

Consumer Testing of Fried Sweetpotato in Rural and Urban Areas in Ghana

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

This report is a part of the RTBfoods project WP1 outputs, essentially devoted to consumer testing (Activity 5) of fried sweetpotato. This activity aims to understand the relationships between sensory properties and consumer overall liking of fried sweetpotato. For this purpose, information related to sensory quality characteristics and processing of the fried sweetpotato were collected from previous activities on fried sweetpotato (Activity 3 “Surveys” and Activity 4 “Processing diagnosis”) and used for this current activity.

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Fried sweetpotato from four varieties namely; Obare, Purupuru, Amuskwera and Abija/Kuffour was subjected to consumer acceptability tests (n= 61) in Bawku, Upper East Region of Ghana. Data on consumer demographics, consumer attitudes and sensory tests (Hedonic/Overall liking, Just About Right (JAR) and Check All That Apply (CATA)) were collected. Majority of consumers were women (69%) in the youthful age group of 18-35 years (68%). Consumers of fried sweetpotato in Ghana mostly consumed it two to three times a week (52%), in salted form (23%) and at lunch (75%). Four distinct consumer segments were realised namely; Purupuru dislikers (31%), All likers (41%), Obare dislikers (13%) and those who did not like Amuskwera (15%). In terms of hedonic test/overall liking, Obare (6.8) was most liked and closer to ‘like moderately’ and it was significantly different from the least liked Purupuru (5.7) which was in the region of ‘like slightly’. All the four fried sweetpotatoes were rated JAR for mealiness, colour, sugariness and flavour by more than 50% of consumers however, only Obare (66%) and Abija/Kuffour (57%) had the appropriate crispiness. Regarding mapping of sensory characteristics using principal component analysis, the most liked Obare fried sweetpotato was described by the terms ‘Good taste’, ‘Hard’, ‘Less sugary’, ‘Dry’ and ‘Crispy’. The information generated in this study can be used by breeders when developing new sweetpotato varieties with the required end-user characteristics for enhanced adoption.

Key Words: sweet potato, fried, hedonic testing, check-all-that-applies, just-about-right test, consumer acceptability, Ghana

1 STUDY CONTEXT AND GENERAL OBJECTIVES

The consumer test of fried sweetpotato was the focus of Activity 5 under WP1 of the RTBFoods project. It followed sequentially from Activity 3 on Gendered Food Mapping and Activity 4 – Processing diagnosis and quality characteristics. The main objective of this Activity 5 “Consumer testing” was to understand the consumers’ demand for the quality characteristics of fried sweetpotato. Also, to provide WP2 with a clear and visual mapping of the most and least liked products associated with high- and low-quality characteristics, and high and low overall liking scores respectively.

Fried sweetpotato is widely consumed in parts of Ghana, Nigeria, Cote d'Ivoire and Burkina Faso constituting approximately 30-80% of total sweetpotato production (Peters, 2015). It is usually consumed as a snack in the form of large slices or chunk fries as well as chips and crisps (Sugri et al., 2012; Carey et al., 2021).

The study was conducted in Bawku Municipality and surrounding areas in the Upper East Region of Ghana which is a major sweetpotato producing area. Four sweetpotato varieties were evaluated namely; Obare, Amuskwera, Abija/Kuffour and Purupuru. Protocols developed during participatory processing diagnosis with processors were used for preparation of fried sweetpotatoes. A semi-structured questionnaire was administered for the consumer testing activity constituting demographic information, consumption attitudes, overall liking, JAR test, CATA test and consumer preferences.

2 METHODOLOGY

2.1 Sampling

Fried sweetpotatoes were prepared from four varieties with unique quality characteristics as prescribed by the processors and respondents in the gendered food mapping. These were tested among 61 consumers of which 42 were women and 19 were men (**Table 1**). The study sites included Bawku central and Manga.

Table 1: Number of consumers (men and women) interviewed in Ghana

	Bawku central	Manga	Total
Women	19	23	42
Men	6	13	19
Number of Consumers	25	36	61

The four varieties were selected based on feedback from the gendered food mapping where respondents indicated the most preferred (Obare), moderately preferred (Purupuru) and least preferred varieties (Amuskwera) regardless of flesh type. In addition, the best orange-fleshed variety (Abija/Kuffour) was also included. The consumer test activity was conducted in September 2019.

2.2 Consumer testing

An approach similar to Forsythe *et al.*, (2021) was used. The method followed that by Fliedel et al. (2018) including; a hedonic test, a just-about-right (JAR) test, and a check-all-that-apply (CATA) test was used. Consumers (n = 61) from Bawku central and Manga were asked individually to look/touch/smell/taste each fried sweetpotato sample, one at a time, 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 the intensity of 4 sensory attributes identified as important in the previous Activities 3 & 4, using the 3-point scale JAR “Just About Right” scale (1 = “Too low”, too weak, not enough, 2= “Just About Right” and 3 = “Too high, too strong, too much”) for each of the fried sweetpotato samples. The attributes chosen were crispiness, mealiness, colour, sugariness and flavour.

Consumers were then asked to select the quality characteristics that best describe each fried sweetpotato sample from a list of 18 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 fried sweetpotato samples. The CATA quality characteristics (n=18) are shown in **Table 2**. The characteristics are in different font colour depending on whether they were identified during Activity 3, Activity 4 or both.

Table 2: Fried sweetpotato quality characteristics identified during the previous Activities 3 & 4 and selected for building the CATA table

	Quality characteristics of fried sweetpotato
List of the most liked characteristics	Appearance - Light brown colour - Orange - White - Yellow Odour - Good smell Texture when touching - Soft - Dry Taste - Sugary - Good taste Texture in mouth - Crispy - Soft Perception/Feeling - Filling - Satisfying - Strong
List of the least liked characteristics	Appearance - - Odour - Bad smell Texture when Touching - Hard - Taste - Less sugary - No taste - Burnt Texture in mouth - Hard

*Blue – Activity 3; Red – Activity 4; Green – Both Activity 3 & 4

Most of the quality characteristics were derived from both Activity 3 and 4. Amongst those from Activity 3 was the good smell of sweetpotato. The processors were able to describe the quality characteristics better.

2.3 Data analysis

An analysis of variance (one-way ANOVA) was carried out to identify significant differences in overall liking scores between the 4 fried sweetpotato samples as tested by the consumers. Multiple pairwise comparisons were applied using the Tukey test, with a confidence interval of 95% at $p < 0.05$. An Agglomerative Hierarchical Clustering (AHC) analysis was used to segment consumers into similar groups of overall liking. The influence of socio-demographic characteristics (such as gender, age, ethnicity etc.) and location was tested on different acceptance groups (clusters) using a Chi-square test (SPSS software at $p < 0.05$). For each fried sweetpotato sample, the number of consumers who rated each specific characteristic either 'Just about Right' (JAR), 'Too weak' or 'Too strong' was counted, and the percentage of consumers determined. A Principal Component Analysis (PCA) was conducted on the number of citations for all the CATA quality characteristics, with sweetpotato varieties as the observation labels, and the mean overall liking for each sample as a supplementary quantitative variable. All statistical analyses were performed using XLSTAT 2014 software (Addinsoft).

3 RESULTS

3.1 Overall liking of the fried sweetpotato samples

Overall liking scores for fried sweetpotato in Bawku is shown in **Tables 3**. Three groups of overall liking emerged. Obare (6.8) was most liked and closer to 'like moderately' and it was significantly different from the least liked Purupuru (5.7) which was in the region of 'like slightly'.

Table 3: Mean overall liking scores for the fried sweetpotato samples tested

Fried sweetpotato samples	Mean overall liking scores*	Groups**	
Obare	6.8	A	
Amuskwera	6.6	A	B
Abija/Kuffour	6.3	A	B
Purupuru	5.7		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. Tukey test ($p < 0.05$).

A third, intermediate category consisted of Amuskwera (6.6) and Abija/Kuffour (6.3). These were not significantly different from either Obare or Purupuru.

3.2 Segmentation of consumers into groups of similar overall liking

The Agglomerative Hierarchical Cluster analysis of mean overall liking scores among consumers of the fried sweetpotatoes in Bawku resulted in four distinct groups namely; Purupuru dislikers (31%), All likers (41%), Obare dislikers (13%) and those who did not like Amuskwera (15%) (**Figure 1 and Figure 2**).

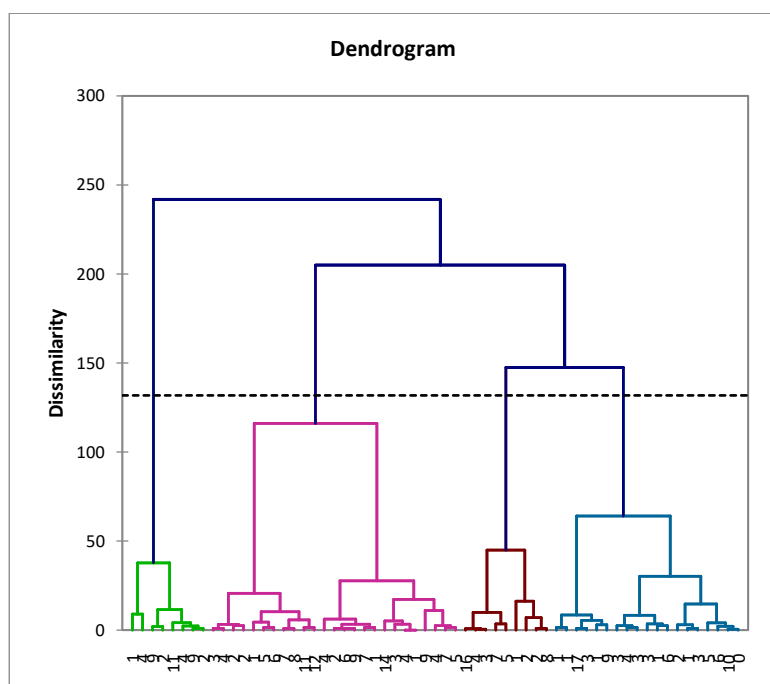


Figure 1: Segmentation of the consumers based on their overall liking scores of the fried sweetpotato in Bawku, Ghana

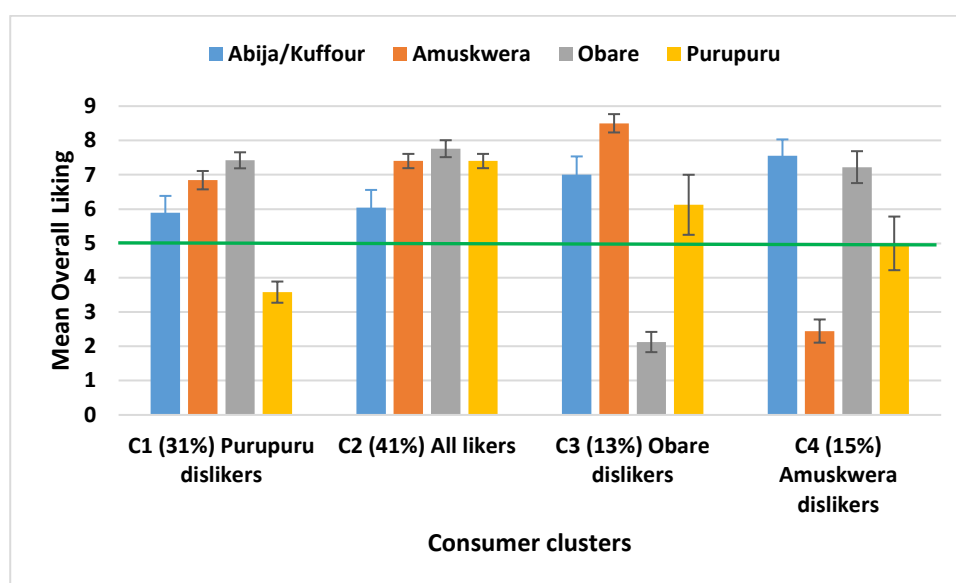


Figure 2: Mean overall liking of the fried sweetpotatoes by consumer segment (%) (error bars represent the standard error)

Most of the consumers liked all the fried sweetpotatoes (C2, 41%) with overall score range 6.0 – 7.8. However, quite a number (C1, 31%) did not like Purupuru (score 3.6). a smaller number (13 and 15%) did not like Obare (score 2.1) and Amuskwera (score 2.4). Only Abija/Kuffour was liked by all the consumers (score 5.9 – 7.6).

3.2.1 Demographic data of the consumers interviewed

Demographic information of consumers of fried sweetpotatoes in Ghana is shown in **Table 4**. Of the 61 consumers, majority were women (69%) while the men were 31%. There were mainly drawn from Manga (59%). Most of the consumers (68%) were youths in the age range of 18-35 years. Their main occupation was farming (30%) and trading (28%). Kusasi (49%) and Bissa (41%) were the

main ethnic groups of respondents. Many of the respondents indicated that they did not have a formal education (34%), were married (59%) and Muslim (87%).

Regarding cluster distribution (**Table 4**), men (53%) were mainly 'All likers' while there was an equal number of women (36%) among the 'All likers' and 'Purupuru dislikers'. There were more men among the 'All likers' than the women (**Figure 3**). However, this difference was not significant ($p>0.05$, Chi-square in Table 5).

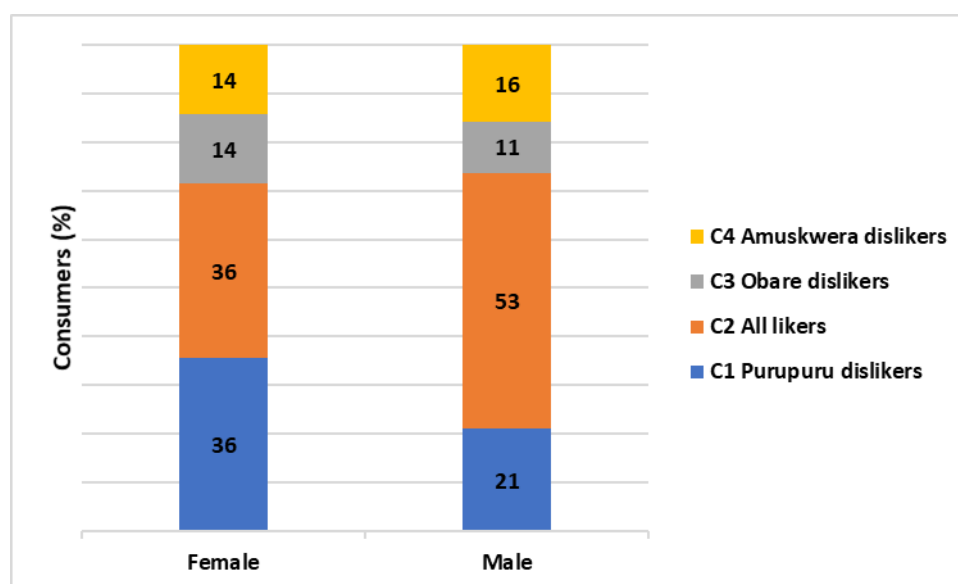


Figure 3: Fried sweetpotato consumer segmentation by gender

Consumers in Bawku central were mainly 'Purupuru dislikers' (60%) compared to those in Manga who were 'All likers' (42%). These differences among consumers by location were significant ($p<0.05$, Chi-square).

Table 4: Demographic differences of the consumers of fried sweetpotato with respect to cluster

		% consumers (n=61)	C1 Purupuru dislikers	C2 All likers	C3 Obare dislikers	C4 Amuskwera dislikers	Chi-square test
Consumers (%)			31	41	13	15	
Location (%)	Bawku central	41	60	40	0	0	< 0.0001
	Manga	59	11	42	22	25	
Gender (%)	Female	69	36	36	14	14	0.58
	Male	31	21	53	11	16	
Ethnicity (%)	Bissa	41	28	40	20	12	0.35
	Frafra	8	60	40	0	0	
	Kusasi	49	30	43	10	17	
	Moosi	2	0	0	0	100	
Age Group (%)	18-25	34	24	38	14	24	0.91
	26-35	34	29	43	19	10	
	36-45	21	46	38	8	8	
	46-55	7	25	50	0	25	
	≥56	3	50	50	0	0	

		% consumers (n=61)	C1 Purupuru dislikers	C2 All likers	C3 Obare dislikers	C4 Amuskwera dislikers	Chi-square test
Education level (%)	Basic (Primary/JHS/Middle)	23	29	50	7	14	0.40
	No formal education	34	48	38	14	0	
	Other	28	12	41	18	29	
	Secondary	11	43	14	14	29	
	Tertiary (Training college/Polytechnic/university)	2	0	100	0	0	
	Vocational/technical/commercial	2	0	100	0	0	
Occupation (%)	Full time crop farmer	30	39	50	11	0	0.70
	Salary worker	2	0	100	0	0	
	Student	20	25	17	25	33	
	Trader	28	29	35	12	24	
	Tradesman/self-employed (bricklayer, carpenter etc)	13	38	38	13	13	
	Civil servant	2	0	100	0	0	
	Laboratory assistant	2	100	0	0	0	
	Food vendor	3	0	100	0	0	
	Unemployed	2	0	100	0	0	
Marital status (%)	Divorced	2	100	0	0	0	0.78
	Married	59	31	44	14	11	
	Single	33	25	35	15	25	
	Widow	5	67	33	0	0	
	Widower	2	0	100	0	0	
Religion (%)	Christian	10	17	67	17	0	0.76
	Muslim	87	34	36	13	17	
	No religion	2	0	100	0	0	
	Traditional	2	0	100	0	0	

Differences between clusters regarding ethnicity, educational level, age group, religion, occupation and marital status were not significant.

3.2.2 Consumption attitudes

Consumers of fried sweetpotato in Ghana indicated that they consumed it two to three times a week (52%) followed by everyday (34%) (**Table 5**). This goes to show that fried sweetpotato is an integral part of the diets of the consumers in Ghana.

Table 5: Consumption attitudes of the consumers of fried sweetpotato

Consumption pattern		Percentage of consumer (n=61)
Consumption frequency	A few times a month	5
	Everyday	34
	Once a week	8
	Two or three times a week	52

Consumption pattern		Percentage of consumer (n=61)
Form of consumption	Plain	10
	With Akara	0
	Salted	23
	With tea	2
	Other (Yaajie)	8
	Other (Beans)	5
	Other (Yazzi)	5
Occasion of consumption	Breakfast	11
	Dinner	2
	In between meals	5
	Lunch	75

In addition, fried sweetpotato was mostly consumed salted (23%) followed by plain (10%). Other forms of consumption were with yaajie (8%), beans and yazzi (both 5%). The consumers indicated that fried sweetpotato was mainly consumed at lunch (75%) followed by breakfast (11%).

3.3 A Just About Right test (JAR)

The four fried sweetpotatoes were scored by consumers for intensity of crispiness, mealiness, colour, sugariness and flavour (**Figure 4**). Only Obare (66%) and Abija/Kuffour (57%) were scored JAR for crispiness by more than 50% of the consumers.

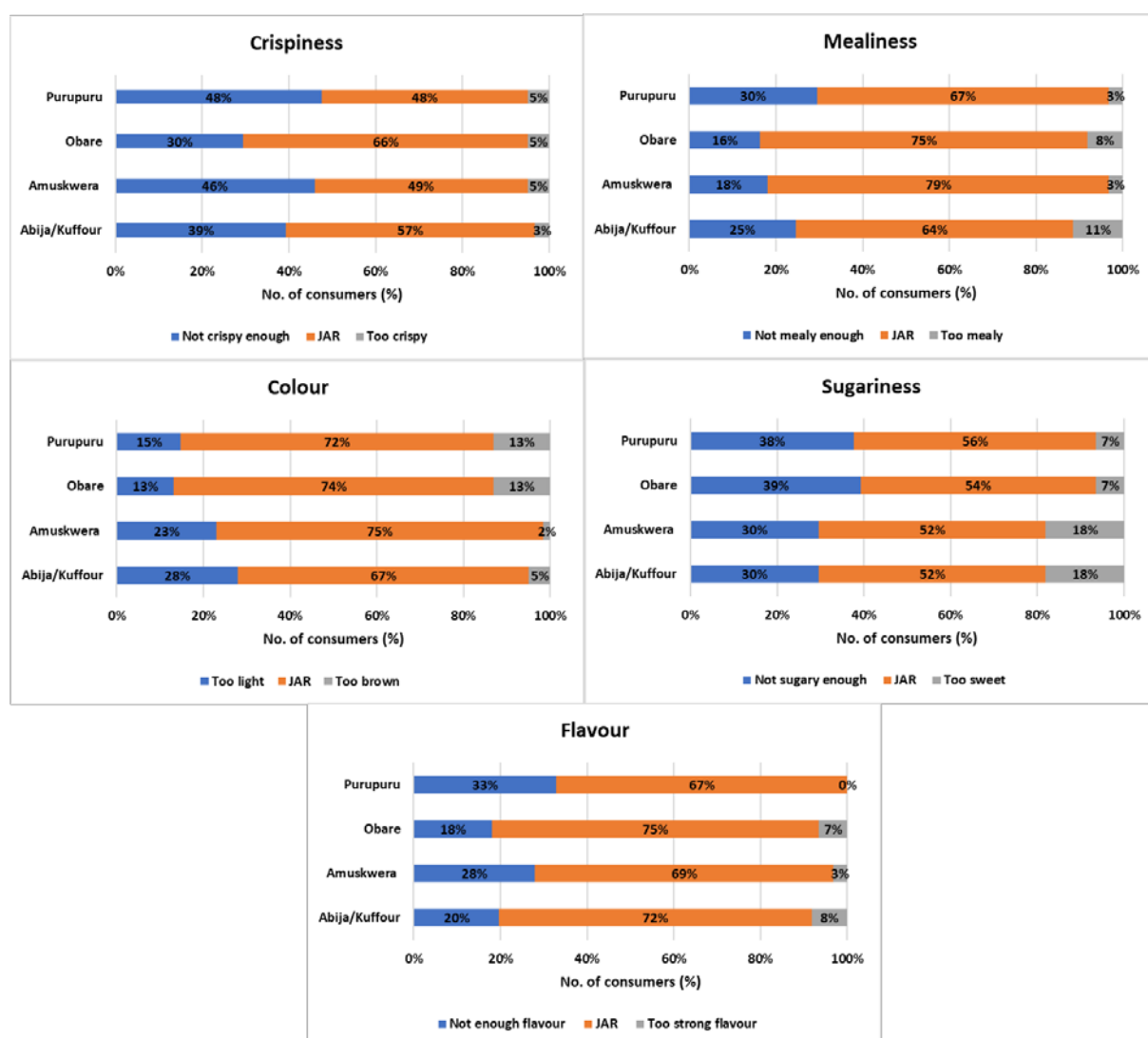


Figure 4: Percentage of consumers who scored the five quality attributes (crispiness, mealiness, colour, sugariness and flavour) using a 3-point JAR test

However, all the four fried sweetpotatoes had the right mealiness, colour, sugariness and flavour as indicated by more than 50% of consumers rating them JAR in this category.

3.4 Check All That Apply (CATA) test

The frequencies for the most cited sensory characteristics, which best described the fried sweetpotato products are shown in **Table 6**. The most cited characteristics (≥ 90 citations) were; Soft, less sugary, Satisfying, Good taste and Good smell. On the contrary, the least cited (< 20 citations) were; Strong, No Taste, Bad smell and Burnt.

Table 6: Frequency of citations of each quality characteristic by consumers of fried sweetpotato

Quality characteristics/Sample	Abija/Kuffour	Amuskwera	Obare	Purupuru	Total
Soft	36	43	28	38	145
Less sugary	26	30	34	34	124
Satisfying	29	25	26	21	101
Good taste	22	23	26	25	96
Good smell	24	25	21	20	90
Sugary	24	22	13	14	73
Filling	14	6	14	12	46
Light brown colour	12	9	11	13	45
White	10	10	15	9	44
Crispy	12	4	15	11	42
Hard	7	7	12	8	34
Dry	8	1	15	6	30
Orange	9	6	3	5	23
Yellow	6	6	6	4	22
Strong	5	4	5	4	18
No Taste	0	4	5	4	13
Bad smell	1	1	2	2	6
Burnt	0	0	1	1	2
Mean Overall liking	6.3	6.6	6.8	5.7	

Of the most cited characteristics, Abija/Kuffour had the highest citations for Soft (43), Satisfying (29) and Good smell (25). Obare and Purupuru were equally cited for Less sugary (34). More so, Obare was most cited as Good taste (26).

3.5 Mapping of the sensory characteristics

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

The PCA plot explained 83.93% of sensory characteristic variance (F1 55.80% and F2 28.14%). Most of the variance was explained by the first axis (**Figure 5**). A positive mean overall liking was neither associated with any characteristic nor fried sweetpotato. Obare fried sweetpotato was associated with Good taste, Hard, Less sugary, Dry and Crispy.

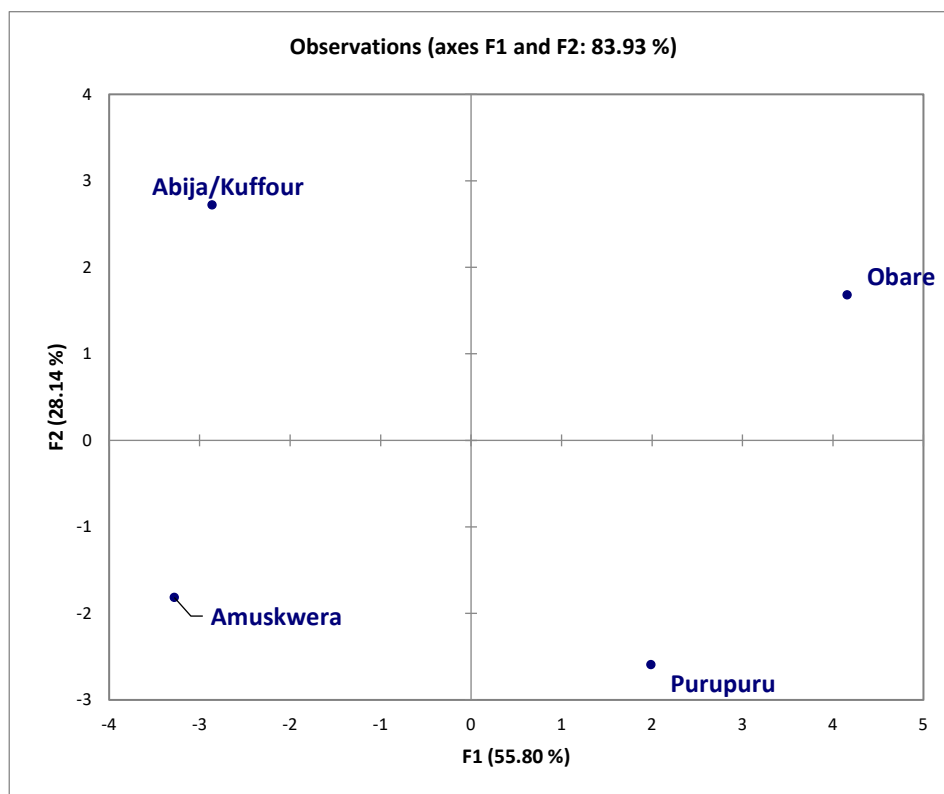
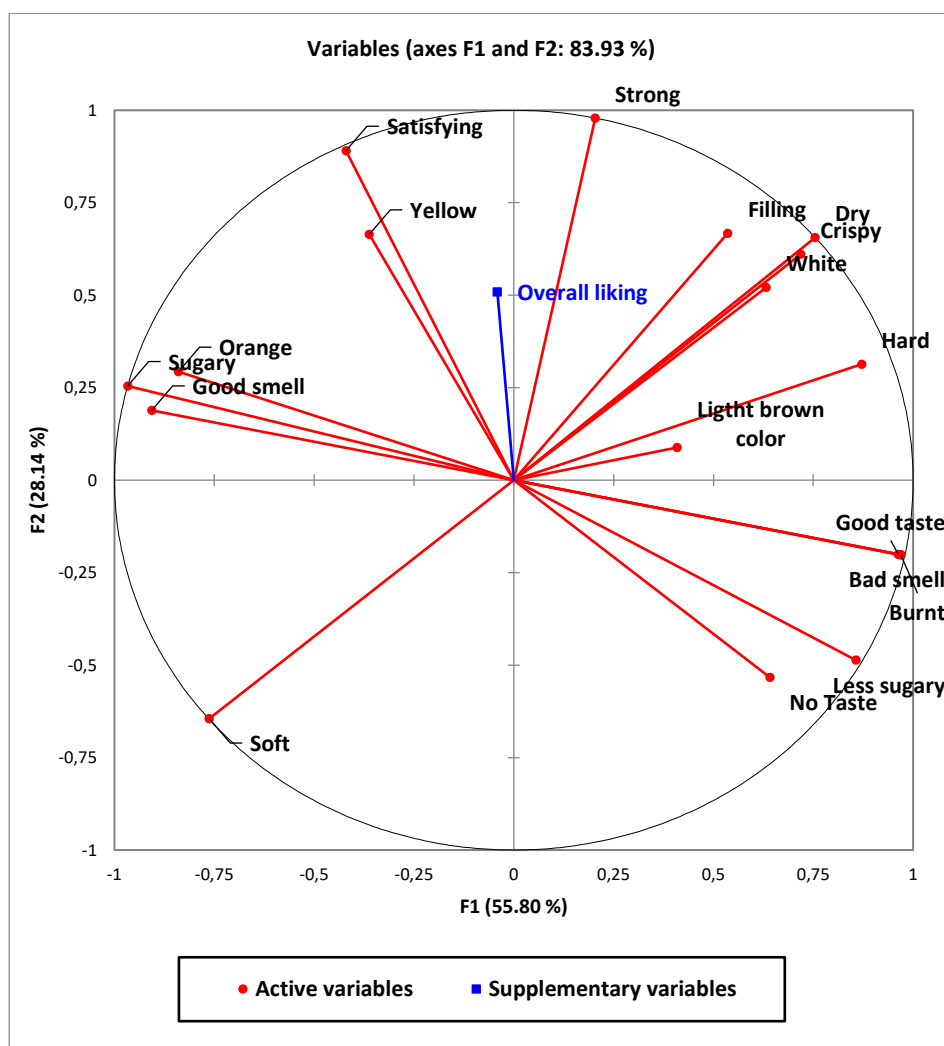


Figure 5: Mapping of the sensory characteristics and the overall liking of the fried sweetpotatoes

Amuskwera and to a lesser extent Abija/Kuffour (0.46 squared cosine) were described by Sugary, Good smell, Orange and Soft. Purupuru was also not strongly associated with any of the sensory characteristics.

4 DISCUSSION

Regarding consumption pattern, consumers indicated that they consumed fried sweetpotato 2-3 times a week. Therefore, fried sweetpotato plays an important role in the diets of the consumers for food and nutrition security.

Fried sweetpotato of Obare had the highest overall liking score therefore was most preferred. This was not surprising as it had been mentioned among the most liked varieties by processors during participatory processing diagnosis with. It is a white-fleshed land which was appreciated for its appropriate firmness and sweetness (Ssali *et al.*, 2021). On the other hand, Purupuru had the lowest overall liking score and was only liked slightly. Processors (Activity 4) had previously indicated that it was too soft and not dry enough because of a high moisture content therefore it was less preferred.

With overall liking above the threshold of 5, all the fried sweetpotatoes were generally liked hence the 'All likers' segment were the majority in the Agglomerative hierarchical clustering. This was augmented by the JAR test where all the fried sweetpotatoes had the appropriate intensity for mealiness, colour, sugariness and flavour. A number of consumers did not like Purupuru and this could be due to the previously alluded to softness and inadequate dryness. More so, a number of consumers indicated that Purupuru and Amuskwera were not crispy enough. Interestingly, Abija/Kuffour was liked by all consumers. This could be due to consumers citing it for being soft, satisfying and having a good smell.

Mapping of sensory characteristics by principal component analysis further strengthened the previous observations where the most liked fried sweetpotatoes of Obare were described as Good taste, Hard, Less sugary, Dry and Crispy.

5 CONCLUSION

Obare was the most liked fried sweetpotato right from the gendered food mapping, participatory processing diagnosis and the consumer test. It was linked with a good taste (less sugary) and texture (firm, dry and crispy). Therefore, it is a prime candidate as a yardstick for breeders developing new varieties. In addition, the orange fleshed Abija/Kuffour was also generally liked by consumers and its unique qualities can also be utilized for varietal improvement programs by breeders.

The consumer test study design covered locations in Ghana and Nigeria. However, it may be limited by a relatively smaller number of consumers tested (n=61) in Ghana. The general assumption was that the same varieties would be tested across the study locations in Ghana and Nigeria for a statistically acceptable cumulative number. However, the varieties were different hence creating this discrepancy.

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