Field Scientific Report

Consumer Testing of Boiled and Steamed Sweetpotato in Rural and Urban Areas in Uganda

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

Boiled and steamed sweetpotato from different varieties was tested for consumer acceptability in Uganda. The consumer test activity spanned multiple locations: Lira, Kamwenge, Kampala, and Masaka. Consumer tests for the varieties from Lira were conducted around Lira area (north-eastern Uganda) and in Kampala City (south) while those from Kamwenge were done around Kamwenge area and in Masaka City (western Uganda). Varieties from Kamwege were steamed whilst those from Lira were boiled, following traditional processing practices.

The steamed sweetpotato variety from Kamwenge with the highest overall liking was NASPOT 8 (score of 7.5 = 'like very much') and the one with the lowest was Ndererabana (score of 5.6 = 'like slightly'). The boiled sweetpotatoes from Lira varieties were not significantly different to each other in terms of overall liking (score of 6.5-7.0, like moderately). Acceptance clusters for consumers of Kamwenge varieties were the following: Ndererabana dislikers (35%), All likers (50%) and Kiribwamukwe dislikers (15%) while those for Lira were; Otada dislikers (23%), 'All likers' (61%) and 'Arakaraka dislikers' (16%).

Most varieties were rated JAR for colour, sweetness, firmness, and mealiness by more than 50% of consumers in Kawmenge and Lira districts.

The sensory mapping of steamed sweetpotato varieties from Kamwenge showed that a positive mean overall liking was associated with 'yellow', 'orange', 'vitamins', 'attractive', 'smooth' and 'sweet'; in relation to the improved variety NASPOT 8. Steamed sweetpotatoes from the slightly liked Ndererabana were associated with 'too soft', 'watery', 'no smell', 'tasteless', and 'sticky between fingers'.

For boiled sweetpotato varieties from Lira, the sensory characteristics such as 'orange', 'vitamins', 'smooth', 'yellow', 'not sweet enough' and 'fibrous' were associated with NASPOT 8. Arakaraka was associated with 'white', 'no smell' and 'tasteless'. Otada and Okonynedo were associated with 'watery', 'blackish', 'bad aftertaste', 'non-uniform texture', 'non homogeneous colour', 'too soft' and 'sweet'.

This study shows a clear differentiation between 'liked' and 'disliked' sensory characteristics of boiled and steamed sweetpotato.

Key Words: sweetpotato, Uganda, check-all-that-applies, just-about-right, consumer acceptability, sensory characteristics gender

1 STUDY CONTEXT AND GENERAL OBJECTIVES

The consumer test was the focus of the final activity (Activity 5) under WP1 of the RTBFoods project. It followed on chronologically from Activity 3 on Gendered Food Mapping and Activity 4 – Processing diagnosis and quality characteristics. The main objectives of this Activity 5 "Consumer testing" was to understand the consumers' demand for the quality characteristics of Root, Tuber and Banana products. Also, the aim was 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.

In Uganda, sweetpotato is mainly prepared by boiling or steaming, depending on location. In this case the steamed sweetpotatoes were prepared using varieties from Kamwenge while boiled sweetpotatoes were from Lira varieties. Those differences in processing were based on local customs. Boiled or steamed sweetpotatoes were tested by consumers at source and in the bigger cities which were more than 200 km away. Four different varieties were picked from each location namely; NASPOT 8, Kiribwamukwe, Otandibata and Ndererabana from Kamwenge; NASPOT 8, Arakaraka, Otada and Okonynedo from Lira. Preparation was done based on protocols developed during Activity 4 involving processors and standardised. A semi-structured questionnaire was administered for the consumer testing activity constituting demographic information, consumption habits, overall liking, JAR test, CATA test and consumer preferences.

2 METHODOLOGY

2.1 Sampling

Boiled and steamed sweetpotatoes made by the processors from four varieties with very different quality characteristics during the Activity 4 "Processing diagnosis", were tested by a total of 245 consumers. Of these, 127 were women while men were 118 (Table 1). Lira (rural location) constituted Barkwoyo, Abalalai, Obato and Aweo villages. Urban locations for consumer test of Lira varieties were Lira town and Kampala city. Kamwenge (rural location) was composed of Byabasambu (I & II) and Kyakanyemera (I & II) villages. Urban locations for consumer test of Kamwenge varieties were Kamwenge town and Masaka city.

Table 1: Number of consumers (men and women) interviewed in the rural and urban areas of the two regions and type of sweetpotato processing

Type of product and origin		**Boiled varieties from Lira**			**Steamed varieties from Kamwenge**		
	Total	Lira		Big city	Kamwenge		Big city
		Rural	Town	Kampala	Rural	Town	Masaka
Women	127	7	25	32	18	17	28
Men	118	10	19	28	13	16	32
Number of Consumers	245	17	44	60	31	33	60

The four varieties selected - either boiled or steamed sweetpotatoes - included the most preferred, intermediate and least preferred varieties, according to processors in the different locations. In Lira

these were Arakaraka (local), Okonynedo (local), NASPOT 8 (improved) and Otada (local). While in Kamwenge, they were Kiribwamukwe (local), NASPOT 8 (improved), Ndererabana (local) and Otandibata (local).

The consumer test activity was conducted in Lira (north-eastern Uganda) and Kamwenge (western Uganda) in September and October 2019 respectively. In addition, consumer tests for the varieties from Lira were conducted in Kampala City while those from Kamwenge were done in Masaka City.

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 = 245 in total) from different locations in rural and urban areas were asked individually to look/touch/smell/taste each steamed/boiled sweetpotato 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 perceive the intensity of 4 characteristics 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 steamed/boiled sweetpotato samples. The characteristics chosen were colour, sweetness, firmness and mealiness. These characteristics had been identified as being important characteristics that influence preference of different sweetpotato varieties.

Consumers were then asked to select the quality characteristics that better describe each steamed/boiled sweetpotato sample, among a list of 24 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 steamed/boiled sweetpotato samples.

The CATA quality characteristics (n=24) 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: Quality characteristics identified during the previous Activities 3 & 4 and selected for building the CATA table

	Quality characteristics of Boiled/Steamed sweetpotato
List of **the most liked** characteristics	**Appearance** - Attractive - Orange - Vitamins - White - Yellow **Odour** - Good sweetpotato smell Texture when touching - Firm **Taste** - Sweet **Texture in mouth** - Dry - Mealy - Smooth - Thick

	Quality characteristics of Boiled/Steamed sweetpotato
List of the least liked characteristics	**Appearance** - Blackish - Non homogeneous colour **Odour** - No smell **Texture when Touching** - Non uniform texture - Sticky between finger **Taste** - Not sweet enough - Tasteless **Texture in mouth** - Hard - Too soft - Fibrous - Watery **Aftertaste** - Bad after taste

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

Most of the quality characteristics were mentioned both in Activity 3 and 4. Therefore, respondents generally had a clear idea of their preferred and least preferred characteristics. Amongst those from Activity 3 was the perception associating good sweetpotato with vitamins. The processors were more discerning in providing their quality characteristics.

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 steamed/boiled sweetpotato samples at each location as tested by a total of n=121 consumers for Lira varieties and n=124 for Kamwenge varieties. 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 organize 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 4 steamed/boiled sweetpotato 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 121 for consumers of Lira varieties and 124 for those of Kamwenge)) was 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 2019 software (Addinsoft).

3 RESULTS

3.1 Overall liking of the boiled/steamed sweetpotato samples

Overall liking scores for steamed and boiled sweetpotato from Kamwenge and Lira are shown in Tables 3 and 4 respectively.

Table 3: Mean overall liking scores for the steamed sweetpotato samples tested from Kamwenge

Steamed sweetpotato samples	Mean overall liking scores*	Groups**		
NASPOT 8	7.5	A		
Kiribwamukwe	6.7		B	
Otandibata	6.5		B	
Ndererabana	5.6			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).

Of the steamed sweetpotatoes from Kamwenge (**Table 3**), NASPOT 8 was the most liked variety with overall liking close to 8 ('like very much') and this was significantly different from the others (p<0.05, one-way ANOVA). Kiribwamukwe and Otandibata had similar liking close to 7 ('like moderately'). Ndererabana had the lowest overall liking tending towards 6 ('like slightly') and this was significantly different to the other varieties. Consumer preference for the improved NASPOT 8 could be associated with its dry texture, moderate sweetness and high dry matter content (Mwanga et al., 2021). More so, this was verified during Activity 4 with the processors where NASPOT 8 dry matter content was 37.15%. Overall, its sensory attributes were akin to those of the preferred local varieties. Ndererabana had been identified as one of the least preferred varieties during the gendered food mapping and participatory processing diagnosis. The processors indicated that it was soft, not mealy, not sweet, and bad appearance. In the current study it was described as being 'watery', 'too soft', 'no smell', 'tasteless', 'sticky between fingers' and also 'not sweet enough'

Table 4: Mean overall liking scores for the boiled sweetpotato samples from Lira

Boiled sweetpotato samples	Mean overall liking scores*	Groups**
NASPOT 8	7.0	A
Arakaraka	6.9	A
Otada	6.8	A
Okonynedo	6.6	A

*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 overall liking of sweetpotato varieties from Lira did not vary significantly (p>0.05, one-way ANOVA) (**Table 4**). All the varieties tested had similar overall liking score of 7 (like moderately). This result is slightly different from the processors (Activity 4) who had Otada as the most preferred sweetpotato variety followed by Okonynedo with NASPOT 8 and Arakaraka (joint third). Nevertheless, a general observation from the processors was that all the varieties demonstrated similar and overall good quality characteristics in terms of appearance, flavour, texture and taste. Therefore, it could be that the preference for the selected varieties was different among respondents

during gendered food mapping compared to processors and consumers. Also, there might have been a bias in processing (e.g. cooking time and quantity of water added) and this may require investigation. In addition, at the time of the study sweetpotato samples were in short supply and therefore not sourced from the same garden. These could have been at slightly different stage of maturity hence affecting the result.

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.

The Agglomerative Hierarchical Cluster analysis of mean overall liking scores among consumers of the Kamwenge sweetpotatoes resulted in three distinct groups that is Ndererabana dislikers (35%), All likers (50%) and those who did not like Kiribwamukwe (15%) (**Figure 1 and Figure 2**).

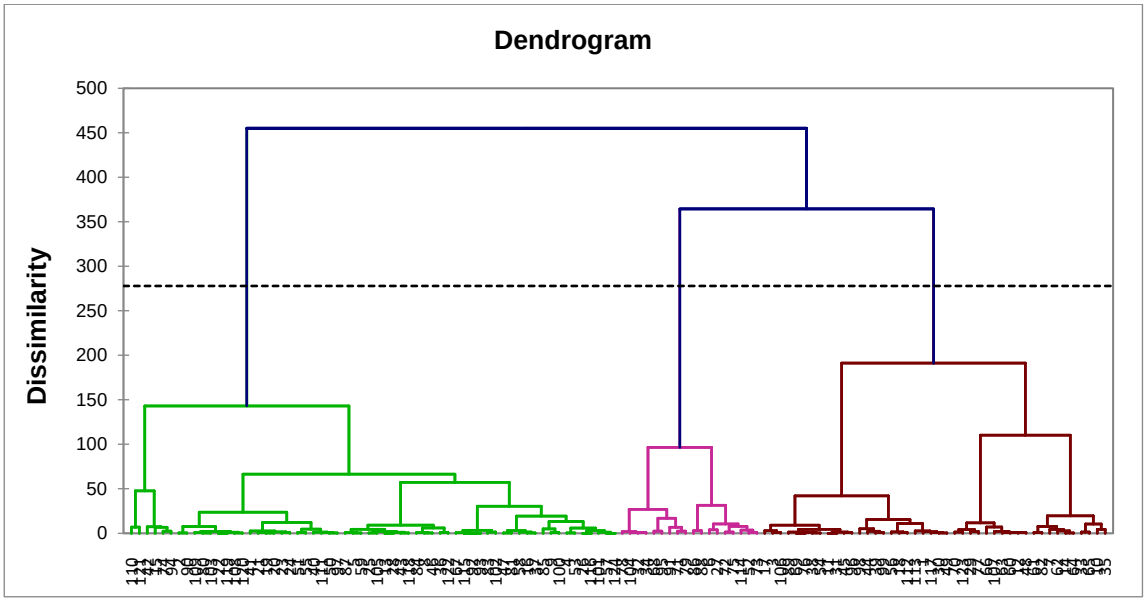


Figure 1: Clustering of the consumers based on their overall liking scores of the steamed sweetpotatoes from Kamwenge

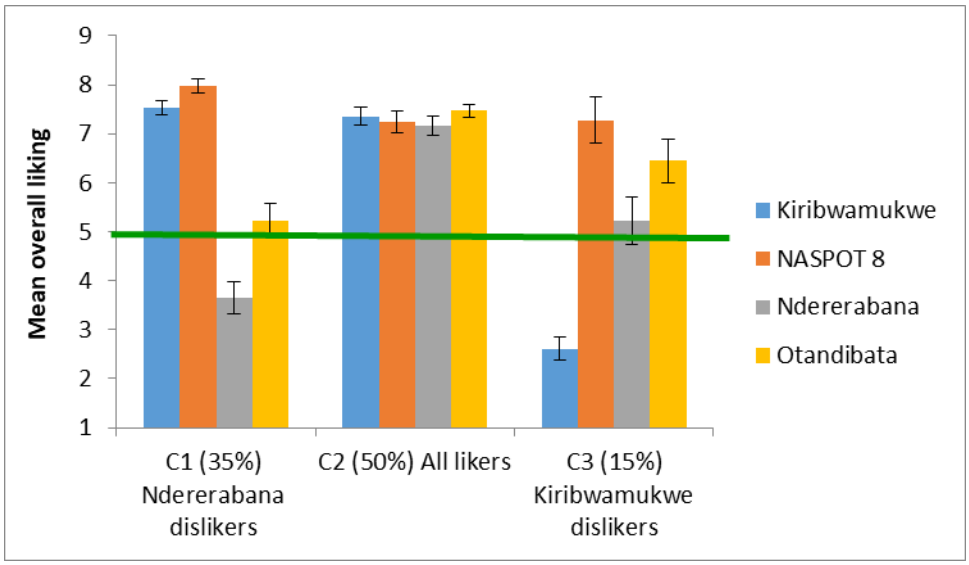


Figure 2: Mean overall liking of the steamed sweetpotatoes varieties from Kamwenge by consumer cluster type (%) (error bars represent the standard error)

The improved NASPOT 8 was liked by all the consumers in the 3 classes with a score between 7.2 and 8. Consumers in C1 (35%) of were classified 'Ndererabana dislikers' (score of 3.7), and consumers in C3 (15%) as 'Kiribwamukwe dislikers' (score of 2.6). Half of the consumers interviewed were 'All likers'.

Ndererabana was disliked because it was described as being 'watery', 'too soft', and 'no smell, tasteless', 'sticky between fingers' and also 'not sweet enough' Kiribwamukwe was described as being 'blackish', with 'non-homogenous colour', 'non-homogeneous texture', 'not sweet enough' and 'hard' and this may explained why it was disliked by consumers in C3.

The Agglomerative Hierarchical Cluster analysis of mean overall liking scores among consumers of the boiled sweetpotatoes from Lira varieties also produced three distinct groups namely; 'Otada dislikers', 'All likers' and 'Arakaraka dislikers'. These constituted 23%, 61% and 16% of the consumers, respectively (**Figure 3 and Figure 4**).

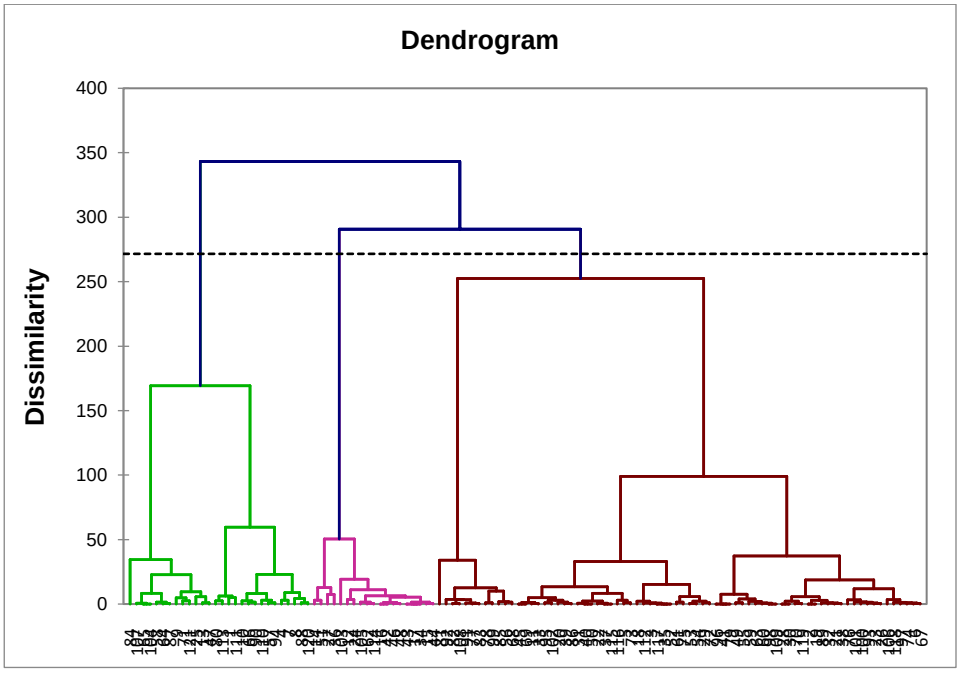


Figure 3: Clustering of the consumers based on their overall liking scores of the boiled sweetpotatoes from Lira varieties

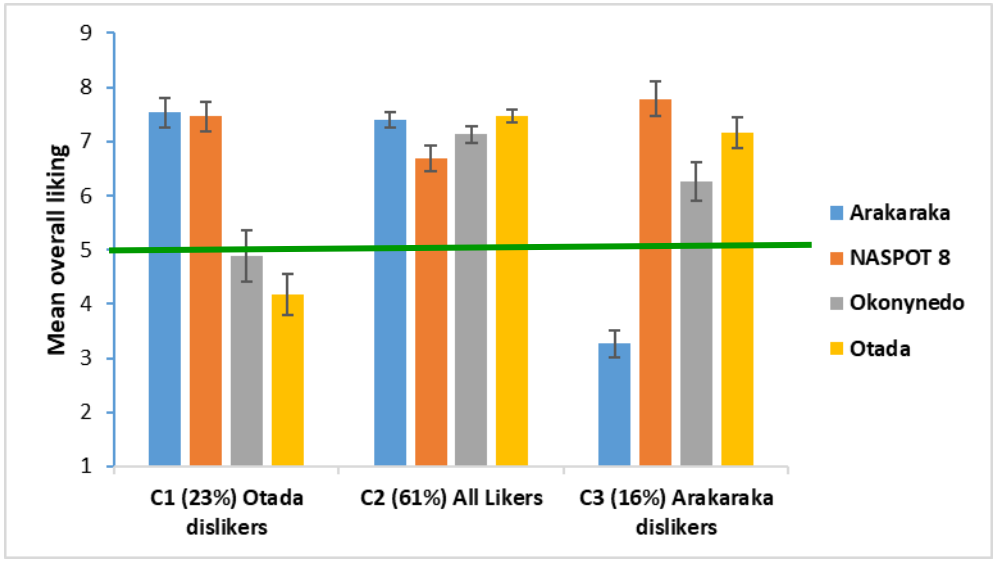


Figure 4: Mean overall liking of the boiled sweetpotatoes varieties from Lira by consumer cluster type (%) (error bars represent the standard error)

C1 consumers (23%) were classified as 'Otada dislikers' (C1) (overall liking score of 4.2). C1 consumers expressed indifference towards Okonynedo (5.0, neither like nor dislike). Those two varieties were described by some consumers as being 'watery', 'blackish', having 'bad aftertaste', 'non-uniform texture', 'non homogeneous colour', and being 'too soft'. C3 consumers (16%) were Arakraka dislikers (C3) (score of 3.3). Arakaraka was described by some as having 'no smell' and being 'tasteless'. NASPOT 8 was liked by all consumers in the 3 classes with an overall liking score comprised between 6.7 and 7.9. NASPOT 8 was associated with 'smooth in the mouth', 'firm', and good sweetpotato smell for many consumers.

3.2.1 Demographic data of the consumers interviewed

Demographic information of consumers of steamed sweetpotatoes made from varieties in Kamwenge is shown in **Table 5.** Of the 124 consumers, 51% were women while the men were 49%. Most of the consumers (35%) were in the age range of 26-35 years. These were mainly engaged in farming (26%), trading business (25%) and artisanship (22%). Most consumers indicated that they were moderately rich (72%) and married (61%). Majority of the consumers were from Kamwenge (52%) with the rest from Masaka (48%). Regarding ethnicity the Baganda were dominant (41%) followed by the Banyankore (20%) and Batagwenda (19%).

In terms of cluster distribution (**Table 5**), both women (44%) and men (56%) were mainly 'All likers'. There were slightly more women among the 'Ndererabana dislikers' and 'Kiribwamukwe dislikers' than men (**Figure 5**) but the difference was not significant (Chi-square in Table 5).

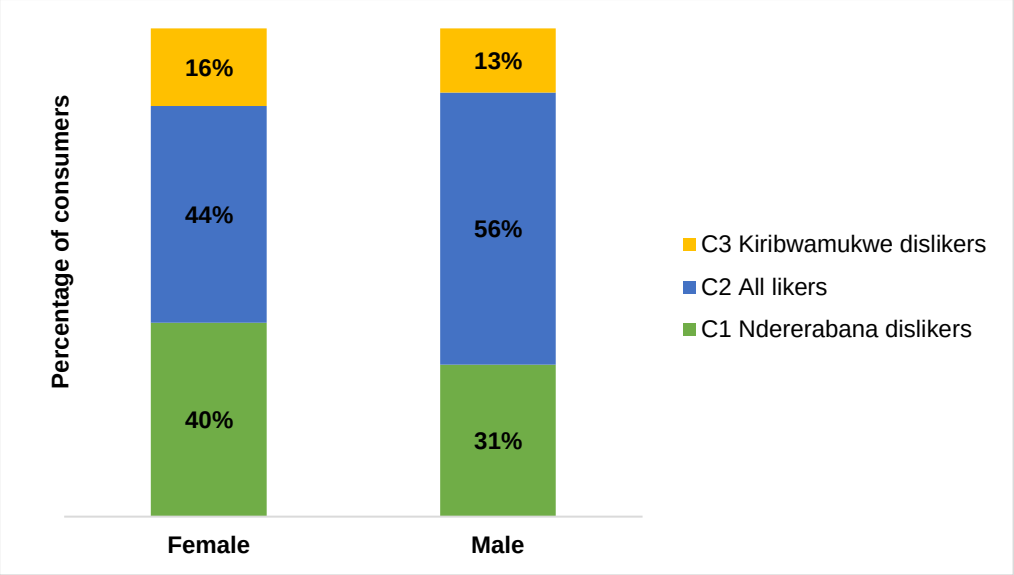


Figure 5: Percentage of consumer cluster type by gender - Kamwenge

The dominant age groups (26-35) and (18-25) were mainly 'All likers' at 47% and 56% respectively. The 36-45 years old were mostly Ndererabana dislikers (46%). In terms of testing site, consumers in Kamwenge town (49%) and Masaka city (60%) were mostly 'All likers'. However, majority of consumers in rural Kamwenge (52%) were 'Ndererabana dislikers'. Of the major ethnic groups among consumers, the Baganda (63%) were mostly 'All likers' while the Banyankore (48%) and Batagwenda (54%) were 'Ndererabana dislikers'. Farmers (47%) were mainly 'Ndererabana dislikers' whereas traders (55%) and artisans (48%) were 'All likers'

Table 5: Demographic differences of the consumers of steamed sweetpotato with respect to cluster division - Kamwenge

		Percentage of consumers (n=124)	C1 Ndererabana dislikers	C2 All likers	C3 Kiribwamukwe dislikers	Chi-square test
Consumers (%)			35	50	15	
Location (%)	Kamwenge Rural	25	52	32	16	0.106
	Kamwenge Town	27	39	49	12	
	Masaka City	48	25	60	15	
Gender (%)	Female	51	40	44	16	0.452
	Male	49	31	56	13	
Age group (%)	18-25	31	36	56	8	0.317
	26-35	35	30	47	23	
	36-45	19	46	38	17	
	46-55	9	45	55	0	
	≥56	6	14	71	14	
Ethnicity (%)	Bafumbira	2	0	100	0	0.31
	Baganda	41	20	63	18	
	Bahororo	1	100	0	0	
	Bakiga	6	43	43	14	
	Banyankore	20	48	40	12	
	Banyarwanda	5	50	33	17	
	Banyole	1	100	0	0	
	Banyoro	1	0	100	0	
	Basoga	1	0	100	0	
	Batagwenda	19	54	29	17	
	Batoro	3	25	75	0	
Marital status (%)	Married	61	39	41	20	0.087
	Single	36	30	64	7	
	Widow(er)	3	25	75	0	
Occupation (%)	Student	1	0	100	0	0.465
	Artisanship	22	37	48	15	
	Civil service	6	25	75	0	
	Trading business	25	23	55	23	
	Employed	19	39	52	9	
	Unemployed	2	50	0	50	
	Farmer	26	47	41	13	
Wealth status (%)	Rich	5	0	83	17	0.035
	Moderate	72	43	42	16	
	Poor	23	21	69	10	

There were no gender and socioeconomic differences between the clusters except for wealth status. The rich and the poor were mostly 'All likers' (C3) while the moderately rich were more of 'Ndererabana dislikers'. There may be confounding factors that explain these differences; for example location or ethnicity linked to wealth. ($p<0.05$, Chi-square test).

Demographic information of consumers of boiled sweetpotatoes made from Lira varieties is shown in **Table 6**. Of the 121 consumers, 53% were women while the men were 47%. Most of the

consumers (40%) were in the age range of 18-25 years followed by 26-35 years (30%). These were mainly civil servants (27%), employed variously (23%) and farmers (21%). Most consumers indicated that they were moderately rich (60%) and married (51%). Half of the consumers were from Lira town and villages (50%) and and the other half from Kampala (50%). Regarding ethnicity the Langi (45%) were dominant followed by the Baganda (24%).

In terms of cluster distribution, both women (59%) and men (63%) were mainly 'All likers' (Figure 6). There were no significant differences between genders in terms of clustering ($p<0.05$, Chi-square test Table 6).

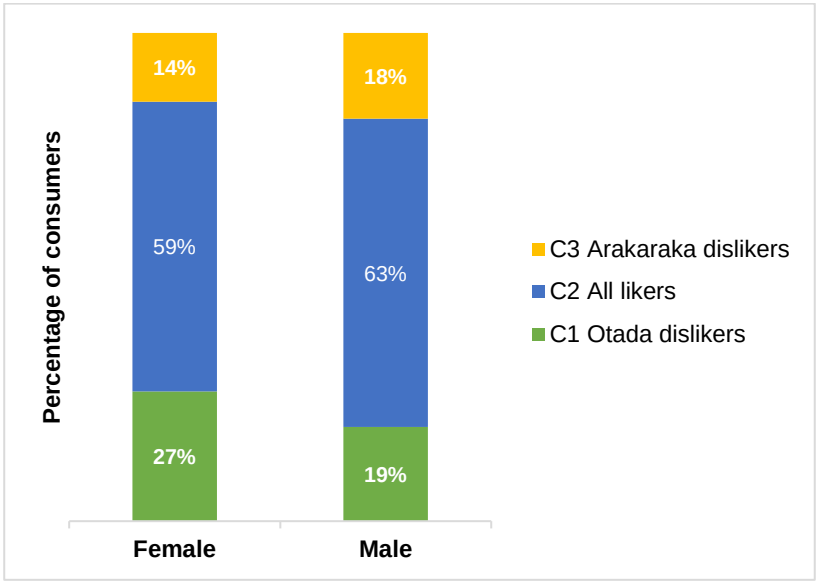


Figure 6: Percentage of consumer cluster type by gender – Lira

In terms of testing location, consumers in Lira town (54%) and Kampala city (68%) were mostly 'All likers'. However, more consumers in Lira town were 'Arakaraka dislikers' (26%) compared to Kampala (5%) (**Figure 7**) Consumers in the two regions significantly differ in their liking ($p<0.05$, Chi-square test) (**Table 6**). Those who disliked Arakaraka could have been because they found it to be 'Tasteless' with 'no smell'

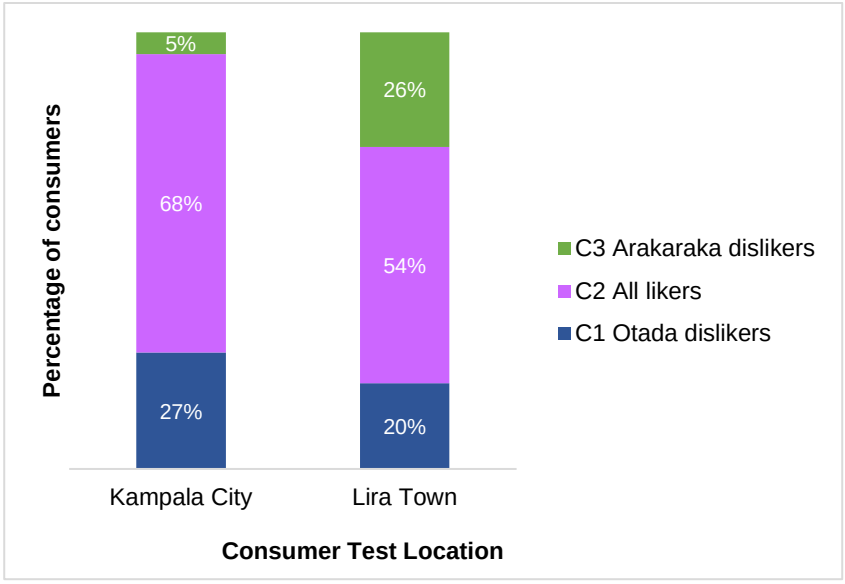


Figure 7: Percentage of consumer cluster type by test location – Lira varieties

Age group had a significant influence on the overall liking clustering ($p<0.05$, Chi-square test) (Table 6). The main age groups of 18-25 and 26-35 were mostly 'All likers' with 67% and 69% of consumers respectively. The 36-45 years old were mostly Otada dislikers (52%) (**Figure 8**). Otada was disliked by consumers who indicated that it was 'watery', 'blackish', 'bad aftertaste', 'non-uniform texture', 'non homogeneous colour', and 'too soft' whereas Arakaraka was said to be 'Tasteless' with 'no smell'. It is difficult to explain why the 36-46 year-old category is different to the other age groups. There may be confounding factors (occupation, location) that could explain the difference but this may also be an artefact due to the limited number of consumers in each age group.

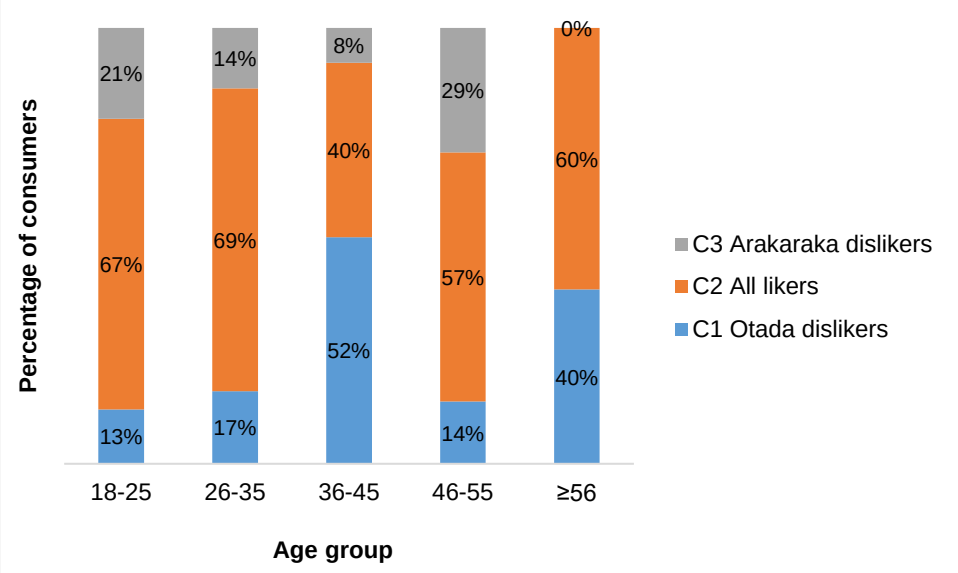


Figure 8: Percentage of consumer cluster type by age group – Lira varieties

There was no influence of ethnicity, gender, marital status, nor wealth status on overall liking (clustering) ($p<0.05$, Chi-square test) (Table 6).

Table 6: Demographic differences of the consumers of boiled sweetpotato with respect to cluster division – Lira

		Percentage of consumers (n=121)	C1 Otada dislikers	C2 All likers	C3 Arakaraka dislikers	Chi square test
Consumers (%)			23	61	16	
Location (%)	Kampala City	50	27	68	5	0.006*
	Lira Town	50	20	54	26	
Gender (%)	Female	53	27	59	14	0.609
	Male	47	19	63	18	
Age group (%)	18-25	40	13	67	21	0.017*
	26-35	30	17	69	14	
	36-45	21	52	40	8	
	46-55	6	14	57	29	
	≥56	4	40	60	0	
Ethnicity (%)	Acholi	1	0	100	0	0.199
	Bafumbira	1	0	100	0	
	Baganda	24	38	55	7	
	Bagisu	3	25	75	0	
	Bagwere	1	0	100	0	

		Percentage of consumers (n=121)	C1 Otada dislikers	C2 All likers	C3 Arakaraka dislikers	Chi square test
	Bakiga	1	0	100	0	
	Banyankore	8	20	80	0	
	Banyarwanda	2	50	50	0	
	Banyoro	5	0	100	0	
	Basoga	1	100	0	0	
	Batoro	1	0	0	100	
	Iteso	6	14	86	0	
	Kumam	1	0	100	0	
	Langi	45	20	51	29	
	Lugbara	1	0	100	0	
Marital status (%)	Living with parents/elders	6	0	100	0	0.181
	Married	51	31	55	15	
	Single	40	16	65	18	
	Widow(er)	2	33	33	33	
Occupation (%)	Student	12	7	67	27	0.052
	Artisanship	6	0	100	0	
	Civil service	27	21	67	12	
	Trading business	7	22	56	22	
	Employed	23	18	71	11	
	Unemployed	2	33	67	0	
	Farmer	21	46	31	23	
Wealth status (%)	Rich	10	17	67	17	0.352
	Moderate	60	21	67	12	
	Poor	30	31	47	22	

3.2.2 Consumption attitudes

Of the consumers of steamed sweetpotato varieties from Kamwenge, most indicated consuming several times a week (45%) followed by one time a week (26%) and daily (21%) (**Table 7**). The most common form of consumption is with other sauce served separately (usually greens, beans or groundnuts) constituting 52% of consumers followed by plain snack form (35%). According to most consumers, steamed sweetpotatoes were mostly consumed at lunch (49%) and breakfast (32%).

Table 7: Consumption attitudes of the consumers of steamed sweetpotato– Kamwenge

Consumers %	Consumption habit	Percentage of consumer (n=124)
Consumption frequency (%)	Every day	21
	Several times a week	45
	Once a week	26
	Several times a month	5
	Once a month	3
Form of consumption (%)	Katogo (Added with beans/groundnuts/ingredients and spices)	12
	Mashed (Mugoyo)	1
	Plain (Dry Snack)	35

Consumers %	Consumption habit	Percentage of consumer (n=124)
	With other sauce served separately (greens, beans, groundnuts)	52
Time of the day (%)	Breakfast	32
	Lunch	49
	In between meals	2
	Dinner	16

Consumers of boiled sweetpotato varieties from the Lira also mostly reported consumption several times a week (53%) followed by once a week (19%) and daily (11%) (**Table 8**). In addition, the most common form of consumption was with other sauce separately (56%) followed by plain snack (36%). Furthermore, boiled sweetpotato was mostly consumed at lunch (55%) and breakfast (38%).

Table 8: Consumption attitudes of the consumers of boiled sweetpotato– – Lira

Consumers %	Consumption habit	Percentage of consumer (n=121)
Consumption frequency (%)	Every day	11
	Several times a week	53
	Once a week	19
	Several times a month	11
	Once a month	7
Form of consumption (%)	Katogo (Added with beans/groundnuts/ingredients and spices)	8
	Plain (Dry Snack)	36
	With other sauce served separately (greens, beans, groundnuts)	56
Time of the day (%)	Breakfast	38
	Lunch	55
	In between meals	1
	Dinner	7

The consumption of steamed/boiled sweetpotato was not dissimilar between the two districts: the frequency of consumption, most frequent form of consumption, and time of the day followed the same pattern.

3.3 A Just About Right test (JAR)

Just about right (JAR) scale was used to determine the percentage of consumers who perceived the four important sensory quality characteristics, namely colour, sweetness, firmness and mealiness, JAR or Not JAR for the four steamed and boiled sweetpotato varieties. This diagnosis of the sensory descriptors helps to shed more light on what drives consumers' liking for the steamed or boiled sweetpotatoes.

Of the steamed sweetpotatoes from Kamwenge varieties, the four specific characteristics such as colour, sweetness, firmness, and mealiness were scored JAR "Just about right" by more than 50% of the consumer for NASPOT 8, Kiribwamukwe and Otandibata steamed sweetpotato (**Figure 9**).

Colour was scored JAR by 90%, 80% and 73%, sweetness was JAR for 78%, 68% and 63%, firmness was scored 75%, 59% and 73% and mealiness was 54%, 56% and 55% for NASPOT 8, Kiribwamukwe and Otandibata, respectively. Less than 50% of the consumers thought that Ndererabana had the right degree of firmness (46%) and mealiness (39%). It was considered 'Not firm enough' 'Not mealy enough' and "Not sweet enough" by 51%, 60% and 46% of consumers respectively. These could have been factors contributing to a lower overall liking score (5.6 or 'like slightly') of steamed sweetpotatoes from this variety compared to the others. Also, NASPOT 8 had

the highest percentage of consumers scoring JAR for colour, sweetness and firmness. This could explain it having the highest overall liking (score of 7.5) that was significantly different from the others. NASPOT 8 is an improved variety with dry texture, moderate sweetness and high dry matter content (Mwanga et al., 2021). More so, this was verified during Activity 4 with the processors where NASPOT 8 dry matter content was 37.15%. Overall, its sensory attributes were akin to those of the preferred local varieties. All the four steamed samples have been judged "Not mealy enough" by 42 to 60% of consumers.

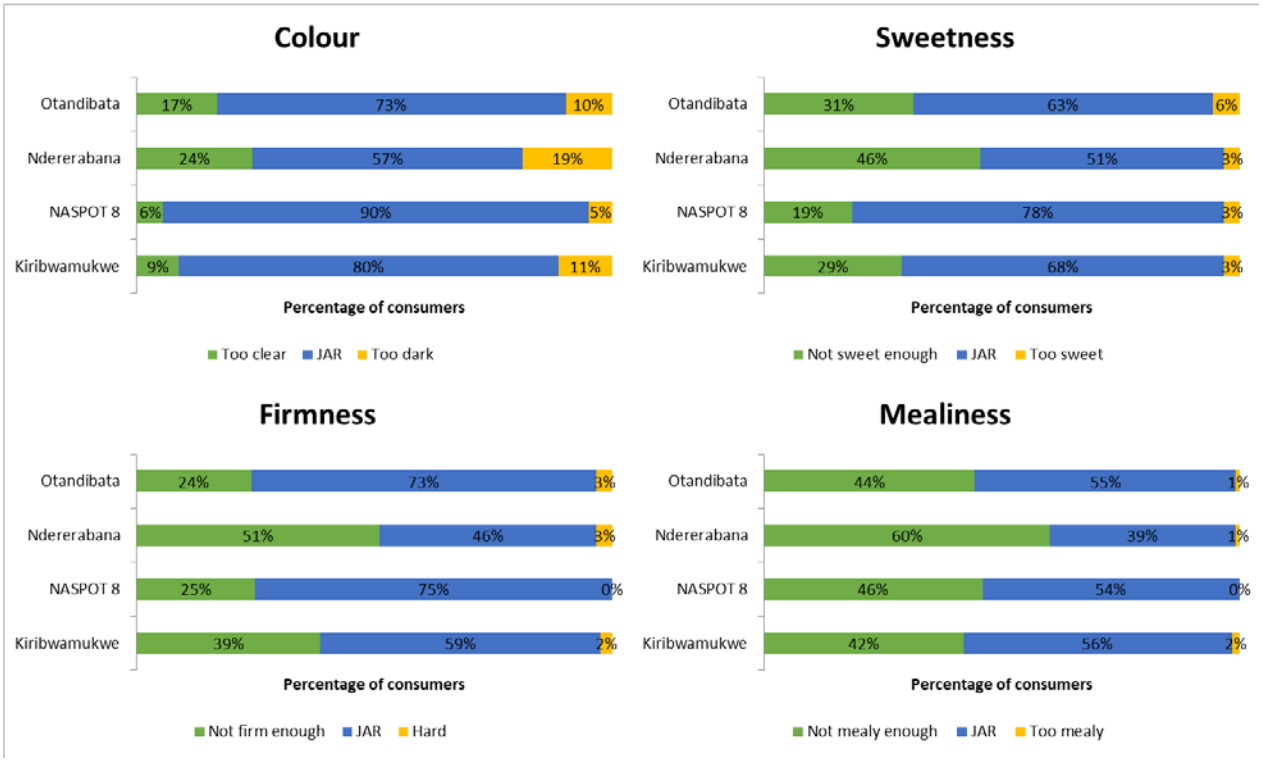


Figure 9: Percentage of consumers who scored the four specific quality characteristics (colour, sweetness, firmness, mealiness) using a 3-point JAR test– Kamwenge

According to **Figure 10**, all boiled sweetpotatoes from Lira varieties were rated JAR by at least 50% of the consumers for colour, sweetness, firmness and mealiness. The only exception was Okonynedo which was rated JAR for mealiness by 42% of consumers. As such, 54% of consumers indicated that Okonynedo was "not mealy enough". NASPOT 8 was scored JAR by 78%, 59%, 75% and 63% of consumers for colour, sweetness, firmness and mealiness, respectively, Arakaraka was given a JAR score by 74%, 60%, 68% and 64% of consumers for these characteristics, respectively. Otada had 64%, 69%, 56% and 50% while Okonynedo was JAR by 60%, 61%, 58% and the aforementioned 42% of consumers for colour, sweetness, firmness and mealiness respectively. A relatively lower percentage of consumers found the sweetness of NASPOT 8 and the firmness of Otada just about right 59% and 56% of consumers, respectively compared to the boiled sweetpotatoes from the other varieties. In terms of colour and sweetness, it was Okonynedo (60%) and NASPOT 8 (59%) respectively with relatively lower percentage of consumers rating them JAR. All the four boiled samples have been judged "Not sweet enough", "Not firm enough" and "Not mealy enough" by 22-41%, 24-38% and 34-54% of consumers. The boiled sweetpotatoes from Lira varieties were balanced in terms of the JAR and Not-JAR characteristics and this could explain their overall liking not being significantly different, with a score close to 7 (like moderately).

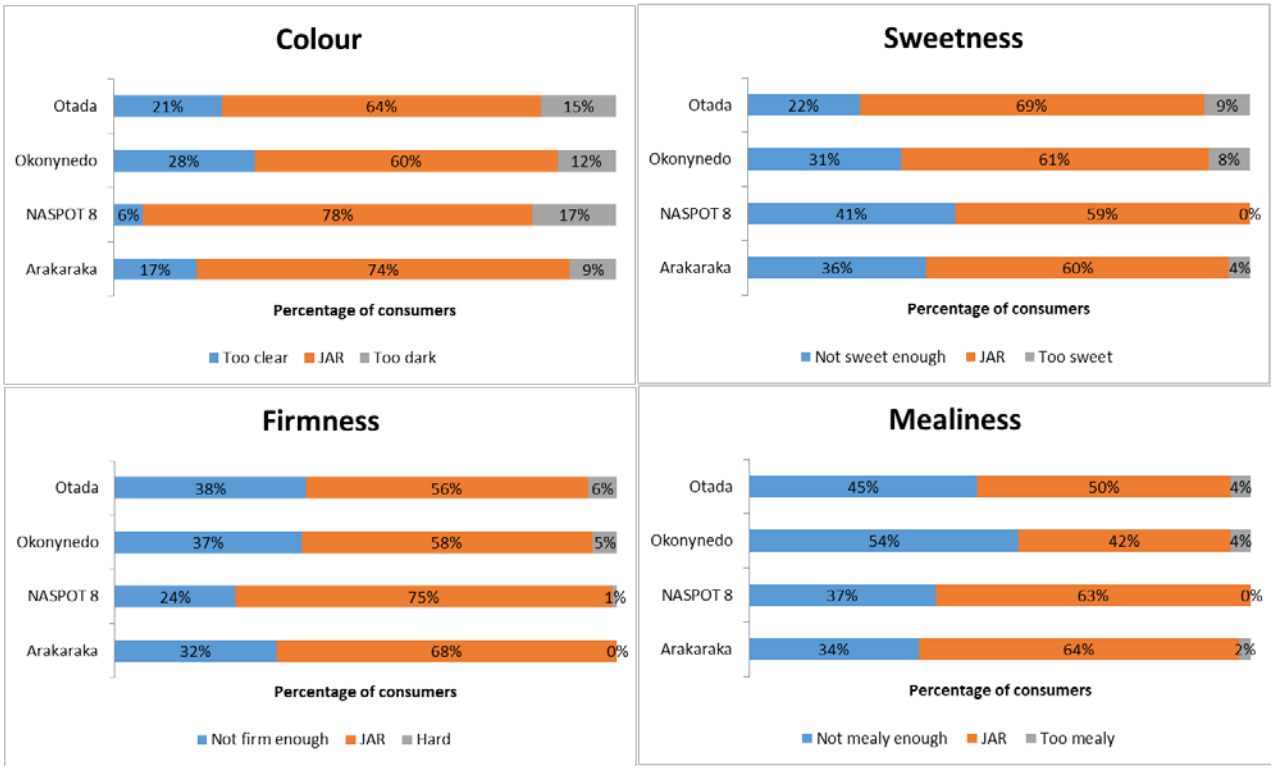


Figure 10: Percentage of consumers who scored the four specific quality characteristics (colour, sweetness, firmness, mealiness) using a 3-point JAR test– Lira

3.4 Check All That Apply (CATA) test

The objective of the CATA test was to show the relationships between overall liking scores for each steamed/boiled sweetpotato 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 sensory characteristics that best described each steamed/boiled sweetpotato samples.

Tables 9 and **10** show the count for the most cited sensory characteristics, which were indicative of the best description of the steamed and boiled sweetpotato products. Regarding steamed sweetpotatoes from Kamwenge varieties (**Table 9**), those were 'smooth', 'sweet' and 'good sweetpotato smell' with citation count between 300 and 400, followed by 'attractive', 'firm', 'mealy'', 'non-homogenous colour' and 'white' between 200 and 300. The descriptors with least citation were 'bad aftertaste', 'hard', 'blackish' and 'tasteless'. Kiribwamukwe was described as 'good sweetpotato smell' and white (94 citations each), 'sweet' and 'smooth' (both 76), 'firm' (74), 'attractive' (73) and 'mealy' (72). NASPOT 8 was described as 'attractive' (104 citations), 'good sweetpotato smell' (93), 'sweet' (92), 'smooth' (90), 'yellow' (78), 'vitamins' (73) and 'firm' (71). Otandibata's descriptors were 'white' (100 citations), 'good sweetpotato smell' (95), 'sweet' (85), 'firm' (75), 'mealy' (72) and 'smooth' (71). Ndererabana was described as 'white' (85 citations), 'smooth' (81) and 'good sweetpotato smell' (77). For some consumers (between 40 and 60 citations), that variety is described as 'Sticky between fingers', 'too soft', 'not sweet enough', 'watery', and with a 'non-homogeneous colour'. That could explain JAR results ('not mealy enough', 'not firm enough'), the cluster C1 with some Ndererabana dislikers (35% of consumers) and a medium overall liking (score of 5.6). Therefore, all steamed sweetpotato products were described as 'good sweetpotato smell' and 'smooth'.

Table 9: Frequency of citations of each quality characteristic by all the consumers of steamed sweetpotato - Kamwenge

Quality characteristics/Varieties	Kiribwamukwe	NASPOT 8	Ndererabana	Otandibata	Total
Attractive	73	104	54	55	286
Bad after taste	5	3	3	4	15
Blackish	14	0	13	12	39
Dry	50	37	33	43	163
Fibrous	26	21	17	28	92
Firm	74	71	50	75	270
Good sweetpotato smell	94	93	77	95	359
Hard	4	3	5	7	19
Mealy	72	55	54	72	253
No smell	19	25	36	22	102
Non homogeneous colour	56	38	59	51	204
Non uniform texture	20	16	26	27	89
Not sweet enough	36	26	43	30	135
Orange	0	52	3	0	55
Smooth	76	90	81	71	318
Sticky between finger	38	34	40	32	144
Sweet	76	92	68	85	321
Tasteless	7	0	20	6	33
Thick	39	25	32	40	136
Too soft	20	16	42	11	89
Vitamins	21	73	21	34	149
Watery	24	18	46	22	110
White	94	11	85	100	290
Yellow	10	78	7	6	101
Mean overall liking	6.7	7.5	5.6	6.5	

According to **Table 10**, the most cited descriptors for boiled sweetpotatoes from Lira were ‘good sweetpotato smell’ and ‘smooth’ with counts between 300 and 400. These were followed by ‘attractive’, ‘sweet’, ‘firm’, ‘mealy’ and ‘white’ between 200 and 300. Those with the lowest frequency of citation were ‘tasteless’, ‘bad aftertaste’, ‘hard’ and ‘blackish’. Similar to Kamwenge varieties, boiled sweetpotatoes from the Lira varieties all had ‘good sweetpotato smell’, and ‘smooth’ as the most cited descriptors among consumers. Arakaraka was cited as being ‘white’ (99), ‘attractive’ (89), ‘good sweetpotato smell’ (87), ‘mealy’ (79), ‘smooth’ (76), ‘firm’ (74) and sweet (70). NASPOT 8 was described by ‘smooth’ and ‘firm’ (both 83 citations), ‘attractive’ (82) and good sweetpotato smell (81). Okonynedo was described as ‘smooth’ (80), ‘sweet’ (77) and ‘good sweetpotato smell’ (75). Otada had the same frequently cited descriptors as Okonynedo albeit with different number of citations.

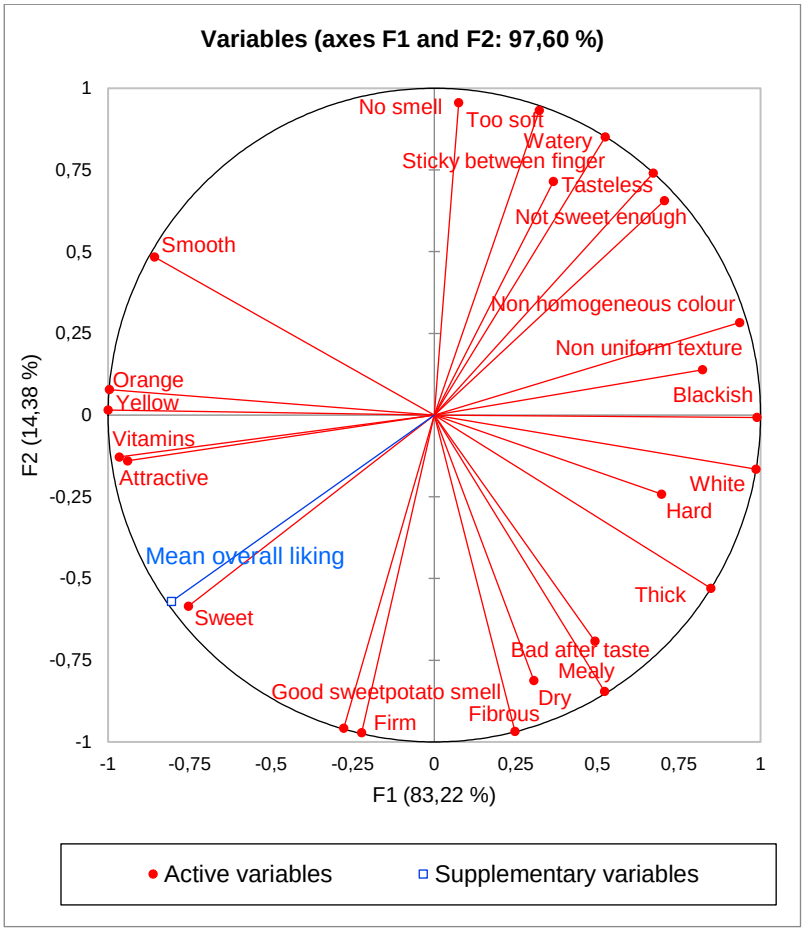
Table 10: Frequency of citations of each quality characteristic by all the consumers of boiled sweetpotato - Lira

Quality characteristics/Varieties	Arakaraka	NASPOT 8	Okonynedo	Otada	Total
Attractive	89	82	57	65	293
Bad after taste	8	8	13	11	40
Blackish	6	5	16	21	48
Dry	54	41	33	28	156
Fibrous	6	28	11	29	74
Firm	74	83	62	66	285
Good sweetpotato smell	87	81	75	81	324
Hard	13	8	10	15	46
Mealy	79	66	49	54	248
No smell	20	9	22	18	69
Non homogeneous colour	23	39	44	38	144
Non uniform texture	11	9	18	17	55
Not sweet enough	31	43	33	24	131
Orange	2	66	0	0	68
Smooth	76	83	80	81	320
Sticky between finger	43	37	43	52	175
Sweet	70	61	77	83	291
Tasteless	12	4	8	6	30
Thick	49	38	32	34	153
Too soft	19	13	33	26	91
Vitamins	23	65	20	35	143
Watery	19	17	31	34	101
White	99	7	68	61	235
Yellow	5	63	43	48	159
Mean overall liking	6.8	7.0	6.5	6.7	

3.5 Sensory mapping of the sensory characteristics

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

For steamed sweetpotatoes from Kamwenge, the PCA plot explained 97.6% of sensory characteristic variance (F1 83.22% and F2 14.38%). Most of the variance was explained by the first axis (**Figure 11**). A positive mean overall liking was associated with ‘yellow’, ‘orange’, ‘vitamins’, ‘attractive’, ‘smooth’ and ‘sweet’. These sensory characteristics are related to the steamed sample made from the improved variety NASPOT 8.



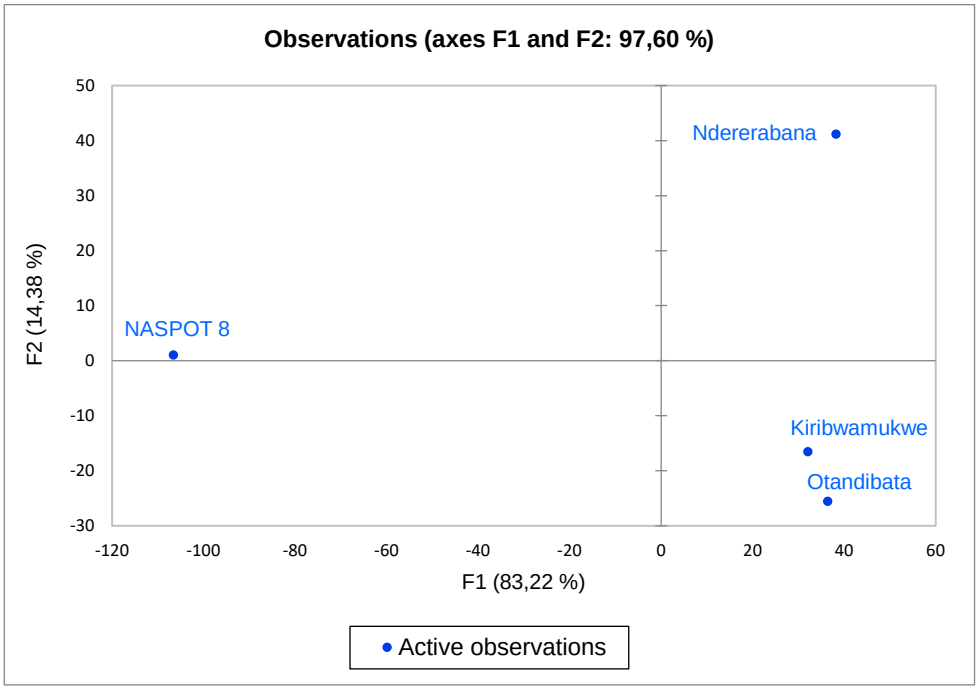


Figure 11: Mapping of the sensory characteristics and the overall liking of the steamed sweetpotatoes – Kamwenge.

Kiribwamukwe and Otandibata were associated with 'blackish', 'white', 'non-homogeneous colour', 'thick', non-uniform texture, 'not sweet enough' and 'hard'. Steamed sweetpotatoes from the slightly liked Ndererabana were associated with 'Too soft', 'Watery', 'No smell', 'Tasteless', and 'sticky between fingers'.

For boiled sweetpotatoes from Lira varieties (**Figure 12**), the PCA plot explained 96.61% of sensory characteristic variance (F1 70.86% and F2 25.75%). Most of the variance was explained by the first axis. The sensory characteristics such as 'orange', 'vitamins', 'smooth', 'yellow', 'not sweet enough' and 'fibrous' were associated with NASPOT 8. Arakaraka was associated with 'white', 'no smell' and 'tasteless'. Otada and Okonynedo were associated with 'watery', 'blackish', 'bad aftertaste', 'non-uniform texture', 'non homogeneous colour', 'too soft' and 'sweet'.

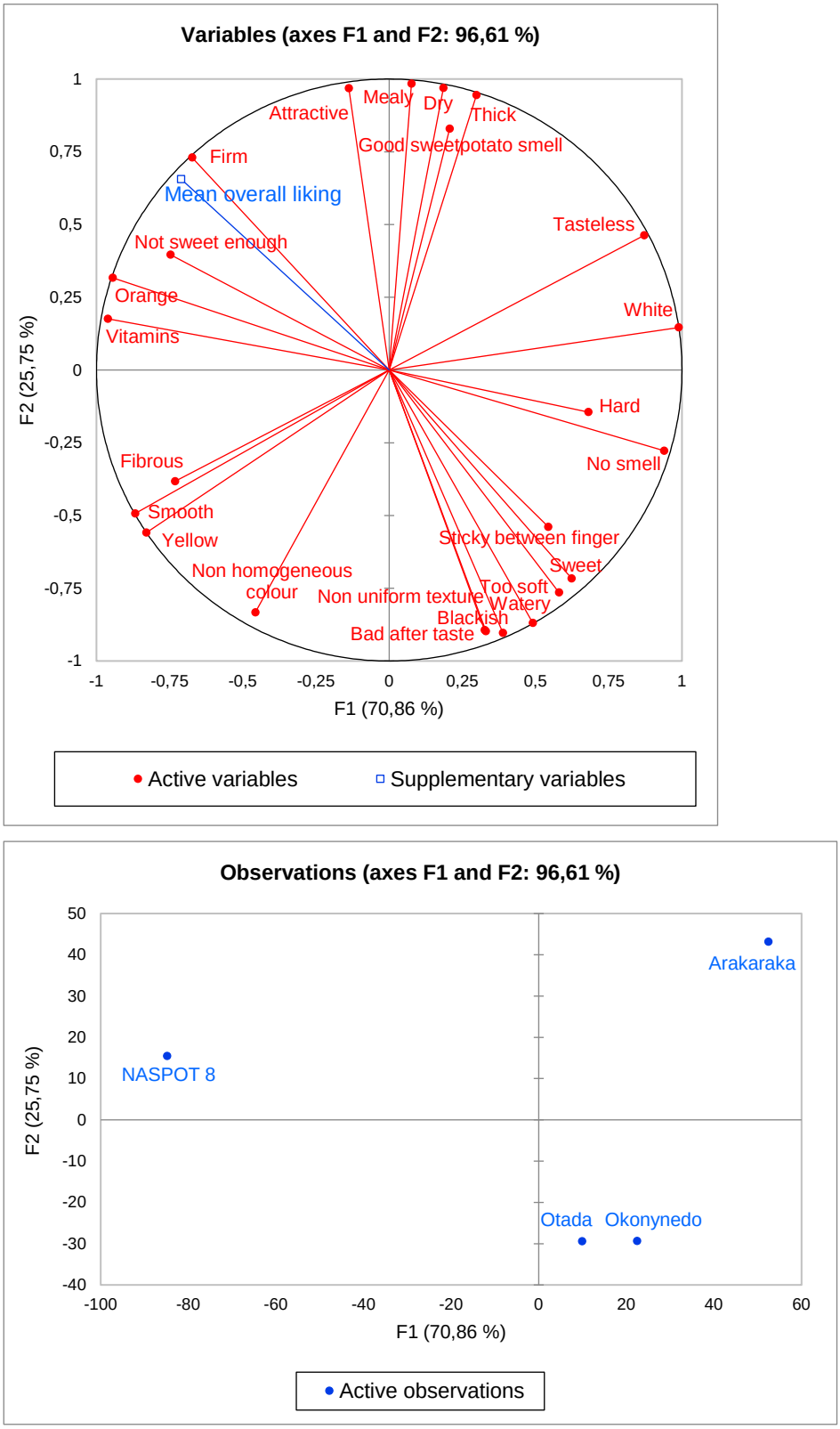


Figure 12: Mapping of the sensory characteristics and the overall liking of the boiled sweetpotatoes – Lira.

4 DISCUSSION

Of the steamed sweetpotatoes made from Kamwenge varieties, NASPOT 8 was the most liked in terms of mean overall liking and was significantly different from the others. NASPOT 8 is an orange-fleshed improved variety that has many similar or even better characteristics than local varieties. This observation was corroborated in the JAR test results that show that a high percentage of consumers found NASPOT 8 JAR in terms of colour, sweetness and firmness. Kiribwamukwe and Otandibata had moderate overall liking scores. On the other hand, Ndererabana had a slightly lower overall liking (score of 5.6, 'like slightly') and this stemmed from more than 50% of consumers indicating that it was neither firm nor mealy enough.

The overall liking of boiled sweetpotatoes from Lira varieties did not vary significantly and was above 5 (='neither like nor dislike'). This means that all the varieties were acceptable to the consumers.

Regarding consumer segmentation, there were three distinct groups from the consumers of steamed sweetpotatoes from Kamwenge varieties namely; 'Ndererabana dislikers' (35%), 'All likers' (50%) and 'Kiribwamukwe dislikers' (15%). Although most categories of consumers belonged to the 'All likers' cluster, there were some exceptions. There was similarity of liking among the 36-45 year consumers, which included the Kamwenge rural dwellers, the Banyankore and Batagwenda ethnic groups, farmers and the moderately wealthy consumers who were more numerous in the 'Ndererabana dislikers' group. Ndererabana could have been disliked by some consumers (35%) because it was described as being 'watery', 'too soft', 'no smell', 'tasteless', 'sticky between fingers' and also 'not sweet enough'. Kiribwamukwe was probably disliked by some consumers (15%) because it was described as being 'blackish', with 'non-homogenous colour', 'non-homogeneous texture', 'not sweet enough' and 'hard'.

The consumers of boiled sweetpotato from Lira varieties were also clustered into three groups namely, 'Otada dislikers' (23%), 'All likers' (61%), 'Arakaraka dislikers' (16%). As in Kamwenge, consumers were mostly 'All likers'. The youth age group 18-35 were 'All likers' while the 36-45 were specifically 'Otada dislikers'. There was a significant difference between consumers in Lira town and Kampala city. Lira had more consumers among 'Arakaraka dislikers'. Dislike for Arakaraka could have been because some consumers described it as 'Tasteless' with 'no smell'. Most consumers who indicated their occupation as farmers were largely Otada dislikers. Otada could have been disliked because of 'bad aftertaste', 'blackish', 'non-homogeneous colour', 'too soft', 'watery', with a 'non-uniform texture'. Therefore, in some cases, consumers in different locations and socio-demographics showed significantly different overall liking scores within the different clusters.

Consumption attitudes were similar across consumers of the steamed/boiled sweetpotato from Kamwenge and Lira regions. All respondents reported consuming steamed/boiled sweetpotato several times a week while serving with other sauce mostly during lunch time. This shows that steamed/boiled sweetpotato is very important to the diets of consumers in Uganda, and greatly contribute to food and nutrition security.

Within the context of sensory mapping, the PCA plot for steamed sweetpotatoes from Kamwenge varieties showed that a positive overall liking on average was associated with characteristics such as 'sweet', 'smooth', 'attractive', 'yellow', 'orange' and 'vitamins'. These were linked to NASPOT 8 which also had the highest overall liking. On the opposite end, Ndererabana (score of 5.6, 'like slightly' was described as 'Too soft', 'Watery', 'No smell', 'Tasteless', 'sticky between fingers' and also 'not sweet enough'. Regarding the PCA plot for Lira varieties, the sensory characteristics such as 'orange', 'vitamins', 'smooth', 'yellow', 'not sweet enough' and 'fibrous' were associated with NASPOT 8. Arakaraka was associated with 'white', 'no smell' and 'tasteless'. Otada and Okonynedo were associated with 'watery', 'blackish', 'bad aftertaste', 'non-uniform texture', 'non-homogeneous colour', 'too soft' and 'sweet'.

5 CONCLUSION

In conclusion, NASPOT 8 had the best overall liking among consumers of steamed/boiled sweetpotatoes tested at different locations and could be used for benchmarking by breeders in developing new varieties. Published studies have shown that yellow or orange colour of biofortified roots (sweetpotato, cassava) was not a hindrance to consumer acceptability in sub-Saharan Africa (Bechoff et al. 2018, Talsma et al. 2013, Tomlins et al. 2012). NASPOT 8 is an example of breeding success because it is highly acceptable and also nutritious (containing provitamin A in link with its yellow-orange colour) as this was also shown in Activity 4 (Mwanga *et al*, 2021). The characteristics identified include 'Too soft', 'Watery', 'No smell', 'Tasteless', 'Not sweet enough', 'sticky between fingers' were linked with the less liked local variety Ndererabana.

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