Field Scientific Report

Consumer Testing of Fufu 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

Consumer testing of Fufu was conducted with 300 consumers in rural and urban areas in two states of South-East Nigeria (Abia and Imo). There were slightly more women than men among the consumers interviewed (n=300):59.3%were women and 40.7% were men. Four fufu products made by the processors from varieties with different quality characteristics during the Activity 4 “Processing diagnosis” were tested. The fufu products were made from the following cassava cultivars: TMS/01/1368 (improved), TMS/01/1412 (Iimproved), Nwaocha (local variety), and TMS/98/0505(improved).These samples were evaluated by hedonic, Just About Right (JAR) and Check-All-That-Apply tests. The most liked Fufu sample was Nwaocha, Frequency of citations of each quality characteristic by all the consumers followed by TMS 98/0505 and TMS 01/1368 with a mean overall liking score close to 7 (liked moderately) for Nwaocha and 6 (like slightly) for TMS 98/0505 and TMS 01/1368 each. The least liked was the TMS 01/1412 sample with a mean overall liking score of 4.5 (neither like nor dislike). Three clusters of consumers were identified namely Nwaocha & TMS 01/1412 likers' (C1), “All likers” (C2), and ‘TMS 01/1412 dislikers’ (C3). The cluster C3 is composed in the majority by men from Imo state while women from Abia state constituted the main consumers of cluster 1. Majority of the consumers were satisfied with the colour of all the Fufu samples, and also with the softness of the Fufu samples except for TMS 01/1412. Stretchiness was scored JAR by more than 50% of consumers for only Nwaocha. Other varieties were characterized as ‘not stretchy enough’. The sensory characteristics associated to the high quality of Fufu were stretchy”, “white”, “draw little”, “heavy weight”, “smooth”, “easy to cut”, “moderately soft”, “easy to swallow”, “no fibre/dirt/particles” while “not easy to mould”, “sticky”, “watery”, “too soft”, “dark in colour” and “offensive odour” sensory characteristics were considered as drivers of disliking.

Key Words: Cassava, Fufu, hedonic testing, Check-All-That-Apply analysis, consumer liking, consumption habits, Just-About-Right analysis, sensory quality characteristics.

1 STUDY CONTEXT AND GENERAL OBJECTIVES

Some sensory characteristics of Fufu, a traditional cassava product, in Nigeria, were collected during previous Activity 3 on Gendered Food Mapping and Activity 4 on processing diagnosis and quality characteristics. The final activity (Activity 5) under WP1 of the RTBFoods project was focused on consumer testing. The main aim of this Activity 5 “Consumer testing” is to understand the consumers’ demand for the quality characteristics of Fufu. Another aim is to provide WP2 with a clear and visual mapping of the most liked Fufu samples associated with high quality characteristics and high overall liking scores, and of the least liked Fufu samples associated with low quality characteristics and low overall liking scores. The activity consists in inviting fufu regular consumers of fufu to test the 4 Fufu samples made in Activity 4from cassava varieties with different quality characteristics (Fig 1 and 2 from Activity 4).

2 METHODOLOGY

2.1 Production of Fufu

Figure 1 gives a description of the steps of processing using the Abia and Imo methods. The four fufu products were produced separately in each of the state following the state’s method.

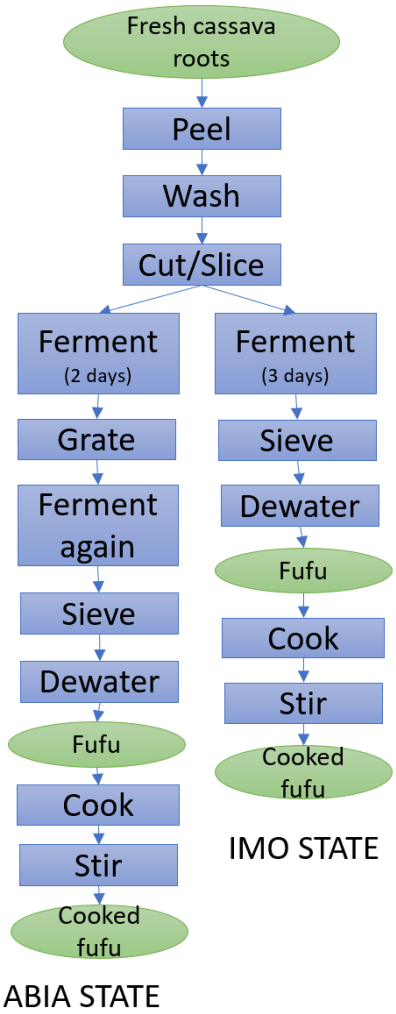


Figure 1 Flow chart diagram for fufu processing

2.2 Sampling

The 4 Fufu products made by the processors from varieties with different quality characteristics during the Activity 4 “Processing diagnosis”, were tested by 300 Fufu regular consumers. The Fufu products were made from the following cassava cultivars: TMS/01/1368 (improved), TMS/01/1412 (improved), Nwaocha (local variety), and TMS/98/0505(improved).The consumer testing for Fufu were carried out in Imo and Abia States of South-east region of Nigeria. The locations of consumer testing in Imo State were Oweri (big city),Isinweke (small town), and Orieagu Nsu(rural areas),while in Abia State the locations were Umuahia (big city), Ubakala (small town), and Umudike (rural areas) (Figure2). For each state, the rural areas are composed of four villages.

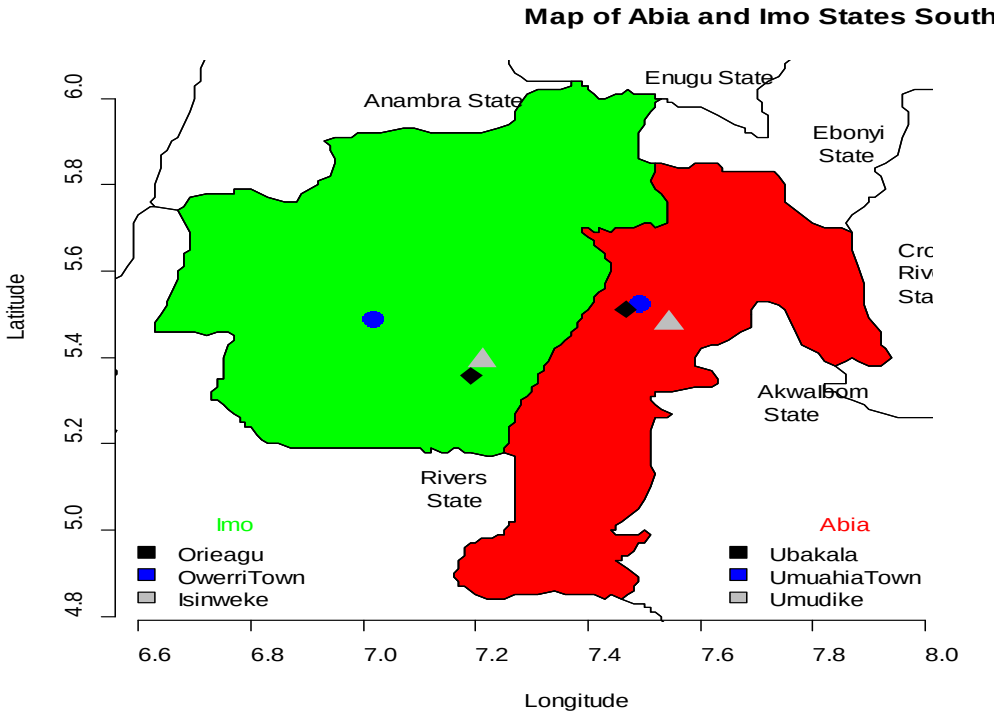


Figure 2 Map of Abia and Imo States, South-East Nigeria

Of a total of 300 consumers, 150 participated to the consumer testing in each state (Table 1). 178 were women (86 and 92 in Abia and Imo state respectively) and 122 were male (64 and 58 in Abia and Imo state respectively).

Table 1: Number of consumers interviewed in the rural and urban areas of the two states

	Abia state						Imo state						
Number of consumers	Oweri	Isinweke	OrieaguNsu				Umuahia	Ubakala	Umudike				Total
			Village 1	Village 2	Village 3	Village 4			Village 1	Village 2	Village 3	Village 4	
Female	30	20	8	10	10	8	45	20	9	3	8	7	178
Male	30	10	7	5	5	7	15	10	6	12	7	8	122
Total	60	30	15	15	15	15	60	30	15	15	15	15	300

2.3 Consumer testing

A hedonic test, a just-about-right (JAR) test, and a check-all-that-apply (CATA) test were conducted. Consumers (n = 300) from the different locations in rural and urban areas were asked individually to look, touch, smell, taste each *Fufu* 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 *Fufu* samples. The three characteristics were identified as important in the previous Activities 3 & 4: Stretchiness ("not stretchy enough", JAR, "too stretchy"), Colour ("too light", JAR, "too dark") and Softness ("too soft", JAR, "too hard"). Consumers were then asked to select the quality characteristics that better describe each *Fufu* sample, among a list of 24 sensory characteristics: the most liked and the least liked collected during the previous Activities 3 and 4. Finally, consumers were invited to give their opinion and preferences on the *Fufu* samples in relation to *Fufu* 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 Fufu
List of **the most liked** characteristics	**Appearance** - White - Butter/cream colour High Starch **Texture when touched** - Smooth - Stretchy - Easy to cut - Heavy weight(Weighty in hand) - High starch - Draw little **Taste** - Little sour **Texture in mouth** -Easy to swallow -Moderately soft
List of the least liked characteristics	**Appearance** -Dark in colour - Yellow - Fibre/dirt/particles - Lumps - Low yield - Not rise **Odour** -Offensive odour **Texture when Touching** -Not easy to mould -Sticky **Texture in mouth** - Too soft - Scatters - Too hard - Watery

Note: * represents activity 3 and 4, *activity 3, *activity 4 respectively.

2.4 Data analysis

An analysis of variance (one-way ANOVA) was carried out to identify significant differences in the overall liking scores between the four Fufu samples. Multiple pairwise comparisons were applied using the Tukey test, with a confidence interval of 95% at $p < 0.05$ (n=300 consumers). An Agglomerative Hierarchical Clustering (AHC) analysis was used to organize consumers into similar groups of overall liking. For each Fufu 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 300) was determined. A Principal Component Analysis (PCA) was conducted on the frequency of citations for all the CATA quality characteristics, with Fufu samples as the observation labels, and the mean overall liking for each sample as a supplementary quantitative variable. All statistical analyses were performed using XLSTAT 2019 software (Addinsoft).

3 RESULTS

3.1 Overall liking of the product samples

The mean overall liking scores for each fufu sample tested by consumers in Southeast Nigeria (here n=300 consumers, 150 from Imo state and 150 from Abia State), significantly differed between the four varieties at a significant level of $p<0.05$ (one-way ANOVA) (Table 3).

Table 3: Mean overall liking scores for the four Fufusamples tested in the two states combined

Fufu Samples Variety (Code)	Mean Overall liking scores (n=300)	Groups**		
TMS 01/1412(721)	4.5	A		
TMS 01/1368 (463)	5.7		B	
TMS 98/0505 (289)	5.8		B	
Nwaocha(135)	7.2			C

**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. Tukey test (p<0.05).*

The most liked Fufu sample was made from the local cassava variety Nwaocha,with a mean overall liking score of 7.2 (close to 7,'like moderately').Dry matter of wet mash was highest in Nwaocha (58.3%) and the difference in dry matter may explain the differences in consumer liking.(A4).Consumers also prefer fufu dough with high dry matter content because it is heavy in weight and moderately soft and easily mouldable(A3).

Fufu made from the two improved varieties TMS 98/0505 and TMS 01/1368 were scored 5.8 and 5.7 respectively (both close to 6, 'like slightly'). There were no significant differences in the average scores for TMS 98/0505 and TMS 01/1368.The least liked Fufu was the TMS 01/1412 (721)sample with a mean overall liking score of 4.5 (neither like nor dislike).

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.

Using an Agglomerative Hierarchical Clustering analysis of the mean overall liking scores, we identified three groups of consumers that we have named 'Nwaocha & TMS 01/1412 likers'(C1), "All likers" (C2), and 'TMS 01/1412dislikers' (C3).These three clusters contained 32%, 21%, and 47% of all the consumers interviewed, respectively. There were significant differences ($p < 0.001$) in the overall liking of the three clusters (Figures3 & 4).Only Nwaocha was scored more than a score of 6 by all consumer clusters. This showed that the local variety was largely adopted by the consumers and fulfilled their hedonic expectations. Another important information from this segmentation is that all variety received a score higher than 5 by at least one consumer cluster, thus depending on consumer clusters, all evaluated varieties are suitable to produce high quality of Fufu product and there was highlighted by the overall liking score variable from 4.5 to 7.2

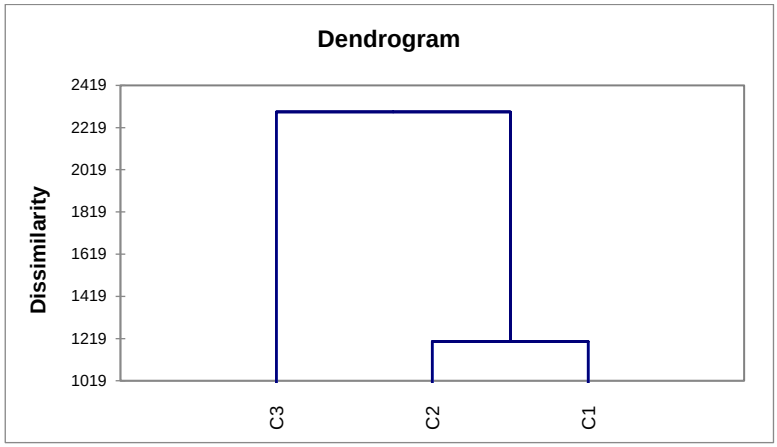
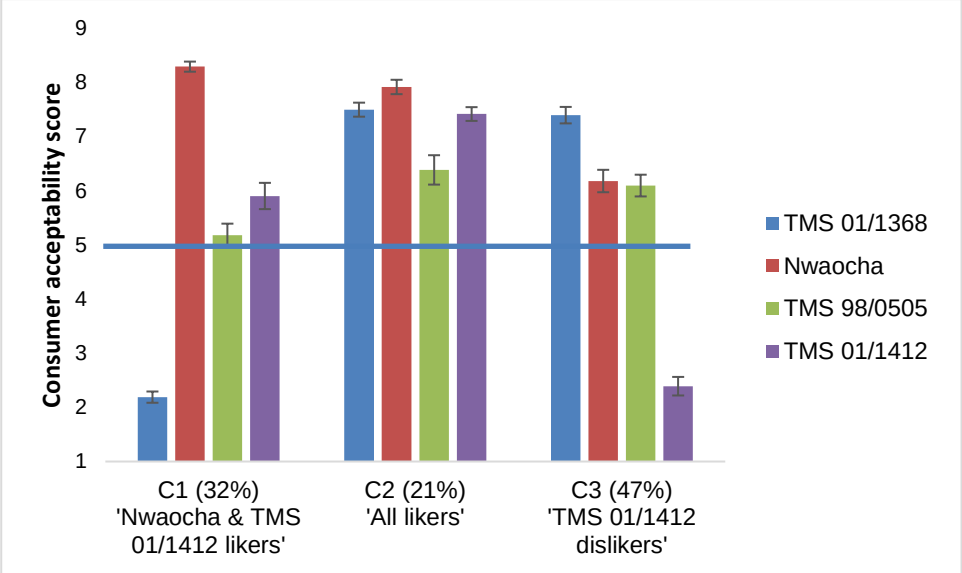


Figure 3 Clustering of the consumers based on their overall liking scores of Fufu samples



Where: error bars represent the standard error.

Figure 4 Mean overall liking of the Fufu samples by consumer cluster type (%)

3.2.1 Demographic data of the consumers interviewed

Among the 300 consumers interviewed, 59.3% were women and 40.7% were men. About15.7% were 18-25 years old, 18.7% were aged between 26-35, 46-55 and above 56years old. About 20% were aged between 36-45years. Results show that many of the consumers were youth. Youth in Nigeria includes citizens of the Federal Republic of Nigeria aged 18–29 years according to the new youth policy. However, the African youth charter recognises youth as people between 15–35

(FMYSD, 2019).Many (39.3%) of them were employed as traders. 8.3%, and 18.3% were artisans and civil servants, respectively, while 9.0% were students. Significant differences at p<0.05 were observed between the three clusters for location, gender, marital status, and occupation.

Table 4: Demographic differences of the consumers (n = 300) with respect to cluster division

		C1	C2	C3	Sum	Chi-square test (p) -
Consumers	Total	95	62	143	300	
State	Abia	75	42	33	150	<0.001*
	Imo	20	20	110	150	
Location	Isinweke	1	4	25	30	<0.001*
	Orieagu	9	10	41	60	
	Owerri town	10	6	44	60	
	Ubakala	13	10	7	30	
	UmuahiaUrban	32	18	10	60	
	Umudike	30	14	16	60	
Gender	Female	70	31	77	178	0.002*
	Male	25	31	66	122	
Ethnicity	Igbo	94	62	141	297	0.784
	Yoruba	0	0	1	1	
	Other	1	0	1	2	
Marital status	Single	11	13	42	66	0.040
	Married	75	44	88	207	
	Widower	9	5	11	25	
	Other	0	0	2	2	
Age	18-25	9	9	29	47	0.132
	26-35	15	12	29	56	
	36-45	25	11	24	60	
	46-55	22	12	22	56	
	56+	17	17	22	56	
Occupation	Student	6	6	15	27	<0.001*
	Artsanship	6	6	13	25	
	Civil Service	5	3	47	55	
	Trading business	52	26	40	118	
	Employed	8	11	11	30	
	Unemployed	11	6	2	19	
Consumptionfrequency	Everyday	42	25	47	114	0.419
	Several times a week	41	27	63	131	
	Once a week	6	5	17	28	
	Several times a month	1	2	9	12	
	Once a month	5	3	7	15	

* Significant at p<0.05

3.2.2 Consumption attitudes

Most consumers interviewed were used to consuming the product several times a week (43.7%) and daily (38%). A minority (9.3%) consume it once a week, while 4% and 5% consume it several times

a month and once a month, respectively. Results show no significant differences in consumption frequency among the respondents in the study areas.

Figures 5 and 6 represent clusters by gender and location, respectively.

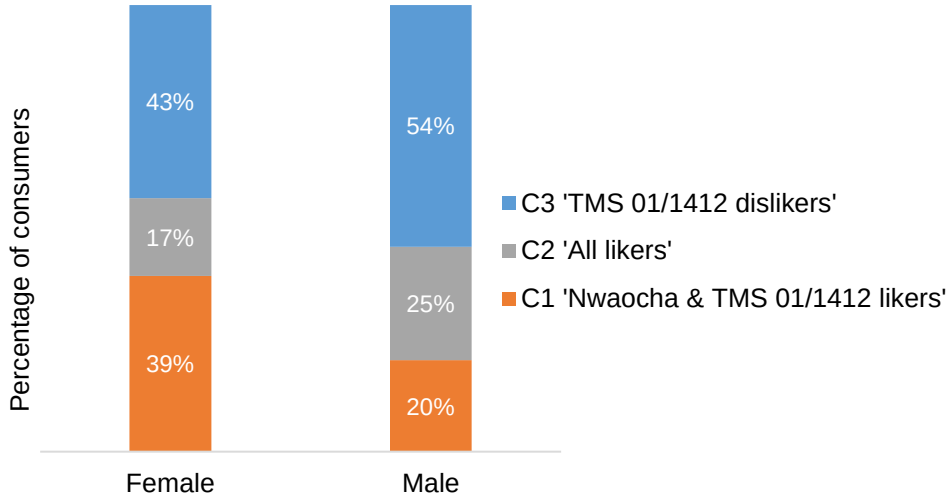


Figure 5 Percentage of consumer cluster type by gender

There were significant gender differences: 39%, 17% and 43% of women were within Cluster 1 (C1), Cluster 2 (C2), and Cluster 3 (C3), respectively whilst20%, 25% and 54% of men were within Cluster 1 (C1), Cluster 2 (C2), and Cluster 3 (C3), respectively. A higher percentage of menwas “all likers” and 'TMS 01/1412 dislikers”, while a majority of women were “Nwaocha & TMS 01/1412 likers”. This shows that women are more demanding towards the quality of fufu – they rated the traditional variety higher - whilst men are less demanding and are satisfied with a range of fufu products.

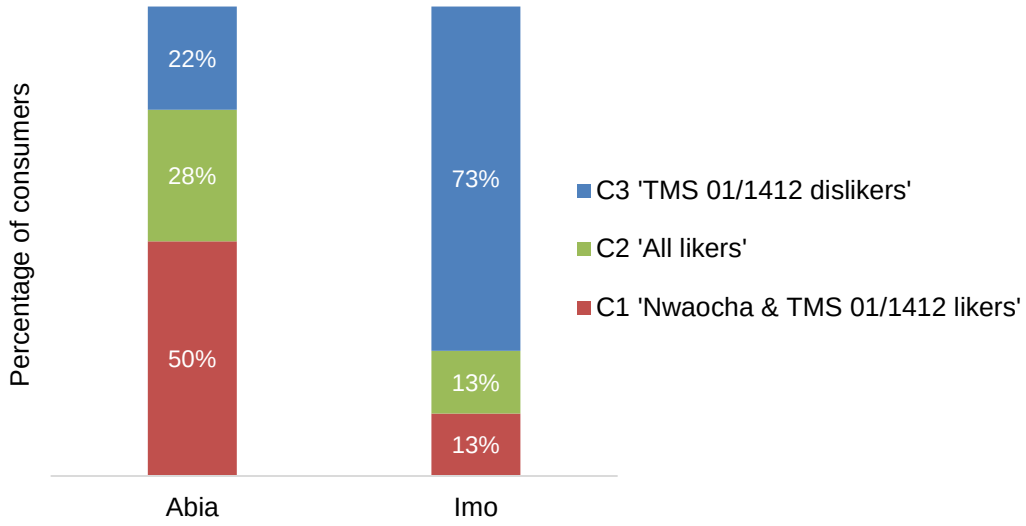


Figure 6 Percentage of consumer cluster type by state

There were also significant location differences: the results above show that very high variation within the clusters and between the States. About 50% and 13% of the consumers in cluster 1 (Abia and Imo States respectively) were likers of Nwaocha and TMS 01/1412 whilst about 28% and 13% of the consumers in Abia and Imo States were ‘all likers’ (Cluster 2): there were more ‘all likers’ in Abia. A Majority (73%) of the consumers in Imo dislike TMS 01/1412 compared to Abia (22%). In Imo, the yield of fufuwas higher than that in Abia. It rangedfrom 20% to 60% with Nwaocha having the highest,

and TMS 01/1412 and TMS 01/1368 the lowest. The difference in fufu dough yield between Imo and Abia could be attributed to the method of fufu preparation. The preparation of TMS 01/1412 in Imo could have resulted in more consumers disliking the product because of its low dry matter content.

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 fufu samples. Such "descriptors' diagnostic" may help understand why consumers like or dislike this fufu sample.

Consumers were asked to give their perception of Stretchiness, Colour and Softness of each Fufu sample, by using a 3-point JAR scale (1 = "not enough stretchy, too light, too soft" 2= "Just About Right" and 3 = "too stretchy, too dark, too hard").

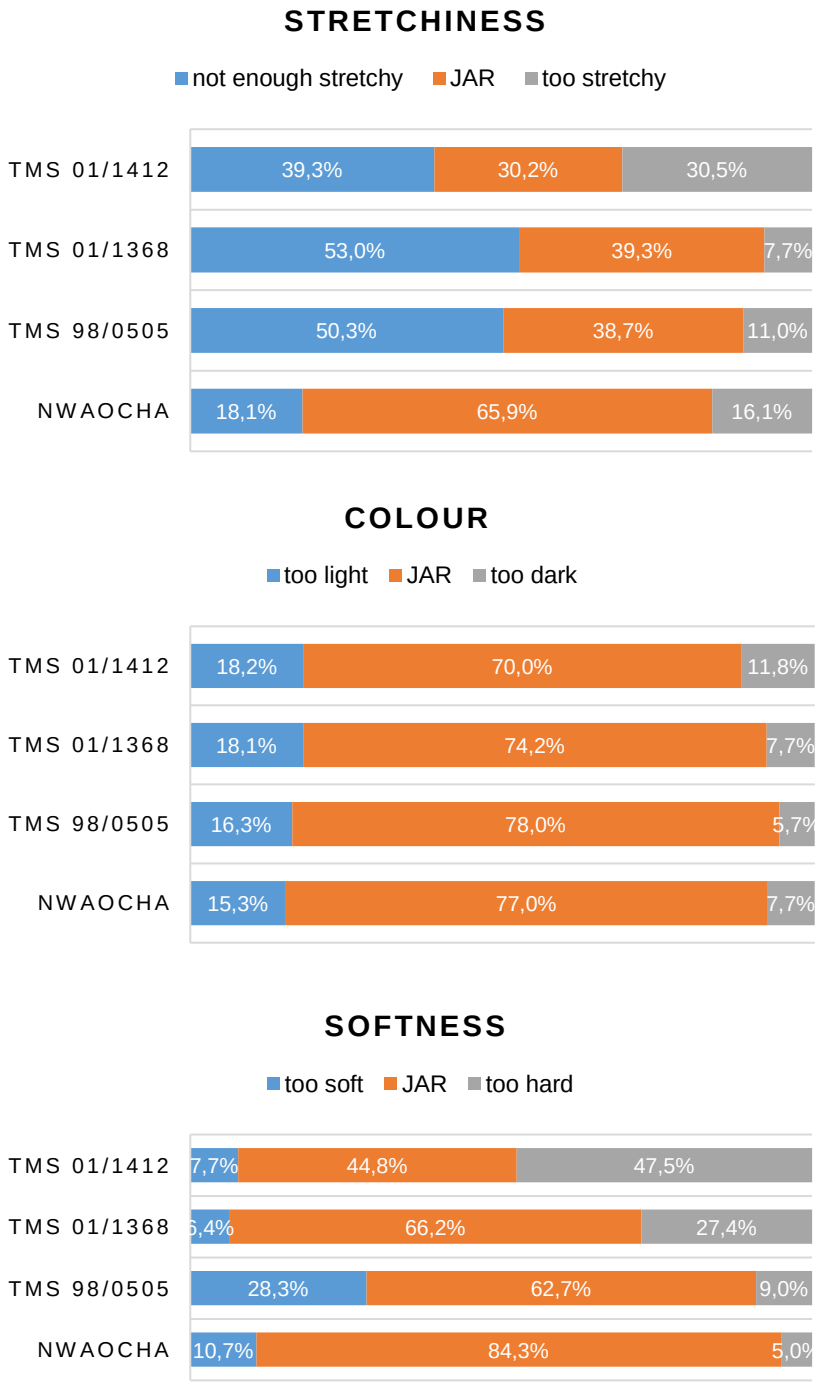


Figure 7 Percentage of consumers who scored the three specific quality characteristics

A majority of the consumers (70% to 78%) were satisfied with the colour of all the Fufu samples, thus this descriptor can be considered not discriminating the selected Fufu samples (Figure 7).A majority of the consumers were also satisfied (62.7% to 84.3%) with the softness of the Fufu samples except for TMS 01/1412 sample which was scored JAR by only 44.8% of consumers and "too hard" by 47.5%.Stretchiness was scored JAR by more than 50% of consumers for only Nwaocha Fufu sample (65.9%); consequently this sample was scored JAR by both discriminating characteristics. Other varieties were characterized as "not enough stretchy"by39.3% to 53.0% of consumers.

3.4 Check All That Apply (CATA) test

The objective of the CATA test is to show the relationships between hedonic scores for each Fufu 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 24 CATA sensory characteristics that better describe each Fufu sample. The count of citations given by consumers to describe each Fufu sample were calculated (Table 5).

Table 5: Percentage of consumers who scored the three specific sensory characteristics

Fufu samples	Sticky	Offensive Odour	Stretchy	Dark in colour	Lumps	Not easy to mould	Scatters	Easy to cut	Too soft	Easy to swallow	Little sour	Heavy weight
Nwaocha	58	25	118	1	12	27	3	264	14	243	44	184
TMS 98/0505	59	42	53	5	32	60	30	245	21	200	57	142
TMS 01/1368	74	30	50	5	19	67	61	253	75	215	0	98
TMS 01/1412	187	56	98	9	30	121	19	185	135	179	53	112
Total	378	153	319	20	93	275	113	947	245	837	154	536

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

Fufu samples	White	Moderately soft	Low yield	High starch	Smooth	Butter/ cream colour	Too hard	Draw little	Yellow	Fibre/dirt/ particles	Watery	Not rise
Nwaocha	115	236	8	184	253	44	25	160	141	32	4	24
TMS 98/0505	58	172	42	134	236	102	73	123	129	38	3	79
TMS 01/1368	62	179	46	112	240	95	16	90	135	36	15	95
TMS 01/1412	110	126	14	145	198	46	17	124	141	16	105	39
Total	345	713	110	575	927	287	131	497	546	122	127	237

The sensory characteristics most frequently cited by the consumers were considered the best for describing the products. They were the following: "easy to cut", "smooth", "easy to swallow" and "moderately soft" and with a number of citations between 950 and 700, followed by "high starch", "yellow", "heavy weight" and "draw little" (500-575 citations). The least frequently cited were "dark in colour" (20 citations) and "lumps" (93 citations).

Nwaocha, the most liked Fufu sample (mean overall liking score of 7.2, like moderately) was described mainly as "easy to cut", "smooth""easy to swallow" and "moderately soft" (230-270 citations)followed by "heavy weight", "draw little", "stretch", and "white" (115-185 citations).

The least liked Fufu sample TMS 01/1412(mean overall liking score of 4.5, neither like nor dislike) was described mainly as "sticky", but also "smooth", "easy to cut", "easy to swallow", "high starch" and "yellow" (140-200 citations).

3.5 Sensory mapping of the sensory characteristics

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

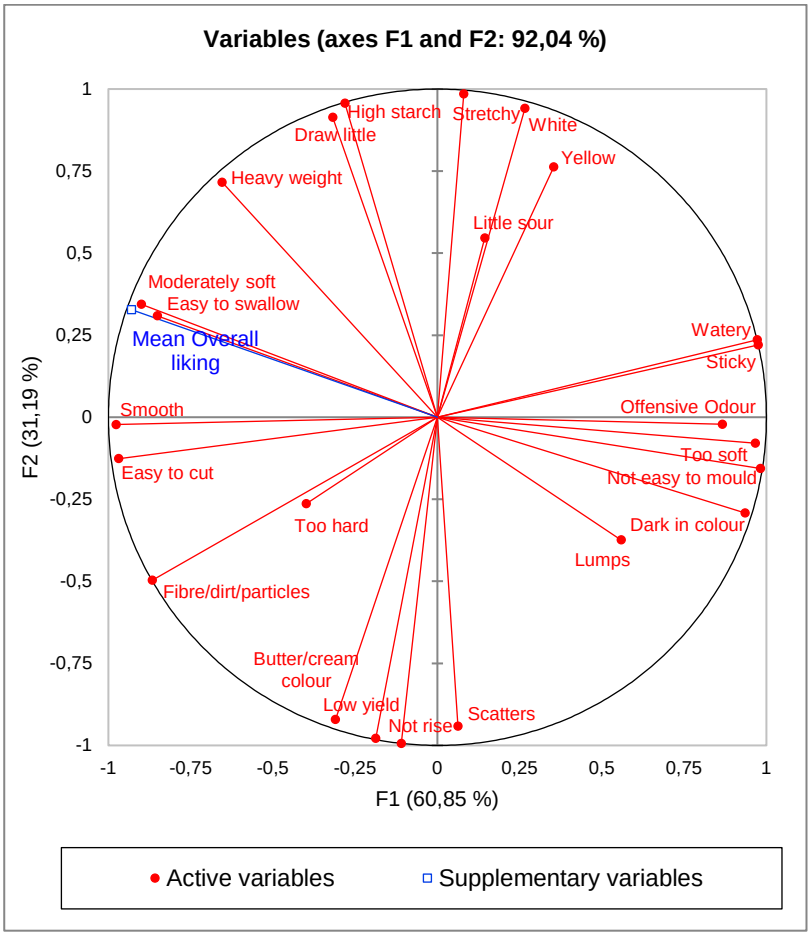
The PCA plot explained 92.0% of the variance of the sensory characteristics, the first and second axes accounting for 60.8% and 31.9% respectively. Most of the variance was explained by the first axis (X axis).

The loading of sensory characteristics on PCA plan (Figure 8) shows that axis 1 was mainly explained negatively by “smooth”, “easy to cut”, “moderately soft”, “easy to swallow” associated to the Fufu sample made by the local cassava variety Nwaocha and a higher mean overall liking. These sensory characteristics can be considered as the drivers liking of Fufu.

At the opposite, axis 1 was positively explained by the terms such as “Not easy to mould”, “sticky”, “watery”, “too soft”, “dark in colour” and “offensive odour” related to a lower mean overall liking score and associated to the lower liked Fufu sample TMS 01/1412 (mean overall liking score of 4.5).

Axis 2 (Y axis) was explained negatively by the terms “not rise”, “low yield”, “scatters” and “butter/cream colour” related to the Fufu sample TMS 01/1368.Positively, axis 2 was explained by the terms “stretchy”, “white”, “draw little”, “heavy weight”.

TMS 98/0505 was associated to the terms “too hard”, “little sour” and “lumps” explaining only 8% of the variance (axis 3).



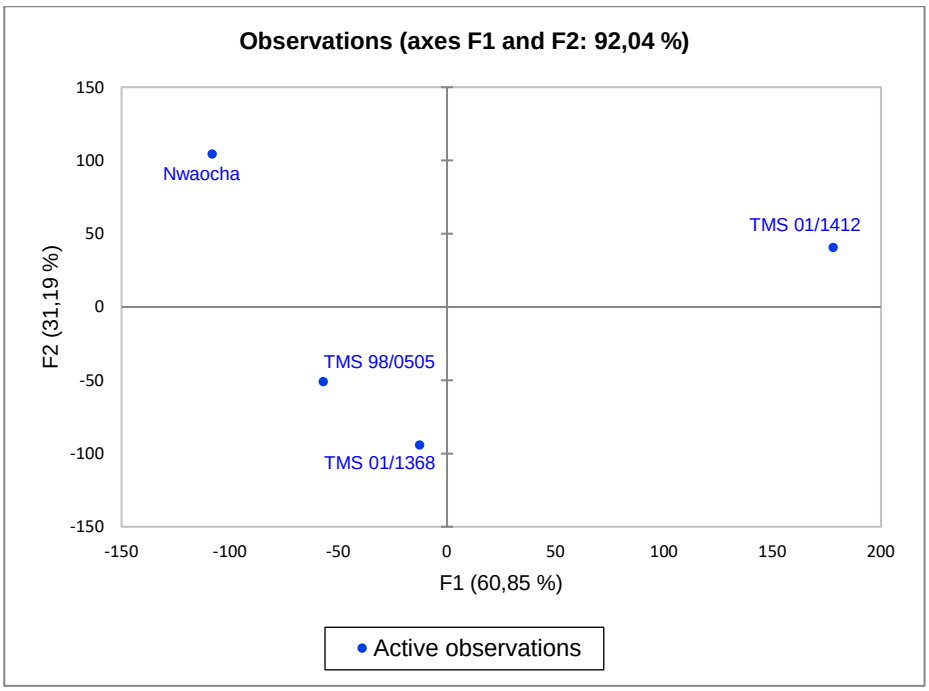


Figure 8 Mapping of the sensory characteristics and the overall liking of the product samples

4 DISCUSSION AND CONCLUSION

Four fufu products were made by the processors from varieties with very different quality characteristics and tested by 300 fufu consumers in Imo and Abia States of South-East region of Nigeria. The four product samples were perceived differently by consumers. The most liked product sample was Nwaocha with a mean overall liking score close to 7 (liked moderately), followed by TMS 98/0505 and TMS 01/1368 with a mean overall liking score close to 6 (like slightly).Segmentation of the consumers from overall liking score revealed three clusters with different demographic aspects. For instance, the TMS 01/1412 sample was disliked by a majority of men in Imo state while Nwaocha and TMS 01/1412were preferentially liked by women in Abia state; this shows that there is also an interaction between gender and location in our study.The difference in overall liking results between the two states can be attributed by a difference in Fufu dough yield due to the method of fufu preparation. In Imo, the mash was cooked twice and pounded twice. Also, there was no evaporation of water because the mash was cooked in balls which let out little or no water out. While in Abia, the cooking of the mash by stirring in an open oval cooking pot made evaporation of moisture a lot easier thereby reducing the percentage fufu yield and making the fufu feel light and less acceptable to consumers.The least liked TMS 01/1412Fufu sample with a score of 4.5 ('neither like, nor dislike') was mainly because it was found "sticky", "not easy to mould", "too soft", and "watery", "dark in colour" and "offensive odour", especially in Imo state. A majority of the consumers were satisfied with the colour of all the product samples and with their softness except for TMS 01/1412.Stretchiness was scored JAR by more than 50% of consumers for only Nwaocha. Other varieties were characterized as "not enough stretchy". In our study, the traditional variety Nwaocha is therefore universally liked compared to the other varieties.

5 REFERENCE

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