

Consumer Testing of Boiled Yam in Rural and Urban Areas in Nigeria

Understanding the Drivers of Trait Preferences and the Development of Multiuser RTB Product Profiles, WP1, Step 4

Umudike, Nigeria, 12th December 2021

Tessy MADU, National Root Crops Research Institute (NRCRI) Umudike, Nigeria

Benjamin OKOYE, NRCRI, Umudike, Nigeria

Blessing UKEJE, NRCRI, Umudike, Nigeria

Nnaemeka ONYEMAUWA, NRCRI, Umudike, Nigeria

Miriam OFOEZE, NRCRI, Umudike, Nigeria

Geneviève FLIEDEL, Centre de coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Montpellier, France (Validator)

Laurent ADINSI, Université d'Abomey-Calavi, Faculté des Sciences Agronomiques (UAC-FSA), Cotonou, Benin (Validator)

Aurelie BECHOFF, Natural Resources Institute (NRI), Chatham Maritime, UK (Validator)



This report has been written in the framework of RTBfoods project.

To be cited as:

Tessy MADU, Benjamin OKOYE, Blessing UKEJE, Nnaemeka ONYEMAUWA, Miriam OFOEZE, Geneviève FLIEDEL, Laurent ADINSI, Aurelie BECHOFF (2022). Consumer Testing of Boiled 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. Umudike, Nigeria: RTBfoods Field Scientific Report, 18 p. https://doi.org/10.18167/agritrop/00635

<u>Ethics</u>: 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.

<u>Acknowledgments</u>: This work was supported by the RTBfoods project https://rtbfoods.cirad.fr, through a grant OPP1178942: Breeding RTB products for end user preferences (RTBfoods), to the French Agricultural Research Centre for International Development (CIRAD), Montpellier, France, by the Bill & Melinda Gates Foundation (BMGF).

Image cover page © MADU T., OKOYE B., UKEJE B., ONYEMAUWA N., OFOEZE M. for RTBfoods.





This document has been reviewed by:									
Aurélie BECHOFF (NRI)	24/09/2021								
Laurent ADINSI (UAC-FSA)	30/09/2021								
Aurélie BECHOFF (NRI)	11/01/2022								
Aurélie BECHOFF (NRI)	13/01/2022								
Laurent ADINSI (UAC-FSA)	14/01/2022								
Final validation by:									
Laurent ADINSI (UAC-FSA)	14/01/2022								





CONTENTS

Table of Contents

1	Stu	dy context and general objectives	7
2	Met	thodology	7
2.	1	Sampling	7
2.	2	Consumer testing	9
2.	3	Data analysis	10
3	Res	sults	10
3.	1	Overall liking of the product samples	10
3.	2	Segmentation of consumers into groups of similar overall liking	10
	3.2	.1 Demographic data of the consumers interviewed	11
	3.2	.2 Consumption attitudes	12
3.	3	Just About Right test (JAR)	13
3.	4	Check All That Apply (CATA) test	14
3.	5	Sensory mapping of the sensory characteristics	15
4	Cor	nclusion	16





List of tables

Table 1: Number of consumers interviewed in the rural and urban areas of Ebonyi State	8
Table 2: Quality characteristics identified during the previous activities 3 & 4 and selected for building the CATA table	9
Table 3: Mean overall liking scores for the four product samples tested	. 10
Table 4: Demographic differences of the consumers with respect to cluster division	. 12
Table 5: Overall liking score and frequency of citations of each quality characteristic by all the consumers	15

List of figures

Figure 1 Map of Ebonyi, South-East Nigeria, showing study locations	7
Figure 2 A flow diagram of boiled yam in south-east Nigeria	8
Figure 3 Clustering of the consumers based on their overall liking scores of the product	. 11
Figure 4 Mean overall liking of the product samples by consumer cluster type (%)	. 11
Figure 5 Percentage of consumer cluster type by gender	.13
Figure 6 Percentage of consumers who scored the three specific quality characteristics	.14
Figure 7 Mapping of the sensory characteristics and the overall liking of the product samples	.16







The consumer testing for boiled yam was conducted in rural and urban areas of Ebonyi State, South-East Nigeria with 300 consumers including 37% women and 63% men. The variety names included: TDA 1100477, TDA 1100203, TDR 1100497, and TDR 11/0010. The urban areas were Onueke and Abakaliki; rural (Amagu Izzi and Umuebe Ezzamgbo) and a small town (Nkwagu). The most liked product samples was TDR 1100497 and this was explained by its good aroma, attractive appearance and hard texture. Sample TDR 11/0010 that was described as having the following characteristics: "sweet taste", "heavy weight", "smooth", "high in starch", while TDA 1100203 that was considered "easy to swallow", "moderately soft", "easy to break", "with no spot". The least liked was TDA 1100477 which was described as not having positive attributes. The less preferred traits in this study include: "dull/dark colour"," threadlike lines" and "dark spots", "texture too soft", and "bad odour".

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





1 STUDY CONTEXT AND GENERAL OBJECTIVES

The main aim of this Activity 5 "Consumer testing" is to understand the consumers' demand for the quality characteristics of Root, Tuber and Banana products. Another aim is to provide WP2 with a clear and visual mapping of the most liked products associated with high quality characteristics and high overall liking scores, and of the least liked products associated with low quality characteristics and low overall liking scores. The activity consists in inviting a large number of consumers to test the 4 products made in the previous processing step from varieties with very different quality characteristics.

2 METHODOLOGY

2.1 Sampling

The 4 boiled yam products made by the processors from varieties with very different quality characteristics during the Activity 4 "Processing diagnosis" were tested by 300 consumers in the study area. The variety names and code numbers (in parentheses) included: TDA 1100477 (289), TDA 1100203 (463), TDR 1100497 (135), and TDR 11/0010 (721). The urban areas were Onueke and Abakaliki; rural (Amagu Izzi and Umuebe Ezzamgbo) and small town (Nkwagu) (Figure 1). The majority of the respondents interviewed were female (63%), and a minority were male (37%).



Figure 1 Map of Ebonyi, South-East Nigeria, showing study locations





Onueke				Abaka	aliki		Amag	u Izzi				Umue	be Ezza	amgbo			Small	Town		
Male	5 Urban 1	t Urban 2	S Total	5 Urban1	t Urban2	2 Total	vill 1	vill2 م	► vill 3	^o vill4	2 Total	۲ vill1	^o vill 2	► vill3	4 Vill 4	S Total	t Obinagu Ishiagu	b Nkwagu	Grand total	Percent
Iviale	10	12	22	10	11	21	0	5	4	0	21	5	0	4	'	22	12	15	111	51
Female	20	18	38	20	19	39	9	10	11	9	39	10	9	11	8	38	18	17	189	63
Total	30	30	60	30	30	60	15	15	15	15	60	15	15	15	15	60	30	30	300	100

Table 1: Number of consumers interviewed in the rural and urban areas of Ebonyi State



Figure 2 A flow diagram of boiled yam in south-east Nigeria





2.2 Consumer testing

A method including a hedonic test, a just-about-right (JAR) test, and a check-all-that-apply (CATA) test was used. Consumers (n = 300) from different locations in rural and urban areas were asked individually to look/touch/smell/taste each product 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 four 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 boiled yam samples. Four characteristics were identified as important in the previous Activities 3 & 4: Mealiness ("Too mealy enough", JAR, "Too mealy"), Colour ("Too light", JAR, "Too dark"), Softness ("Too hard", JAR, "Too soft"), and Sweetness ("Not too sweet", JAR, "Too sweet"). Consumers were then asked to select the quality characteristics that better describe each boiled yam samples, among a list of 23 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 boiled yam samples in relation to the boiled yam they usually consume.

	Quality characteristics of the ready to eat product
List of the most liked characteristics	Appearance - Bright colour (white or yellow) - Good colour (Milk colour) odour -not offensive odour Texture when touching - Smooth body - Not sticky in the hand - Easy to break apart Taste - Sweet Texture in mouth - when cooked it will be like <i>yawuri yawuri</i> (brittle) - Moderately soft - Mealy -Easy to chew -Easy to swallow Aroma - Pleasant aroma Aftertaste
List of the least liked characteristics	Appearance - Dark in colour Odour - Offensive odour Texture when Touching - Sticky -Too soft - Slippery Taste - Bitter I taste Texture in mouth -Too hard/ too soft Aroma - offensive aroma Aftertaste

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





2.3 Data analysis

An analysis of variance (ANOVA) was carried out to identify significant differences in overall liking scores among the product samples; TDA 1100477 (289), TDA 1100203 (463), TDR 1100497 (135), and TDR 11/0010 (721) tested by 300 consumers. Multiple pairwise comparisons were applied using the Tukey test, with a confidence interval of 95% at p < 0.05 (n=300 consumers). For each product sample, the number of consumers who judged each specific characteristic either Just 'Just about Right (JAR)', 'Too weak' or 'Too strong' were counted, and the percentage of consumers 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 Product sample. All statistical analyses were performed using XLSTAT 2019 software (Addinsoft).

3 RESULTS

3.1 Overall liking of the product samples

The overall liking of the product significantly differed between the four samples at a significant level of p<0.05 (one-way ANOVA) (Table 3).

Variety	Mean overall liking scores* (n=300)	(Groups	5
TDA 1100477 (289)	5.2	А		
TDA 1100203 (463)	6.0		В	
TDR 11/0010 (721)	6.4		В	
TDR 1100497 (135)	7.0			С

Table 3: Mean overall liking scores for the four product samples tested

*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 product samples was TDR 1100497 with a highest mean overall liking score close to 7 (like slightly). This was followed by TDR 11/0010 and TDA 1100203 with mean overall liking score of 6.4 and 6.0 respectively indicating "like slightly" for each and the least liked TDA 1100477 which was "neither like nor dislike" with mean overall liking score of 5.2. Processors in Activity 4 reported that they do not like TDA 1100477 because of its colour, considered not good when touched, the variety also appears slippery and too soft and collapses in the month, and has a bad taste. On the other hand, Variety TDR 1100497 is attractive, sweet. not sticky, easy to chew and swallow, and feels smooth in the mouth.

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.

By using an Agglomerative Hierarchical Clustering analysis of the mean overall liking scores, we identified four groups of consumers namely "C1 (19% of consumers) TDR 1100497 likers & TDR 11/0010 dislikers", "C2 (19%) TDA 1100477 dislikers", "C3 (42%) all likers" and "C4 (20%) TDR 11/0010 likers". There were significant differences (P < 0.001) in the overall liking among the four clusters (Figure 3 and Figure 4). The level of overall liking for TDA 1100203 and TDR 11/0010 were the same but significantly different from TDR 1100497 and TDA 1100477.







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



Where: error bars represent the standard error.

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

3.2.1 Demographic data of the consumers interviewed

Among the 300 consumers interviewed, 37% were women and 67% were men. About 38% were 18-25 years old, while 36%, 16%, and 6% were within the age range of 26-35, 36-45 and 46-55 years respectively. Results show that only 5% of the consumers were more than 56 years old. The results indicate that majority of the respondents were youths with a significant difference in age group disparity among them. About 36% and 28% were employed as civil servants and traders respectively, while 28% were students. Only 4% were artisans. Results also show significant difference in occupational distribution in the study area.





Variable	Description	C1	C2	C3	C4	Sum	Mean (%)	Chisquare
State	Ebonyi	56	58	125	61	300	100.00	
Location	Abakaliki	10	13	25	12	60	20.00	1.000
	Amagu Izzi	12	10	26	12	60	20.00	
	Nkwagu	6	7	11	6	30	10.00	
	Obinagu Ishiagu	5	6	13	6	30	10.00	
	Onueke	12	12	25	11	60	20.00	
	Umuebe Ezzamgbo	11	10	25	14	60	20.00	
Gender	Women	7	36	47	21	111	37.00	<0.0001*
	Men	49	22	78	40	189	63.00	
Nationality	Nigerian	56	58	125	61	300	100.00	
Country of residence	Nigeria	56	58	125	61	300	100.00	
Ethnicity	Igbo	54	46	125	60	285	95.00	<0.0001*
	Hausa	2	3	0	1	6	2.00	
	Other	0	9	0	0	9	3.00	
Age	18-25	12	31	31	40	114	38.00	<0.0001*
	26-35	39	11	43	15	108	36.00	
	36-45	2	14	27	4	47	15.67	
	46-55	2	2	12	1	17	5.67	
	56+	1		12	1	14	4.67	
Occupation	Student	23	22	19	19	83	27.67	<0.0001*
	Artsanship		12	1	0	13	4.33	
	Civil Service	32	22	53	0	107	35.67	
	Trading business	0	1	46	38	85	28.33	
	Employed	0	1	2	1	4	1.33	
	Unemployed	1	0	4	3	8	2.67	
Marital status	Single	34	36	44	31	145	48.33	0.005
	Married	22	22	79	30	153	51.00	
	Widower			2		2	0.67	
Consumption frequency	Every day	9	2	44	3	58	19.33	<0.0001*
	Several times a week	44	23	51	26	144	48.00	
	Once a week	1	20	6	11	38	12.67	
	Several times a month		12	12	12	36	12.00	
	Once a month	2	1	12	9	24	8.00	

Table 4:	Demographic	differences	of the	consumers	with	respect to	cluster	division
	5 1							

3.2.2 Consumption attitudes

Many (48%) of consumers interviewed consumed the product several times a week. About 19%, 13%, 12% and 8% were used to consumption of the boiled yam every day, once a week, several times a month and once a month, respectively. Consumption several times a week ranked highest followed by every day, once a week, several times a month and once a month which ranked second, third, fourth and fifth respectively.







Figure 5 Percentage of consumer cluster type by gender

Many (42% women and 41% men) were all likers (cluster 3), while 19% women and 21% men dislike TDA1100477 (cluster 4), and 32% of women and 12% of men like TDR11/0010 (cluster two). About 6% women and 26% men were likers of TDR1100497 and dislikers of TDR 11/0010 (cluster 1).

3.3 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 boiled yam samples. Such "descriptor diagnostic" may help understand why consumers like or dislike this boiled yam sample.

Majority of consumers were satisfied with the sensory characteristics-mealiness for the 3 boiled yam samples (51.7%, 53.6% and 70.7% for TDR11/0010, TDA 1100477 and TDR 1100497 respectively). For colour, a majority of consumers (60.7% and 52.0%) indicated samples, TDA 1100203, TDA 1100477 as too dark. In terms of sweetness, many (38.0% and 48.7%) of the consumers indicated samples TDR11/0010 and TDR 1100497 as too sweet respectively, while 40.7% indicated TDA 1100477 as not sweet enough and JAR each, and 40.0% as not sweet enough for TDA 1100203. For softness; many (47.7% and 48.0%) of the consumers were satisfied with TDR 11/0010 and TDA 1100477 respectively and too hard and too soft for TDR 10047 and TDA 1100203 also.



SWEETNESS



Figure 6 Percentage of consumers who scored the three specific quality characteristics

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 product sample and the frequencies of citation of each CATA sensory characteristic by all the consumers.

The frequency of citations given by consumers to describe each Product sample were calculated (Table 6). For all the varieties, important characteristic traits include; "no spot", "good aroma",





"attractive", "easy to swallow", "smooth", which scored more than 150 (n=300). Among the least cited were "yellow", "bad odour", "brown", "too soft", "dull-dark", "white", "too soft", and "thread like lines", which scored less than 100 for all the varieties.

Products	Overall liking	Dark spot	No spot	Heavy weight	Low starch	Sweet taste
TDR 1100497	7.01	56	199	189	145	157
TDA 1100477	5.23	137	149	146	217	106
TDA 1100203	5.99	57	208	125	182	117
TDR 11/0010	6.44	121	167	189	101	167
	Hard	Moderately soft	Good aroma	Soft	Yellow	Easy to break
TDR 1100497	144	67	267	34	33	89
TDA 1100477	106	94	190	93	0	136
TDA 1100203	78	129	184	111	0	201
TDR 11/0010	112	100	201	33	33	157
	High starch	Attractive	Bad odour	Easy to swallow	Brown	Too soft
TDR 1100497						
	155	222	22	156	66	34
TDA 1100477	155 93	222 177	22 20	156 192	66 56	34 22
TDA 1100477 TDA 1100203	155 93 96	222 177 171	22 20 60	156 192 245	66 56 22	34 22 33
TDA 1100477 TDA 1100203 TDR 11/0010	155 93 96 199	222 177 171 178	22 20 60 44	156 192 245 212	66 56 22 22	34 22 33 33
TDA 1100477 TDA 1100203 TDR 11/0010	155 93 96 199 Smooth	222 177 171 178 Milk/cream	22 20 60 44 Dull/dark	156 192 245 212 White	66 56 22 22 Too soft	34 22 33 33 Thread-like lines
TDA 1100477 TDA 1100203 TDR 11/0010 TDR 1100497	155 93 96 199 Smooth 201	222 177 171 178 Milk/cream 145	22 20 60 44 Dull/dark 33	156 192 245 212 White 34	66 56 22 22 Too soft 0	34 22 33 33 Thread-like lines 78
TDA 1100477 TDA 1100203 TDR 11/0010 TDR 1100497 TDA 1100477	155 93 96 199 Smooth 201 188	222 177 171 178 Milk/cream 145 123	22 20 60 44 Dull/dark 33 77	156 192 245 212 White 34 56	66 56 22 22 Too soft 0 11	34 22 33 33 Thread-like lines 78 45
TDA 1100477 TDA 1100203 TDR 11/0010 TDR 1100497 TDA 1100477 TDA 1100203	155 93 96 199 Smooth 201 188 187	222 177 171 178 Milk/cream 145 123 124	22 20 60 44 Dull/dark 33 77 0	156 192 245 212 White 34 56 77	66 56 22 22 Too soft 0 11 23	34 22 33 33 Thread-like lines 78 45 24

Table 5: Overall liking score and frequency of citations of each quality characteristic by all the consumers

3.5 Sensory mapping of the sensory characteristics

Principal component analysis (PCA) was used to summarize the relationships between CATA sensory characteristics, product samples, and mean overall liking of each product scored by all the consumers. The PCA plot explained 81.13% of the variance of the sensory characteristics, the first and second axes accounting for 57.74% and 23.39% respectively. Most of the variance was explained by the first axis.

The loading of sensory characteristics on PCA plan (Figure 5) shows that axis 1 was mainly explained positively by the terms such as "moderately soft", "easy to swallow", "easy to break", "white", related to TDA1100203 and negatively by the terms such as "bad odour". Also in axis 1, TDA 1100477 was mainly explained negatively by dark spot (least liked), low starch and soft. In axis 2, TDR 1100497 (most liked product) was mainly explained positively by "good aroma", "attractive", "hard" and negatively by "dull/dark colour" and "thread like lines". Also, TDR 11/0010 in axis 2 was mainly explained positively by the terms such as "Yellow" "sweet taste", "heavy weight", "high starch", "milk cream" and negatively as "too soft".









Figure 7 Mapping of the sensory characteristics and the overall liking of the product samples

4 **CONCLUSION**

The four Product samples were perceived differently by consumers. The least liked product (TDA 1100477 got the lowest mean overall liking score (5.2), mainly because it was found with "dark spots", "low starch" and "soft" by the consumers (JAR test). TDR 1100497 was the most liked because it has "good aroma", is "attractive", and "hard". The terms that better describe the product samples were "smooth", "milk cream colour", "easy to swallow", "good aroma", "no spot", "heavy





weight", "high starch", and "sweet taste" with frequency counts from 100 to more than 200. Positive terms such as "moderately soft", "easy to swallow", "easy to break", "white", were related to TDA1100203 and negative by "bad odour". TDA 1100477 was mainly explained negatively by "dark spot" (least liked), "low starch" and "soft". The most liked products (i.e. TDR 1100497; TDR 11/0010) were mainly explained positively by "good aroma", "attractive", "hard", "milk cream", "yellow" "sweet taste", "heavy weight", "high starch", and negatively by "dull/dark colour", "thread like lines", and "too soft".







Institute: Cirad – UMR QualiSud

Address: C/O Cathy Méjean, TA-B95/15 - 73 rue Jean-François Breton - 34398 Montpellier Cedex 5 - France

Tel: +33 4 67 61 44 31

Email: <u>rtbfoodspmu@cirad.fr</u>

Website: https://rtbfoods.cirad.fr/



