quality characteristics that better describe each sample, among a list of 20-25 sensory characteristics - the most liked and the least liked collected during the

previous Activities 3 & 4- using a “Check-All-That-Apply” (CATA) approach. Finally, consumers were invited to give their opinion and preferences on the Pounded yam samples. Below is a table 3 with CATA quality characteristics. Quality characteristics identified during Activity 3, those identified during Activity 4, and those identified during both activities were used for Activity based on the users’ preferences. The CATA table shows the most liked and the least liked quality characteristics related to the appearance, aroma, texture between fingers, and taste of pounded yam. The quality characteristics were mainly sensory characteristics useful for WP2.

Table 3: Quality characteristics identified during the previous activities 3 & 4 selected for building the CATA table

	Quality characteristics of the ready to eat 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			
	- White	X	X	X
	- Yellow			X
	- Cream			
	Texture when touching			
	- No lumps	X	X	X
	- Soft	X	X	X
	- Mouldable	X	X	X
	- Smooth	X		X
	- Moderate soft			
	- Stretchable	X	X	
	- Not sticky	X	X	X
	Taste			
	- Sweet taste	X	X	X
	- Bland taste		X	
List of the least liked characteristics	Aroma			
	- Good aroma	X	X	X
	Processing ability			
	Easy to pound	X	X	
	Appearance			
	- Grey	X	X	X
	Texture when Touching			
	- Lumps	X	X	X
	- Too hard			X
	- Sticky	X	X	X
	- Hard	X	X	X
	- Not smooth	X	X	X
	- Slightly sticky			X
	- Not stretchable	X	X	X
	- Moderately hard			X
	- Too soft	X	X	X
	- Not mouldable	X	X	X
	Taste			
	- Bitter taste			X
	Aroma			
	- Bad aroma	X	X	X

2.3 Data analysis

Analysis of variance (ANOVA) was carried out to identify significant differences in the overall liking scores between the 4 pounded yam samples (Lasinrin, Awana, Gbongi kamilu, Ewura) as tested by the consumers (n= 180). Multiple pairwise comparisons were applied using the Tukey test, with a confidence interval of 95% at $p < 0.05$. In order to categorize the consumers into similar cluster groups, agglomerative Hierarchical Clustering (AHC) analysis was carried out. For each pounded yam 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 180) was determined. A Principal Component Analysis (PCA) was used to describe the relationships between frequencies of citation of CATA sensory characteristics and the mean Overall liking scores for each Pounded yam sample. All statistical analyses were performed using XLSTAT 2019 software (Addinsoft).

3 RESULTS

3.1 Overall liking of the product samples

The Overall liking scores for each pounded yam sample tested by consumers in Osun (n=180 consumers in one region in Nigeria) using ANOVA. About 109 i.e. 60.6% of the interviewed participants were females and 65 which is 36.1% of the total consumers were males. Overall liking scores was set as the dependent variable and Pounded yam samples as qualitative explanatory variable, using a Turkey test with a confidence interval of 95% for means separation and multiple comparison. The overall liking of the pounded yam samples were significantly different in the four samples at a significant level of $p < 0.05$ (one-way ANOVA) as in Table 4 presented below.

The overall liking scores for each of the 4 pounded yam samples tested by both rural and urban consumers as presented in Table 4 shows that the rated ‘most liked’ pounded yam sample was Lasinrin which had the highest mean overall liking score for the sensory characteristics close to 7 (like moderately) by the consumers. Awana and Gbongi kamilu had mean overall liking scores closer to 7 (like moderately) as rated by both rural and urban consumers. The least liked pounded yam sample was Ewura with a mean overall liking score being close to 4 (dislike slightly) as rated by the consumers based on its quality characteristics.

There was no significant difference in the overall liking score (for both touch and taste) for Awana, Lasinrin and Gbongi kamilu pounded yam samples: though these 3 pounded yam samples, Awana, Gbongi kamilu and Lasinrin, were rated differently by the processors during the processing diagnosis activity, they did not present significant differences in overall liking. However, there was significant difference (at $p < 0.05$) between Ewura and the other pounded yam samples, Awana, Gbongi kamilu with Lasinrin in terms of the overall liking scores.

Table 4: Mean overall liking scores for the four pounded yam samples tested in Osun

Pounded yam Samples	Means Overall liking scores*	Groups**
Ewura	4.2	A
Awana	7.1	B
Gbongi kamilu	7.2	B
Lasinrin	7.2	B

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

**Different letters correspond to the products, which are significantly different. Turkey test ($p < 0.05$).

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 this study, the Agglomerative Hierarchical Clustering analysis of the mean overall liking scores, identified three groups of consumers C1, C2 and C3 as presented in Figure 1; named ‘Gbongi kamilu likers’, ‘Ewura dislikers’ and ‘All likers’ respectively are shown in Figure 2. These three

clusters contained 11%, 58% and 31% of all the consumers interviewed respectively for appearance, taste and textural attributes. Gbongi kamilu, though a less preferred variety for pounded yam, was liked and accepted by consumers in C1 with only 11% of the interviewed consumers. There were significant differences ($P < 0.001$) in the overall liking of the three clusters (Figures below) in the sensory attributes of the pounded yam samples.

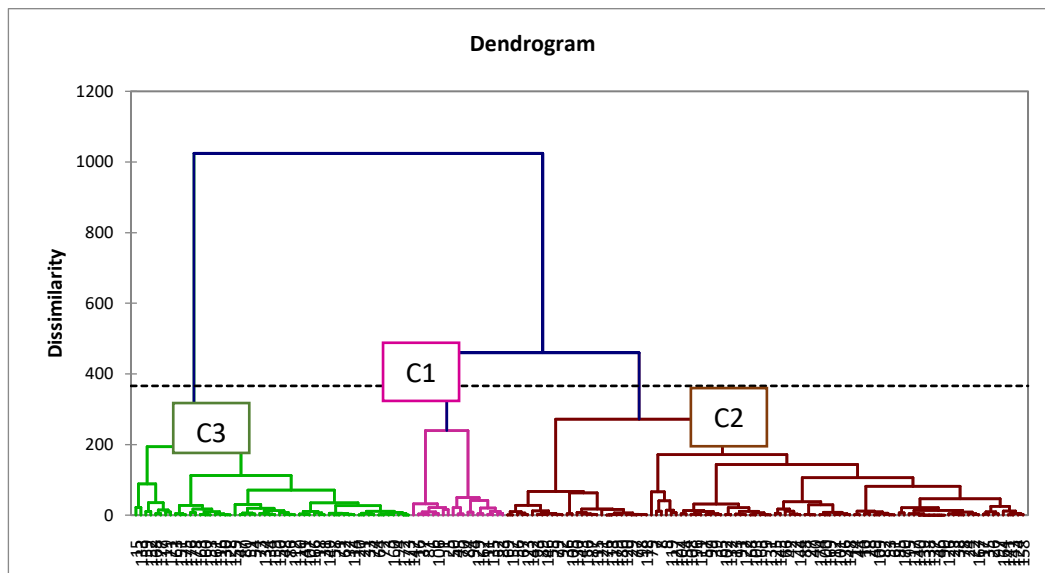
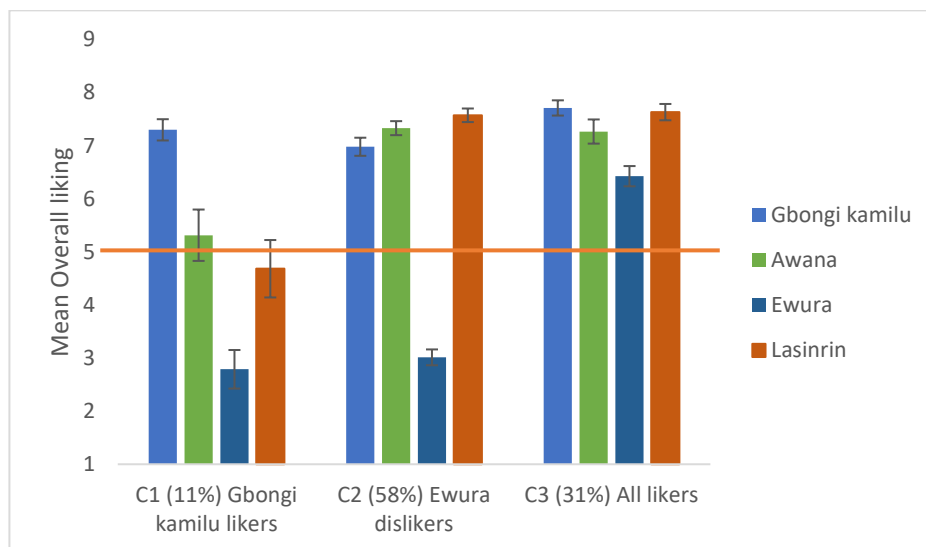


Figure 1 Clustering of consumers based on their overall liking scores of the pounded yam



Where error bars represent the standard error.

Figure 2 Mean overall liking of Pounded yam samples by consumer cluster type in Osun state

3.2.1 Demographic data of the consumers interviewed

The demographic characteristics of the interviewed consumers by frequency and percentage according to the class clusters is presented in Table 5. The total number of respondents for the consumer testing activity was 180 consumers with 10.6%, 58.3% and 31.1% in cluster groups C1 (Gbongi kamilu likers), C2 (Ewura dislikers) and C3 (All likers), respectively.

Among the total respondents ($n=180$) interviewed, the majority (60.6%) of consumers were female while only 36.1% were male. Out of this percentage, only 9.2% of women preferred Gbongi kamilu in C1 while most, 58.7% rated Ewura as not acceptable in C2. The majority, 53.9% of the male

consumers were in the C2 category that disliked pounded yam sample from Ewura with only 32.3% in C3 liking all the pounded yam samples (Figure 3).

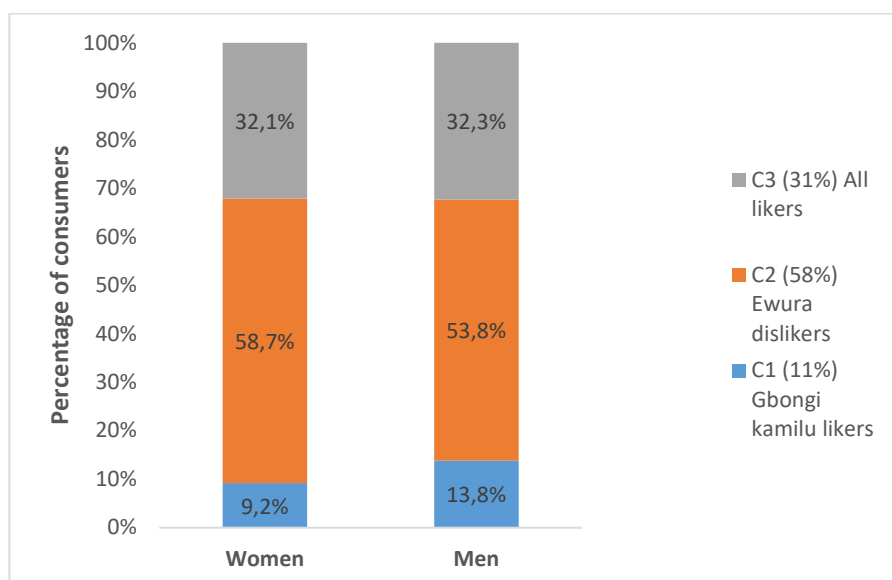


Figure 3 Percentage of consumer cluster type by gender in Osun

More women disliked pounded yam from Ewura than men while more men liked and accepted Gbonji kamilu than women as indicated in figure 3. However the difference in gender with respect to cluster was not significant (see Table 5).

About 77.8% of the total respondents interviewed were urban consumers out of which only 12.1% preferred Gbonji kamilu, 61.4% disliked pounded yam sample prepared from Ewura and 26.4% liked all the pounded yam samples though not equally. On the other hand, only 22.2% were rural consumers with 5.0% liking pounded yam from Gbonji kamilu, 47.5% disliking Ewura pounded yam sample and 47.5% liking all the pounded yam samples. Most of the respondents 141(78.3%) preferred not to state their ethnic group, 8(4.4%) marital status, 21(11.7%) occupation and 23(12.8%) age group as it was seen as an information they are not ready to divulge.

Largely, the respondents were within the ages 18-45 years old with a larger percentage of the participants in this study, 51.1% were between the age bracket of 18-25 years while 17.8% were between the ages 26-35 years. About 61.1% of the interviewed respondents reported being single while 32.8% of the respondents indicated being married. Most of the consumers are from Yoruba ethnic group out of which only 20.0% (36) of the interviewed consumers indicated ethnicity as Yoruba and were majorly within the Ewura dislike cluster group. The occupation of almost half (46.7%) of the respondents were students while 23.9% indicated as employed, 8.3% in civil service, 3.3% were into various forms of trading businesses and 3.9% were artisans from all facets.

Table 5: Demographic differences of the consumers with respect to cluster division in Osun State region

Osun State region (n=180)					Chi-square test (p)
	C1 Number (%)	C2 Number (%)	C3 Number (%)	Sum	
Consumers	19(10.6)	105(58.3)	56(31.1)	180	
Female	10(9.2)	64(58.7)	35(32.1)	109(60.6)	0.611
Male	9(13.9)	35(53.9)	21(32.3)	65(36.1)	
Nigerian	19(12.7)	86(57.3)	45(30.0)	150(83.3)	
Urban	17(12.1)	86(61.4)	37(26.4)	140(77.8)	0.031*

Osun State region (n=180)					
	C1 Number (%)	C2 Number (%)	C3 Number (%)	Sum	Chi-square test (p)
Rural	2(5.0)	19(47.5)	19(47.5)	40(22.2)	0.265
Yoruba	2(5.6)	22(61.1)	12(33.3)	36(20.0)	
Urhobo		1(100.0)		1(0.6)	
Igbo	1(50.0)	1(50.0)		2(1.1)	
18-25	10(10.9)	53(57.6)	29(31.5)	92(51.1)	0.981
26-35	3(9.4)	19(59.4)	10(31.3)	32(17.8)	
36-45	2(10.0)	11(55.0)	7(35.0)	20(11.1)	
46-55	1(8.3)	6(50.0)	5(41.7)	12(6.7)	
≥56			1(100.0)	1(0.6)	
Student	7(8.3)	48(57.1)	29(34.5)	84(46.7)	0.005*
Artisanship	1(14.3)	6(85.7)		7(3.9)	
Civil service	1(6.7)	8(53.3)	6(40.0)	15(8.3)	
Trading business	1(16.7)	2(33.3)	3(50.0)	6(3.3)	
Employed	6(14.0)	22(51.2)	15(34.9)	43(23.9)	
Unemployed	1(25.0)	2(50.0)	1(25.0)	4(2.2)	
Single	13	61	36	110(61.1)	0.884
Married	6	33	20	59(32.8)	
Widower		3		3(1.7)	
Every day		3(60.0)	2(40.0)	5(2.8)	0.830
Several times a week		7(53.9)	6(46.2)	13(7.2)	
Once a week	3(9.7)	19(61.3)	9(29.0)	31(17.2)	
Several times a month	3(8.1)	19(51.4)	15(40.5)	37(20.6)	
Once a month	11(14.7)	44(58.7)	20(26.7)	75(41.7)	
With soup	19(11.7)	94(57.7)	50(30.7)	163(90.6)	0.065
With stew only	2(11.7)	14(82.4)	1(5.9)	17(9.4)	
Without soup/stew	1(7.1)	12(85.7)	1(7.1)	14(7.8)	
Breakfast		12(75.0)	4(25.0)	16(8.9)	0.393
Lunch	13(13.0)	58(58.0)	29(29.0)	100(55.6)	
Dinner	2(4.4)	32(71.1)	11(24.4)	45(25.0)	

*Significant difference at $p < 0.05$.

There was a significant difference in cluster attribution between urban and rural consumers. The occupation also had a significant influence on the cluster consumers belong to.

3.2.2 Consumption attitudes

Most of consumers interviewed were accustomed to consume pounded yam daily when in season and based on yam availability when not in yam season. The consumption frequency as presented in Table 5 shows that about 2.8% of the respondents consumed pounded yam daily, 7.2% consume several times a week, 17.2% one time a week and 20.6% several times a month. Only about 41.7% of the total respondents declared pounded yam consumption was one time a month. The response on the form or mode of consumption shows 90.6% of the respondents consume pounded yam with soup such as efo riro, okro, egusi, etc., 9.4% with stew while 7.8% can consume pounded yam without soup or stew. About 8.9% of the respondents consume pounded yam during breakfast time while majority, 55.6% consume it during lunch time and 25.0% as dinner.

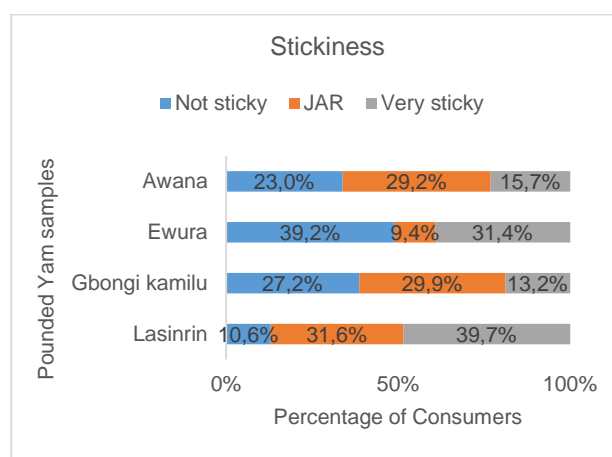
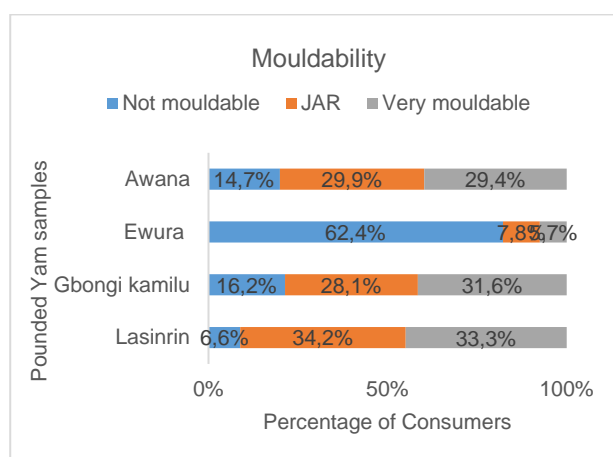
Out of the total sum of the indicated male and female consumers, 5.0% of the urban respondents consume pounded yam daily while 16.4% take it several times a week. Most (44.3%) of the urban respondents several times a month, while 20%, consume pounded yam once a week (see Appendix).. On the other hand, out of the rural consumers, 7.5% consume pounded yam daily. About 15.0% are used to consuming pounded yam several times a week, 20.0% consume one time a week, while 22.5% consume pounded yam several times a month and 32.5%, once a month. A larger percentage of the rural consumers, 97.5%, responded that the consumption form for pounded yam was with soup such as egusi, efo riro, okro etc. while only 88.6% of the urban respondents consume with soup, 12.1% with stew and 8.6% can consume without soup or stew. The first form of consumption was with soup such as egusi, efo riro, okro etc. for about 42.9% of answers from the urban consumers and all answers from the rural consumers while 12.1% answered that they can have second form of consuming pounded yam with stew alone.

Pounded yam was mainly consumed at lunch time for 60.0% of the rural consumers and 54.3% of the urban consumers (n=174) interviewed. Only 22.5% and 5.0% consume pounded yam as breakfast while 20% and 26.4% consume the product as dinner out of the rural and urban interviewees respectively. Only 2.5% of the rural interviewee indicated consumption of pounded can be both as breakfast and lunch while 17.1% of the urban interviewee as dinner and lunch then 4.3% as breakfast, lunch and dinner (see Appendix).

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 Pounded yam samples. Such “descriptor diagnostic” may help understand the reason for consumers to either like or dislike the Pounded yam sample. Consumers were asked to give their perception of the Stretchability, Colour, Softness, Smoothness, Stickiness and Mouldability of each Pounded yam 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”) as presented in Figure 4.

The perception of the consumers on the textural attributes of the pounded yam samples when touched between fingers shows that pounded yam sample made from Ewura was ‘not mouldable’ as scored by a larger percentage, 62.4% of the consumers. Gbongi kamilu was perceived as not mouldable by 16.2% followed by Awana with 14.7% and the least, Lasinrin, with only 6.6% of the respondents. Awana was perceived JAR mouldable by 29.9% of the respondents while 28.1% rated Gbongi kamliu and only 7.8% for Ewura as JAR mouldable. Ewura sample was rated by the least percentage, 5.7% of the respondents as ‘very mouldable’ while 29.4% and 31.6% perceived Awana and Gbongi kamilu as ‘very mouldable’. About 34.2% rated Lasinrin as JAR while 33.3% perceived it as being very mouldable. This pounded yam sample had the highest percentage rating by the consumers in terms of mouldability.



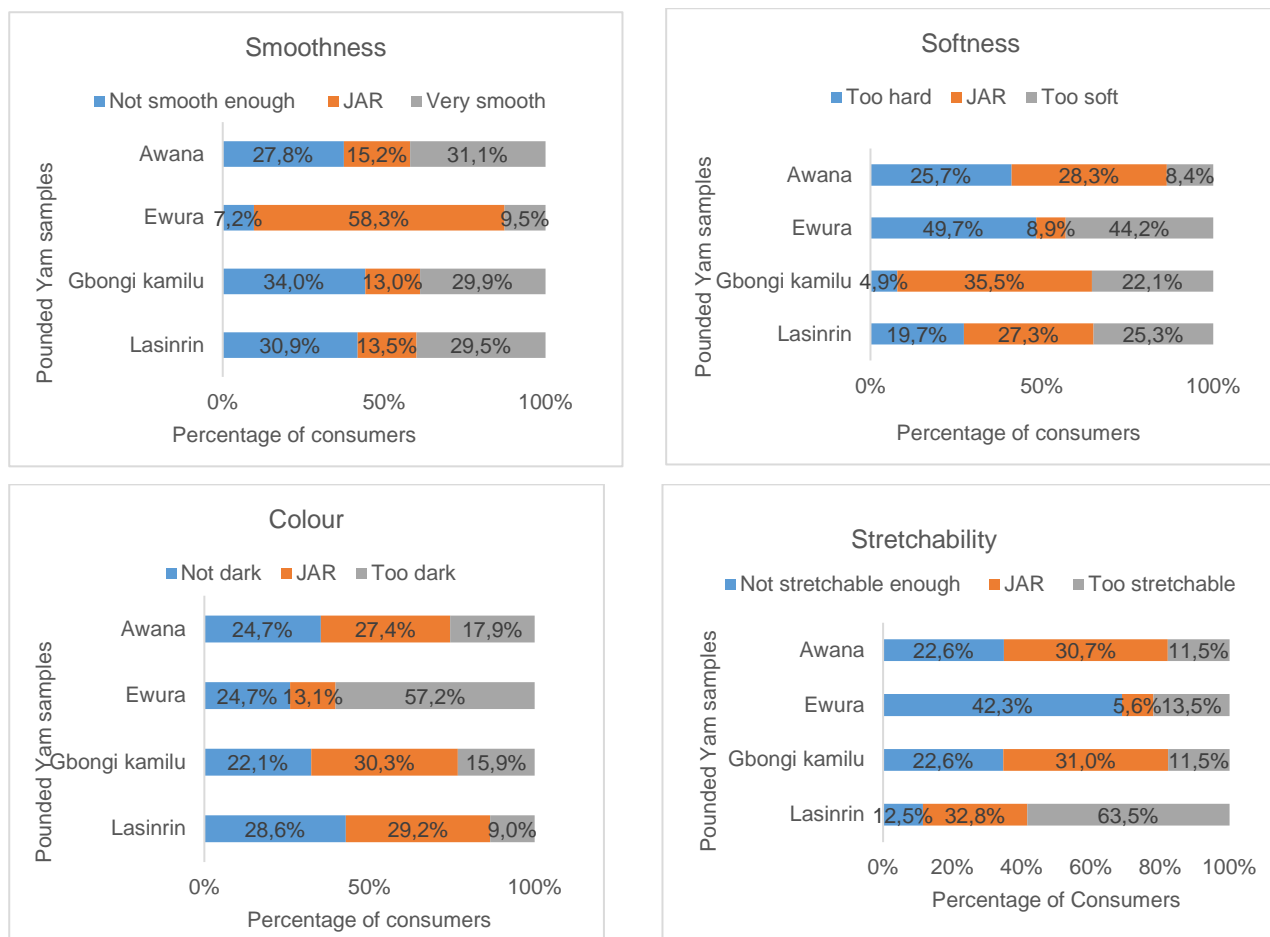


Figure 4 Percentage of consumers who scored specific quality characteristics in Osun State

Stickiness of the pounded yam samples as perceived by the respondents shows that Lasinrin was 'not sticky' to the fingers as it had the least percentage, 10.6%, rating as 'not sticky' while Ewura had the highest percentage by 39.3% of the respondents followed by Gbongi kamilu and Awana with 27.2% and 23.0% respectively. About 31.6% rated Lasinrin as JAR stickiness, while 29.9%, 29.2% and 9.4% perceived Gbongi kamilu, Awana and Ewura as JAR sticky. Gbongi kamilu had the least 13.2% 'very sticky' perception while Awana, Ewura and Lasinrin had 15.7%, 31.4% and 39.7% of the respondents' perception as 'very sticky'.

Awana was perceived as 'very smooth' by 31.1% of the respondents followed by Gbongi kamilu, Lasinrin and Ewura by 29.9%, 29.5%, and 9.5% consumers respectively. Ewura was rated 'not smooth enough' by 7.2% of the respondents while 27.8%, 30.9% and 34.0% of the respondents rated Awana, Lasinrin and Gbongi kamilu as 'not smooth enough'. However, the smoothness of Ewura pounded yam sample was perceived JAR by 58.3% of the respondents.

About 4.9%, 19.7%, 25.7% and 49.7% perceived pounded yam samples, Gbongi kamilu, Lasinrin, Awana and Ewura respectively as 'too hard' while 8.4%, 22.1%, 25.3% and 44.2% perceived Awana, Gbongi kamilu, Lasinrin and Ewura respectively as 'too soft'. Only 8.9%, 27.3%, 28.3% and 35.5% of the respondents perceived Ewura, Lasinrin, Awana and Gbongi kamilu respectively as JAR soft.

The colour of the pounded yam samples was perceived JAR by the highest percentage, 30.3% of the respondents in pounded yam sample, Gbongi kamilu followed closely by Lasinrin with 29.2% rating. This could be due to the white colour of Gbongi kamilu and Lasinrin being a yellow yam variety. The pounded yam samples perceived as 'too dark' by the larger percentage, 57.2% of the respondents was Ewura while only 9.0% perceived Lasinrin as 'too dark'. However, Lasinrin was perceived 'not dark' by 28.6% of the respondents with Gbongi kamilu having the rating 'not dark' by the least percentage, 22.1% of the respondents.

The pounded yam samples were perceived JAR stretchable by 5.7%, 30.7%, 31.0% and 32.8% of the respondents in samples Ewura, Awana, Gbongi kamilu and Lasinrin respectively. However, about 63.5% and 12.5% of the respondents perceived Lasinrin as 'too stretchable' and 'not stretchable enough' respectively. Ewura had the largest percentage of the respondents' perception as 'not stretchable' pounded yam.

3.4 Check All That Apply (CATA) test

The objective of the CATA test was to show the relationship between hedonic overall liking scores for each pounded yam 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 choose the most appropriate terms among about 25 or more sensory characteristics that better described each of the pounded yam samples.

The frequency of citations given by consumers to describe each Pounded yam sample were calculated and presented in Table 6. The sensory characteristics most frequently cited by the consumers such as 'no lumps', 'not sticky', 'sweet taste', 'white', 'soft', 'mouldable', 'smooth', 'good aroma' were considered the best for describing pounded yam products as indicated with different colours in the table 6. The least used terms were 'bad aroma', 'bitter taste' and 'too hard' as each had low citations by both the rural and urban consumers.

Gbongi kamilu was described as 'no lumps' by consumers (129 citations), 'sweet taste' (84 citations), 'soft' (88 citations), 'mouldable' (107 citations), 'smooth' (117 citations) 'cream' in colour (80 citations as opposed to white with 62 citations), and 'good aroma with 130 citations by the consumers. Consumers used the similar characteristics to describe Awana as 'no lumps' by consumers (123 citations), 'sweet taste' (105 citations), 'soft' (68 citations), 'mouldable' (102 citations), 'smooth' (109 citations), 'slightly stretchable' (62 citations), 'good aroma with 118 citations and its 'white colour' with frequencies of citation being 94, 'not sticky' (63 citations) by all the consumers.

Lasinrin was described with more sensory characteristics than Gbongi kamilu and Awana by the consumers as 'no lumps' (130 citations), 'stretchable' (81 citations), 'sweet taste' (90 citations), 'soft' (60 citations), 'yellow' in colour (137 citations), 'mouldable' (114 citations), 'smooth' (122 citations), 'good aroma' (111 citations). However, it was perceived 'sticky' (55 citations), as compared to the other pounded yam samples.

Ewura was termed 'lumpy' (120 citations), 'sticky' (47 citations), 'hard' (52 citations), 'not smooth' (89 citations), 'grey' (74 citations as against white colour with 65 citations), 'bland taste' (64 citations), 'good aroma' (62 citations), 'not stretchable' (77 citations), and 'not mouldable' (95 citations), by the consumers.

The mean of the citation frequencies in terms of taste for all pounded yam samples shows sample Lasinrin having the highest mean overall liking for the consumers. This is followed in a row by Awana and then Gbongi kamilu for the consumers with the values close to 7. However, Ewura had the lowest mean value close to 4 for consumers. This is the same in terms of the mean of the citation frequency for overall sensory textural attributes in Ewura for all the consumers.

Table 6: Frequency of citations of each quality characteristic by all the rural consumers

Pounded yam Product samples/ sensory characteristics	Gbongi kamilu	Awana	Ewura	Lasinrin	Total
Lumps	23	22	120	12	177
No lumps	129	123	26	130	408
Not sticky	52	63	54	46	215
Stretchable	35	35	15	81	166
Sweet taste	84	105	36	90	315
White	62	94	65	6	227

Pounded yam Product samples/ sensory characteristics	Gbongi kamilu	Awana	Ewura	Lasinrin	Total
Too hard	1	17	37	8	63
Sticky	34	35	47	55	171
Hard	4	24	52	20	100
Not smooth	9	11	89	10	119
Soft	88	68	34	60	250
Grey	12	29	74	3	118
Yellow	7	5	4	137	153
Bitter taste	35	6	25	5	71
Mouldable	107	102	28	114	351
Easy to pound	20	17	6	16	59
Smooth	117	109	30	122	378
Bland taste	19	16	64	17	116
Slightly sticky	34	26	14	27	101
Cream	80	31	16	18	145
Slightly stretchable	50	62	18	43	173
Good aroma	130	118	62	111	421
Bad aroma	2	2	24	0	28
Not stretchable	34	35	77	19	165
Moderately soft	68	41	20	43	172
Moderately hard	10	31	30	20	91
Too soft	8	7	25	10	50
Not mouldable	13	16	95	11	135
Mean overall liking taste	7.15	7.23	4.13	7.35	
Mean overall liking touch	7.24	7.10	4.05	7.29	

3.5 Sensory mapping of the sensory characteristics

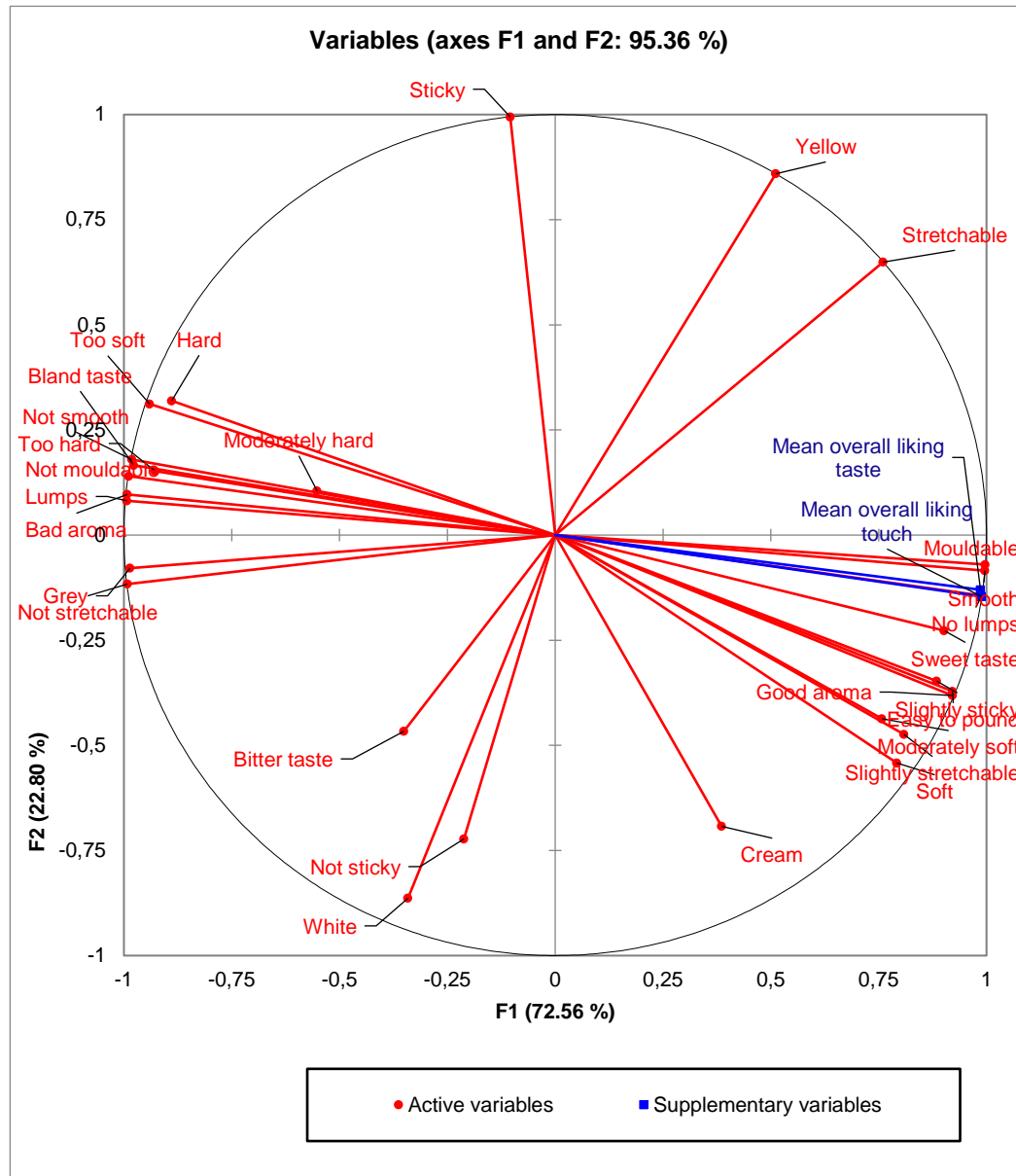
Principal component analysis (PCA) was used to summarize the relationships between CATA sensory characteristics of the Pounded yam samples, and mean Overall liking of each product scored by all the consumers. The PCA plot for the consumers explained 95.4% of the variance of the sensory characteristics with the first and second axes accounting for 72.6% and 22.8% respectively. Most of the variance was explained by the first axis.

The loading of sensory characteristics on PCA plan for the consumers (Figure 5) shows that Axis 1 was mainly explained positively with terms like 'yellow', 'mouldable', 'stretchable', 'no lumps' 'sweet taste', 'smooth', 'soft', 'cream', and good aroma which describes the most liked Pounded yam samples, Lasinrin, Awana, and Gbongi kamilu and negatively by the terms such as 'slightly sticky', 'slightly stretchable, related to the least liked Pounded yam sample, Ewura.

Axis 2 was mainly explained positively by the terms such as 'white' and 'not sticky' related to pounded yam samples, Awana, and Gbongi kamilu and negatively by the terms such as 'hard', 'lumps', 'not stretchable', 'grey', 'bland taste', 'not mouldable' and 'bad aroma' which were used to describe Ewura.

On the right part of the PCA plan, high mean overall liking scored by consumers was related to the high quality characteristics such as 'stretchable', 'no lumps', 'sweet taste', 'soft', 'good aroma', and 'smooth', which were associated to the most liked pounded yam samples, Lasinrin, Awana, and Gbongi kamilu.

A high mean overall liking scored by consumers was related to the high quality characteristics such as 'white', 'not sticky', (here on the left part of the PCA plan), which were associated to the most liked pounded samples, Awana, and Gbongi kamilu, made from good yam varieties. While at the opposite, a low mean overall liking by the consumers were related to the low quality characteristics such as 'grey', 'bitter taste', 'sticky' (as on the left part of the PCA plan), which were associated to the least liked pounded yam Ewura from bad yam variety.



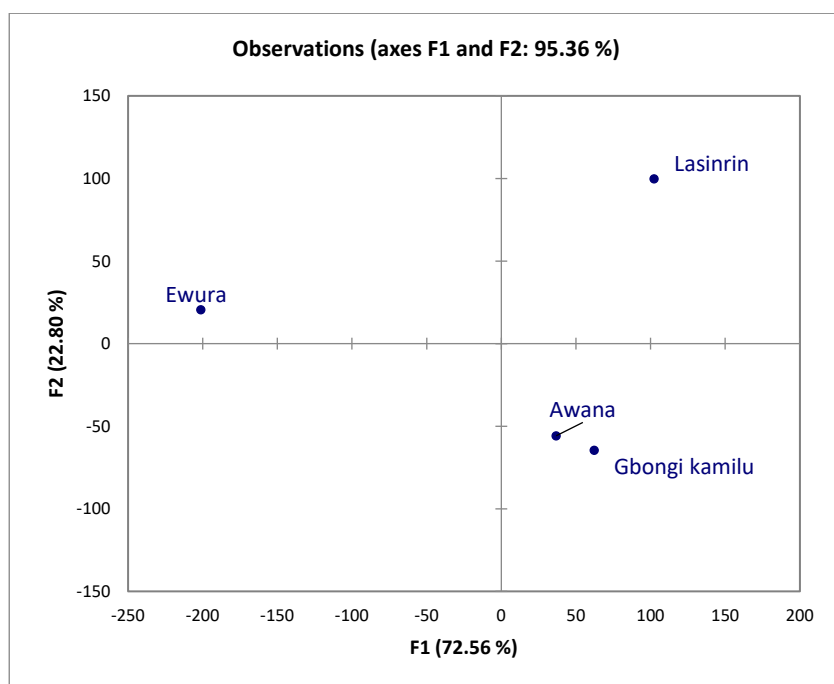


Figure 5 Mapping of the sensory characteristics and the overall liking of the product samples by urban consumers

4 DISCUSSION AND CONCLUSION

The four pounded yam samples used in this study were perceived differently by the consumers at both rural and urban area as they were prepared from yam varieties with different quality characteristics; Lasinrin (the highly preferred yam variety that gives very good pounded yam quality) Gbongi kamilu (the less preferred yam variety when in fresh state as it produces poor pounded yam quality. However, when stored and used to pound yam, it gives a better pounded yam quality), Awana (one of the preferred yam variety that gives good pounded yam quality), and Ewura (not preferred yam variety as it gives very poor pounded yam quality). This is reflected in the cluster groups of consumers that show that more than half of the consumers interviewed disliked pounded yam sample prepared from Ewura which was described from previous activities as a non-preferred variety because it produces very poor quality pounded yam. Though from processors' demonstration activity Gbongi kamilu was described as a less preferred variety due to the change in flesh colour occurring during processing and the 'not too good' quality of pounded yam it produces, it behaved differently when stored by producing a quality of pounded yam that is comparable to Awana and Lasinrin which were referred to as the preferred and highly preferred varieties, respectively with very good quality pounded yam.

The terms that better describe quality pounded yam samples were 'stretchable', 'soft', 'smooth', 'mouldable', 'not sticky', 'white/yellow' depending on the yam flesh colour, 'sweet taste' and 'good aroma'. These were used to describe pounded yam varieties Lasinrin, Gbongi kamilu and Awana. However, Awana was perceived to be more stretchable than Lasinrin by the rural consumers while Lasinrin was described more stretchable by the urban consumers followed by Gbongi kamilu. The colour for samples Awana, Gbongi kamilu and Lasinrin were JAR by the consumers along with the level of softness. These samples were perceived smooth by a majority of consumers as well sticky in some extent. The three samples were mouldable with Lasinrin being perceived as very mouldable.

The least liked pounded yam sample, Ewura received the lowest mean overall liking score mainly because it was found 'lumpy', 'not mouldable', etc. when touched and perceived as 'too dark' in appearance and having a 'bitter' taste by consumers in the JAR test.

Conclusively, the high quality characteristics related to a high mean overall liking and also represented on the right part of the PCA figure are associated to the most liked pounded yam varieties Lasinrin, Awana, and Gbongi kamilu with sensory characteristics such as 'smooth',

'mouldable', 'good aroma', 'stretchable', 'sweet taste', 'soft'. Conversely, the low quality characteristics related to a low mean overall liking and also on the left part of the PCA figure are associated to the least liked pounded yam sample, Ewura, with characteristics such as 'grey'/'too dark', 'bitter taste', 'sticky', 'not stretchable', 'lumps', 'too hard'.

5 APPENDIX

Table 8: Demographic differences of the rural and urban consumers with respect to cluster division

Characteristics		Rural	Urban	Total
Gender	Number of consumers (n)	40	134	174
	Women (%)	34(85%)	75(53.6%)	62.6% (109)
	Men (%)	6(15%)	59(42.1%)	37.4% (65)
Age	18-25 years old (%)	17(42.5%)	75(53.6%)	52.9% (92)
	26-35 years old (%)	11(27.5%)	21(15%)	18.4% (32)
	36-45 years old (%)	2(5%)	18(12.9%)	
	46-55 years old (%)	3(7.5%)	9(6.4%)	
	56years and above (%)	-	1(0.7%)	
Ethnicity	Yoruba (%)	9(22.5%)	27(19.3%)	20.7% (36)
	Others		3(0.2%)	
Marital status	Single (%)	24(60%)	86(61.4%)	63.2% (110)
	Married (%)	15(37.5%)	44(31.4%)	33.9% (59)
	Widower (%)	1(2.5%)	2(1.4%)	
Occupation	Student (%)	21(52.5%)	63(45%)	48.3% (84)
	Artisanship (%)	7(17.5%)	14(10%)	12.1% (21)
	Civil servant (%)	1(2.5%)	3(2.1%)	
	Trading business (%)	3(7.5%)	40(28.6%)	24.7% (43)
	Employed (%)	3(7.5%)	4(2.9%)	
Education	Unemployed (%)	-	2(1.4%)	
	No education (%)	-	-	
	Degree and less (%)	-	-	
	High level degree (%)	-	-	
	Graduated (%)	-	-	
Consumption frequency	Daily (%)	3(7.5%)	7(5%)	5.8% (10)
	Several times a week (%)	6(15%)	23(16.4%)	16.7% (29)
	One time a week (%)	8(20%)	28(20%)	20.7% (36)
	Several times a month (%)	9(22.5%)	62(44.3%)	40.8% (71)
	One time a month (%)	13(32.5%)	-	
Consumption form	With soup (%)	39(97.5%)	124(88.6%)	93.7% (163)
	With stew only (%)	-	17(12.1%)	
	Without soup/stew (%)	2(5%)	12(8.6%)	8.1% (14)
Occasion of consumption	Breakfast (%)	9(22.5%)	7(5%)	9.2% (16)
	Lunch (%)	24(60%)	76(54.3%)	57.5% (100)
	Dinner (%)	8(20%)	37(26.4%)	25.9% (45)



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