Field Scientific Report

Consumer Testing of Matooke 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

Kampala, Uganda, December 2021

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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

This report presents results of a consumer testing study whose aim was to understand the consumers' demand for quality characteristics of steamed matooke bananas in Uganda. The activity was conducted in rural and urban locations in two major bananas growing and consuming regions of Uganda, being Mbarara and Nakaseke districts.

Four matooke varieties per site, with different quality characteristics, were processed into steamed matooke products and presented to a large number of consumers. In Mbarara district, two local varieties Nakitembe and Kibuzi, and two hybrids NARITA 2 and M30 were tested by 132 consumers. In Nakaseke, two local varieties Mpologoma and Nakitembe, and two hybrids NARITA 21 and M30 were tested by 124 consumers. The consumers evaluated the products using a hedonic test, a just-about-right (JAR) test, and a check-all-that-apply (CATA) test.

The results showed that the consumers perceived differently the matooke products made from the four varieties. Consumers in Mbarara liked matooke made from the local varieties Kibuzi and Nakitembe, and gave a mean overall liking score of 7.6 ('like very much') and 7.3 ('like moderately'), respectively. Matooke made from hybrids NARITA 2 and M30 got a mean overall liking score of 4.7 ('neither like nor dislike') and 5.9 ('like slightly'), respectively**.** NARITA 2 was found "too light" in colour, "not soft enough" and "rough" in the mouth by 40.5%, 64.9% and 70.2% of consumers, respectively. In Nakaseke, the most liked matooke were from varieties Mpologoma and hybrid M30 with a mean overall liking score of 8.2 and 7.9 (both close to 8, 'like very much') respectively. The least liked were the matooke hybrid NARITA 21 with a mean overall liking score of 2.1('dislike very much'). Nakitembe, a local variety, got an overall liking score of 6.2 ('like slightly'). Consumers considered the matooke hybrid NARITA 21 as 'too dark' (88.3% of people), 'too soft' (40.3% of people) and 'too rough' (53.3% of people). Whatever the region, the high-quality characteristics associated to the most liked matooke samples were the followings: an attractive appearance "appealing" with a "deep yellow" colour, a "nice smell", "does not harden quickly" and "moldable" in the hand, with a "good matooke taste" and a "mild sugary taste", "soft", "smooth", with a "uniform/even texture" in the mouth, and "easy to digest".

The poor-quality characteristics associated to the least liked matooke samples were: "pale yellow", "blackish", "browish", or a "mixed colour", "no smell", with a "flat taste", "sap like taste", "has particles/grainy texture", "not compact", "watery" "or hard".

Key Words: matooke, overall acceptance, Check-all-that-applies, Just-About-Right, consumer testing, sensory attributes

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 steamed matooke bananas in Uganda.

Another aim is to provide WP2 with a clear and visual mapping of the most liked products associated with high quality characteristics, high overall liking scores and of the least liked products associated with low quality characteristics and low overall liking scores. The activity was conducted in two regions by inviting a large number of consumers to test steamed matooke prepared from four different matooke banana varieties named below.

2 METHODOLOGY

2.1 Sampling

The four steamed matooke products made by the processors from matooke banana varieties with different quality characteristics during the Activity 4 Processing diagnosis (Marimo et al., 2020), were tested by consumers from two regions in Uganda namely; western region represented by Mbarara district and central region represented by Nakaseke district. In Mbarara, consumer testing was conducted at four locations which included two rural villages namely Mugarustya and Kashaka, a small town – Nyeihanga, and one big city –Kiswahili. In Nakaseke, the testing was conducted at three sites; Nakaseke and Kiwoko representing rural villages and one small town – Kasana. A total of 256 consumers were randomly recruited from different villages surrounding the testing location. Of the consumers, 141 were women and 115 were men (Table 1). Varieties used in Nakaseke included NARITA 21, Nakitembe, M30 and Mpologoma while in Mbarara district, they were NARITA 2, M30, Nakitembe and Kibuzi.

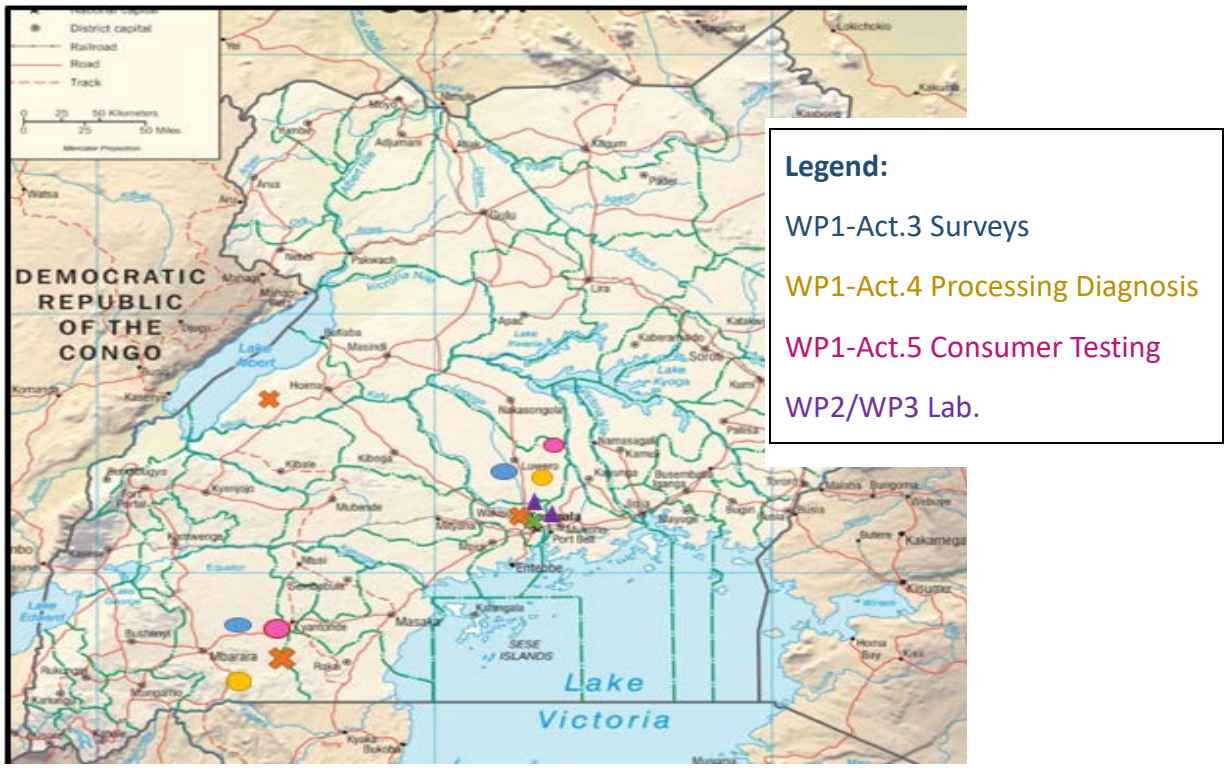


Figure 1: Locations and regions for Work package 1, Activity 5 and other WP1 activities

Table 1: Number of Consumers interviewed in the rural and Urban areas of the two regions

	Total	Mbarara					Nakaseke		
		Kashaka	Kiswahiri	Mugurusya	Nyeihanga	Rwengyenyi	Kasana	Kiwoko	Nakaseke
Number of Consumers	256	31	34	23	33	11	56	40	28
Women	141	12	21	7	17	7	44	25	8
Men	115	19	13	16	16	4	12	15	20

Note: The village mentioned in this table is where the testing sessions were held. Participants were sampled from many neighbouring villages that are not listed.

2.2 The matooke sample preparation and consumer testing

In brief, green mature cooking bananas were harvested, peeled, wrapped in banana leaves, steamed under same cooking conditions (Marimo et al., 2020) and mashed (Fig.2). All the 4 varieties were steamed in one big saucepan as separate bundles marked with distinct colour strings to ease identification.

The samples were coded with different digits and small portions served at warm temperatures to the consumers to evaluate.

Figure 2: The different steps of banana processing into steamed Matooke from peeling up to the Tasting of samples

The evaluation methods used by each consumer included a hedonic test, a Just-About-Right (JAR) test, and a Check-All-That-Apply (CATA) test. Consumers (n = 256) from different locations in rural and urban areas were asked individually to look/touch/smell/taste each matooke sample. The samples were presented one after the other, in a 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 colour, softness and mouthfeel of the matooke products, 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 matooke samples. The three characteristics were identified as important in steamed matooke in the previous Activities 3 & 4. Consumers were then asked to select the quality characteristics that better describe each matooke sample, among a list of 26 sensory characteristics -the most liked and the least liked collected during the previous Activities 3 & 4 (Table 2) using a “Check-All-That-Apply” (CATA) approach. Finally, consumers were invited to give their opinion and preferences on the matooke samples.

Table 2 presents 13 liked and 13 disliked characteristics generated from Activities 3 and 4. All the characteristics presented in the tables are arranged beginning from the most liked and most disliked respectively.

Table 2: Liked and disliked characteristics of Matooke from activity 3

Liked characteristics	Soft texture
	Good smell
	Yellow colour
	Good matooke taste
	Holds together when mashed (compact)
	Elastic/starchy
	Uniform/homogenous texture
	Smooth mouthfeel
	Does not separate/break when served
	Not sticky
	Homogenous colour
	Does not harden quickly
	Satisfying
Disliked characteristics	Hard
	Watery
	White colour
	Separates easily/ not compact
	Poor/flat taste
	No steamed banana smell
	Blackish colour
	Non-homogenous
	Not yellow in colour
	Non-homogenous texture
	Brownish colour
	Cools fast after serving
	With thread like materials

Source; **Akankwasa K et al., (2020)**

2.3 Data analysis

Analysis of variance (one way ANOVA) was carried out to identify any significant differences in overall liking scores between the four matooke banana varieties as tested by the consumers from two regions (Table 1). Multiple pairwise comparisons were applied using the Tukey test, with a

confidence interval of 95% at p < 0.05 (n=370 consumers). An Agglomerative Hierarchical Clustering (AHC) analysis was used to organize consumers into similar groups of overall liking (clusters). A Chi-square test was carried out to identify significant sociodemographic differences between the clusters. For each sample, the number of consumers who judged each specific characteristic either 'Just-About-Right' (JAR), 'too weak' or 'too strong' was counted. A Principal Component Analysis (PCA) was conducted on the count of citations for all the CATA quality characteristics, with matooke 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 matooke samples

In Mbarara, the overall liking of steamed matooke samples significantly differed between the four varieties at a significant level of p<0.05 (one-way ANOVA) (Table 3). The most liked were the matooke prepared from Kibuzi and Nakitembe with a mean overall liking score of 7.7 (close to 8 or like very much) and 7.3 (close to 7 or like moderately) respectively. There were no significant differences in the average scores for Nakitembe and Kibuzi. The matooke hybrid NARITA 2 got the lower mean overall liking score of 4.7 (close to 5 or neither like nor dislike). M30 with a mean score of 5.9 (like moderately) can be considered as an intermediate product among the four samples.

Table 3: Overall liking of the steamed Matooke in Mbarara

Steamed matooke samples	Mean Overall liking scores* (n = 132 consumers)	Groups**		
NARITA 2	4.7	A		
M30	5.9		B	
Nakitembe	7.3			C
Kibuzi	7.7			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).*

In Nakaseke, the overall liking of steamed matooke samples significantly differed between the four varieties at a significant level of p<0.05 (one-way ANOVA) (Table 4). The most liked matooke were obtained from the variety Mpologoma and the matooke hybrid M30 with a mean overall liking score of 8.2 and 7.9 (both close to 8 or like very much) respectively. There were no significant differences between the average scores for M30 and Mpologoma. The least liked matooke sample was the matooke hybrid NARITA 21 with a mean overall liking score of 2.1 (dislike very much). Nakitembe obtained an overall mean score of 6.2 (like slightly).

Table 4: Overall liking of the steamed Matooke in Nakaseke

Steamed matooke samples	Mean Overall liking scores* (n = 124 consumers)	Groups**		
NARITA 21	2.1	A		
Nakitembe	6.2		B	
M30	7.9			C
Mpologoma	8.2			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).

3.2 Segmentation of consumers into groups of similar overall liking

The Matooke consumers were segmented using Agglomerative Hierarchical Clustering (AHC) analysis to create homogeneous clusters of consumers who have similar overall liking scores. The Agglomerative Hierarchical Clustering for Mbarara consumers resulted into three groups of consumers being “All likers” (C1), “Nakitembe & Kibuzi likers” (C2), and “NARITA 2 dislikers” (C3). These three clusters contained 51.5%, 29.5% and 18.9% of all the consumers interviewed in Mbarara respectively (Figures 3a and b).

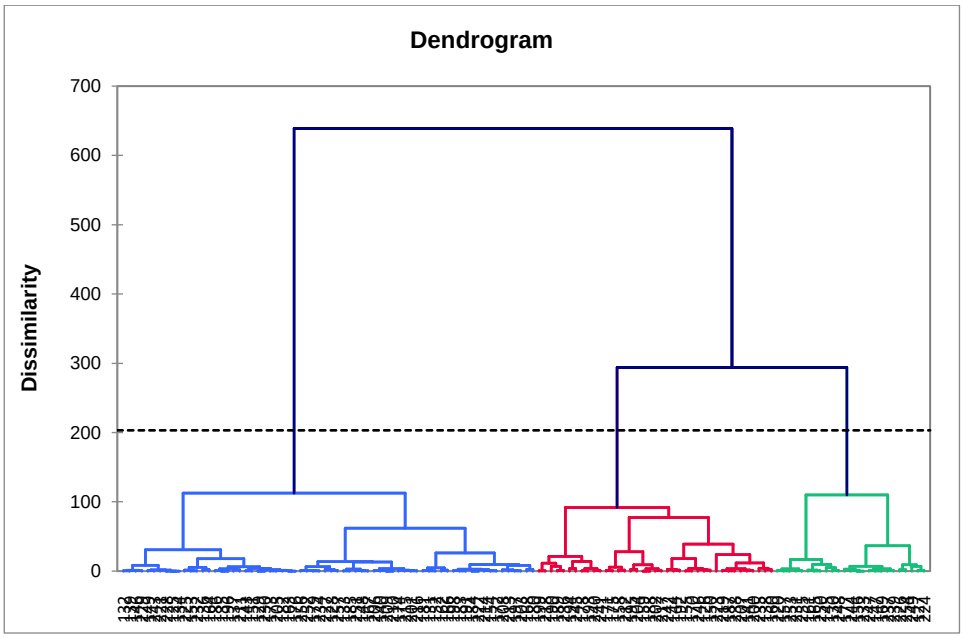


Figure 3a: Clustering of the consumers based on their overall liking scores of the steamed Matooke in Mbarara

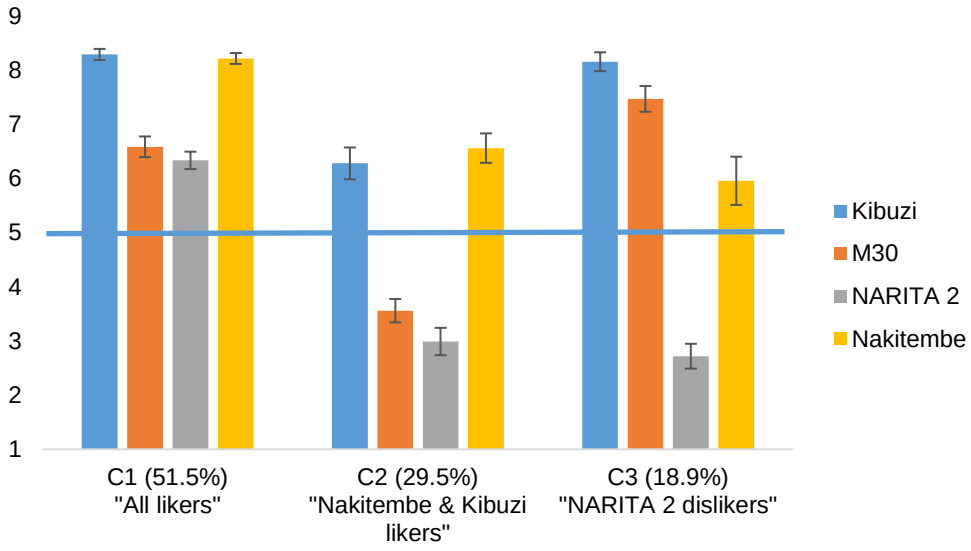


Figure 4b: Mean overall liking of the product samples by consumer cluster type (%) in Mbarara

For Nakaseke, the Agglomerative Hierarchical Clustering also resulted into three groups of consumers being “NARITA 21 dislikers (C1), “Mpologoma & M30 likers” (C2) and “Mpologoma, M30 and Nakitembe likers (C3). These three clusters contained 65.3%, 17.7% and 16.9% of all the consumers interviewed in Nakaseke respectively (Figures 4a and b).

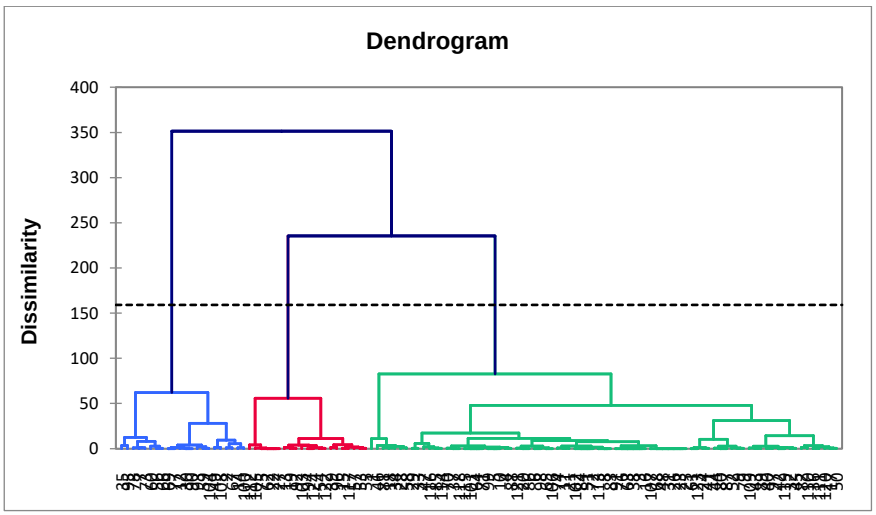


Figure 5a: Clustering of the consumers based on their overall liking scores of the steamed Matooke in Nakaseke

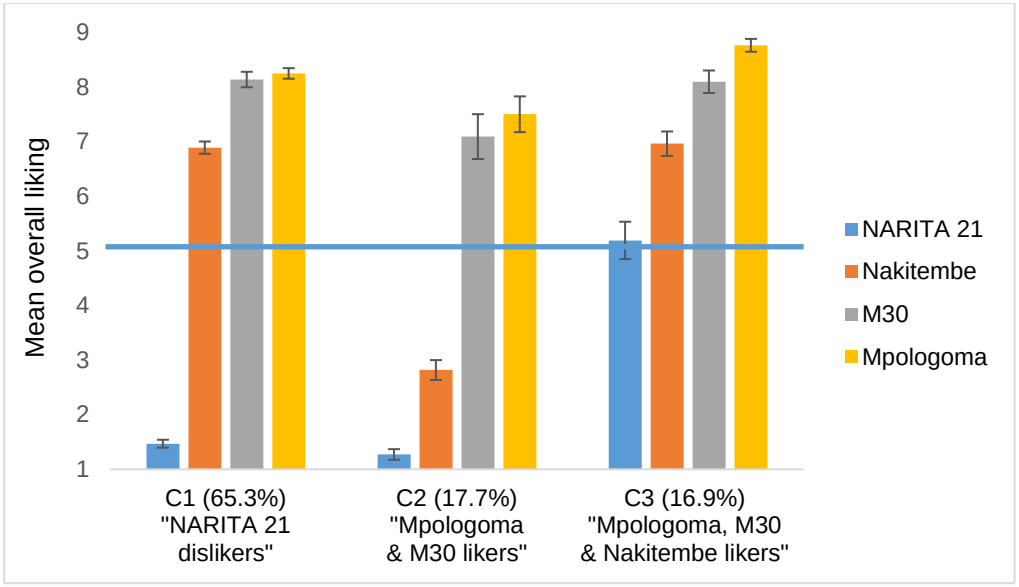


Figure 6b: Mean overall liking of the product samples by consumer cluster type (%) in Nakaseke

3.3 Demographic data of the consumers interviewed

Among the 256 consumers interviewed at both locations, 38% were women and 62% were men with an average age of 45 years old. Over 80% of the respondents had an education of secondary school and above. Out of the 256 consumers, 30.5% were farmers while 41.5% were self-employed and 63% of them were married.

C1 consumers (all likers) were also likers of mainly Kibuzi and Nakitembe, which are known as the best varieties for making matooke. Women are often more critical while making choice on matooke or any other food. In Cluster 1, 53% of the consumers in Mbarara were Banyankore while 60% of the consumers in Cluster 2 were Bakiga. Bakiga are not traditional matooke consumers and are expected to be less critical while judging matooke qualities (Karamura et al.1998). The majority of the consumers (56%) had primary education, most of whom were in Cluster 1. Cluster 3 had the smallest percentage of the none educated consumers. Cluster 3 were also the dislikers of the matooke from hybrid NARITA 2 (Table 5a).

In Mbarara, there were no significant differences between the clusters based on ethnicity, education, employment status, marital status, frequency of consumption and form of consumption. However, there were significant differences by gender at $p<0.1$(Table 5a).

Table 5a: Demographic differences of the consumers with respect to cluster division (Mbarara)

		Total	C1 "All likers"	C2 "Nakitembe & Kibuzi likers"	C3 "NARITA 2 dislikers"	Chi-square test (p)
Consumers	Total	132	68	39	25	
Gender	Female	64	24	23	17	0.060
	Male	68	44	16	8	
Ethnicity	Muganda	7	3	1	3	0.319
	Mukiga	7	1	3	3	
	Munyankole	113	60	35	18	
Age	(average)	35	37	32	37	
Education	None	5	2	2	1	0.281
	Pre primary	1	0	0	1	
	Primary	59	31	14	14	
	Secondary	45	26	14	5	
	Post secondary	21	8	9	4	
Employment status	Farmer	49	28	15	6	0.937
	Full time salary employed	4	2	1	1	
	Part time wage employed	7	5	1	1	
	Self employed - specify	48	21	15	12	
	Other	8	3	3	2	
	Two jobs or more	10	5	3	2	
	Unemployed	6	4	1	1	
Marital status	Single	24	11	9	4	0.63
	Married monogamous	96	51	26	19	
	Married polygamous	1	1	0	0	
	Cohabiting	4	1	3	0	
	Divorced/Separated	6	3	1	2	
	Widowed	1	1	0	0	
Consumption frequency	Every day	89	50	23	16	0.415
	Once a week	2	1	1	0	
	More than once a week	39	15	15	9	
	More than once a month	2	2	0	0	
Form of consumption	Steamed mashed	98	49	29	20	0.56
	Boiled mashed	3	2		1	
	Katogo	14	10	2	2	
	Mpogola	11	5	5	1	
	Eminwe	4	2	2	0	

In Nakaseke, there were no significant differences between the clusters based on any of the socioeconomic factors (Table 5b).

Table 6b: Demographic differences of the consumers with respect to cluster division (Nakaseke)

		Total	C1 "NARITA 21 dislikers"	C2 "Mpologoma & M30 likers"	C3 "Mpologoma, M30 & Nakitembe likers"	Chi-square test (p)
Consumers	Total	124	81	22	21	
Nationality	Ugandan	118	76	21	21	0.804
	Rwandese	5	4	1	0	
	Tanzanian	1	1	0	0	
Gender	Female	77	50	14	13	0.987
	Male	47	31	8	8	
Ethnicity	Muganda	89	60	19	10	0.175
	Mululi	2	1		1	
	Munyankole	9	5		4	
	Munyoro	3	1	1	1	
	Musoga	5	4		1	
	Rwandese	5	4	1		
	Tanzanian	2	1		1	
Age	(average)	33	33	34	33	
Education	None	1	1			0.251
	Pre primary	5	3		2	
	Primary	52	28	11	13	
	Secondary	59	43	10	6	
	Post secondary	7	6	1		
Employment status	Farmer	23	16	4	3	0.845
	Full time salary employed	11	7	2	2	
	Part time wage employed	11	5	3	3	
	Self employed - specify	48	34	7	7	
	Other	13	8	2	3	
	Two jobs or more	9	7	2		
	Unemployed	9	4	2	3	
Marital status	Single	29	20	6	3	0.222
	Married monogamous	62	41	8	13	
	Married polygamous	5	4		1	
	Cohabiting	4	1	3		
	Divorced/Separated	20	13	4	3	
	Widowed	4	2	1	1	
Consumption frequency	Every day	48	31	10	7	0.848
	Once a week	11	7	2	2	
	More than once a week	58	39	8	11	
	Once a month	2	2			
	More than once a month	5	2	2	1	
Form of consumption	Steamed mashed	100	63	19	18	0.607
	Katogo	11	7	3	1	
	Mpogola	7	5		2	

3.4 Consumption attitudes

In the Mbarara district, majority of consumers (67%) interviewed consumed steamed matooke daily, 29% more than once a week, 2% once a week, while 2% consume matooke more than once a month. The most common form of consumption was also steamed and mashed (74%), the second was Katogo (11%), then boiled in peel (Mpogolo) (9%), while 2% consumed boiled whole fingers. In Mbarara, the majority of the consumers in cluster 1 were male (65%), while women were more equally divided into the 3 clusters (Figure 5a).

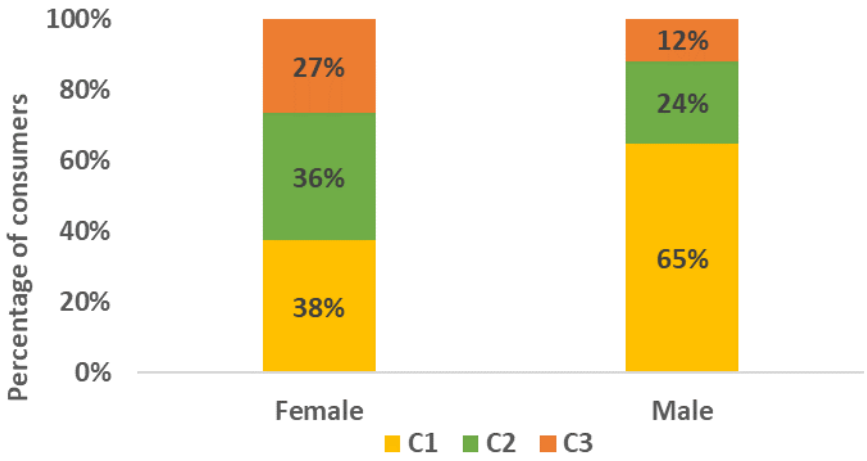


Figure 7a: Percentage of consumer cluster type by gender (Mbarara)

In the Nakaseke district, most of consumers interviewed were used to consuming steamed matooke daily (39%) while 47% are used to consuming steamed matooke several times a week, 2% once a month and 4% several times a month. The most popular form of consumption was steamed and mashed (83%), the second was Katogo (9%), boiled in peel (Mpogolo) was 6% while 3% consumed both steamed and Katogo. In Nakaseke there were equal numbers of male and female in all clusters majority of the consumers in cluster 1 were male (65%), while women were more equally divided into the 3 clusters (Figure 5b).

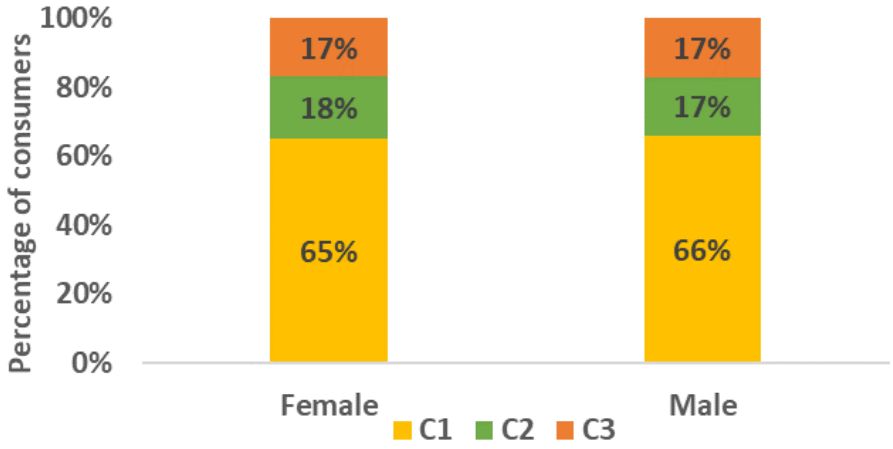


Figure 8b: Percentage of consumer cluster type by gender (Nakaseke)

3.5 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 three important characteristics of matooke, colour, softness and mouthfeel. Such a “descriptors’ diagnostic” may help understand why consumers like or dislike matooke.

Consumers were asked to give their perception of the colour, softness and mouthfeel of each matooke sample by using a 3-point "Just About Right" (JAR) scale (Colour: 'too light', JAR, 'too dark'; Softness: 'not soft enough', JAR, 'too soft'; Mouthfeel: 'too smooth', JAR, 'too rough').

In Mbarara, majority of consumers were satisfied with the three sensory characteristics of Kibuzi and Nakitembe (Figure 6a). Colour was scored JAR by 93.9 and 79.5 % of consumers, respectively. The softness of these 2 varieties was scored JAR by 78.8 and 69.7% of consumers, respectively, and the mouthfeel was also scored JAR by 83.3 and 73.5% of consumers, respectively. The product samples from the matooke hybrids - NARITA 2 and M30 were perceived as "too light" in colour by 40.5% and 42.4% of consumers respectively. NARITA 2 was found "not soft enough" and "too rough" by 64.9% and 70.2% of consumers respectively. However, M30 was found JAR by 50%, 53% and 58.3% of consumers for its colour, its softness and its texture in mouth respectively, and "too light", "not soft enough" and "too rough" by 42.4%, 40.9% and 36.4% of consumers respectively. These results can be explained by the mean overall liking obtained for M30 (close to 6, like moderately) and that only 29.5% of consumers (Cluster 2) disliked it. NARITA 2 was disliked by 48.4% of consumers (Clusters 2 and 3).

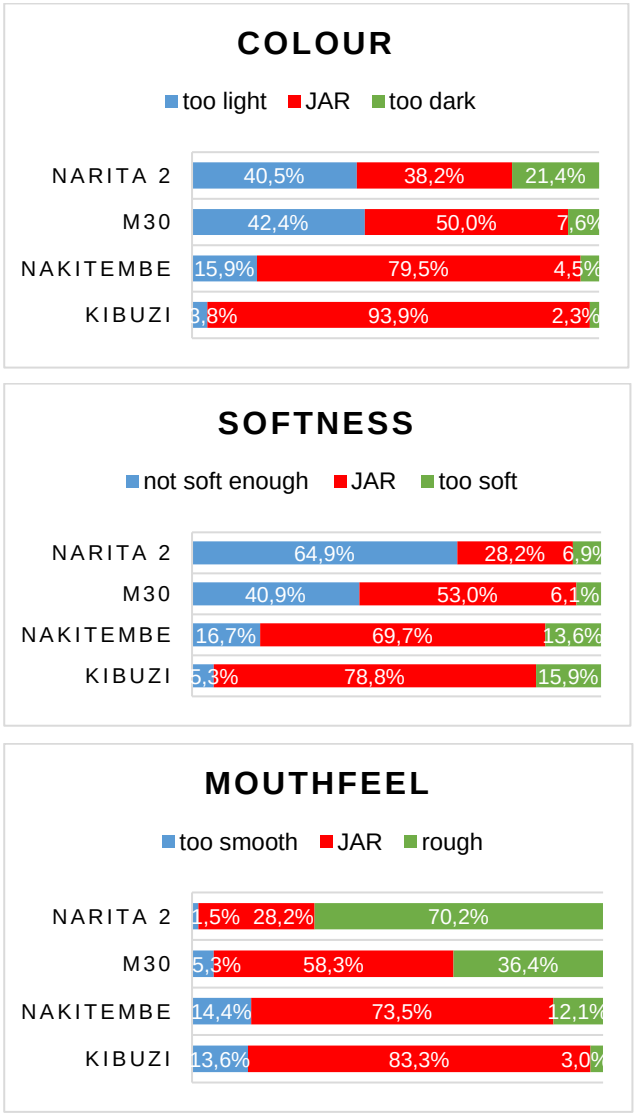


Figure 9a: Percentage of consumers who rated the three specific characteristics in Mbarara district

In Nakaseke district, the majority of consumers were satisfied with the three characteristics of the matooke made from Mpologoma and the hybrid M30 (Figure 6b). The colour was scored JAR by 94.4% and 89.4% of the consumers respectively, the softness was scored JAR by 91.1% and 86.3 % of the consumers respectively, and the texture in the mouth scored also JAR by 91.1% and 90.3%

of consumers respectively. Both of them got a mean overall liking of 8 ('like very much'). Nakitembe, another local variety, was perceived also JAR for the three characteristics, but by a lower percent of consumers: 54.0%, 48.4% and 61.5% of consumers scored JAR its colour, softness and mouthfeel respectively. On the other hand, Nakitembe was judged as 'too light' (40.3%), 'not soft enough' (43.5%), and 'too rough' (28.7% of consumers). This variety had a mean overall liking of 6.2 ('like moderately') and was disliked (mean overall liking lower than 3) by 17.7% of the consumers (Cluster 2).

Consumers considered the matooke hybrid NARITA 21 as 'too dark' (88.3% of people), 'too soft' (40.3% of people) and 'too rough' (53.3% of people). NARITA 21 got the lowest mean overall liking (2.1, dislike very much). Two clusters (C1 and C2) included consumers who disliked it extremely (score of overall liking lower than 1.5 for 83% of consumers), and Cluster 3 included consumers (16.9%) who were neutral towards the product (mean overall liking of 5.2, 'neither like nor dislike').

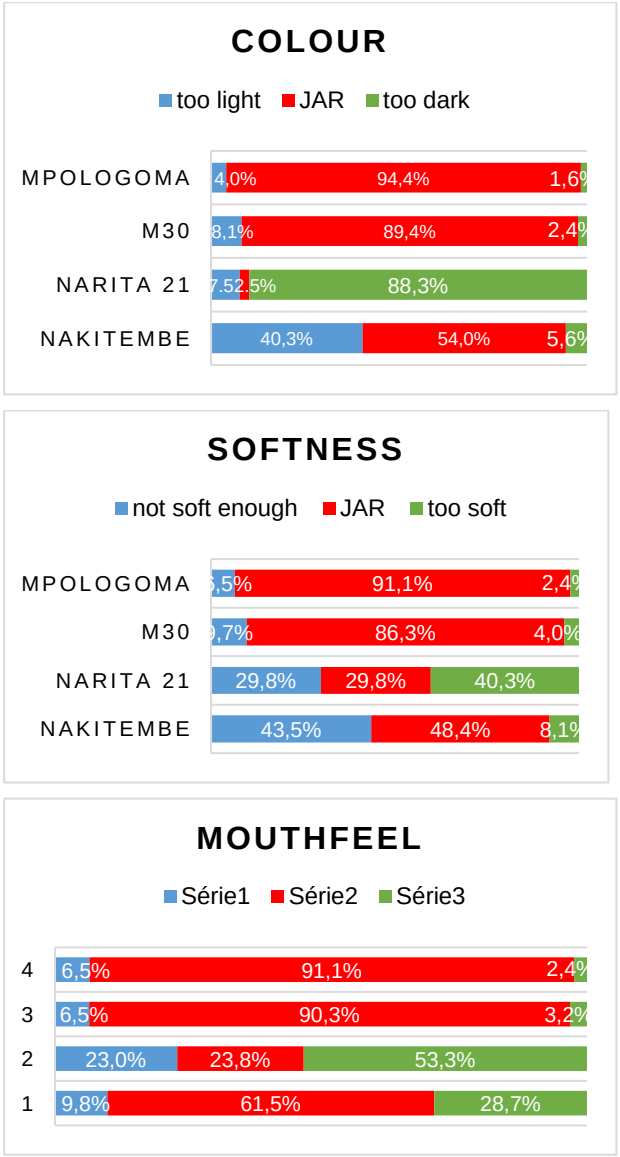


Figure 10b: Percentage of consumers who rated the three specific sensory characteristics in Nakaseke district

3.6 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. After scoring the overall liking and the perception of some specific sensory characteristics, consumers were invited to choose the most appropriate terms among 20-25 sensory

characteristics that better describe each product. The frequency of citations given by consumers to describe each product were calculated.The sensory characteristics most frequently cited by the consumers were considered the best for describing the products. They were the following: “soft” “nice smell”, “smooth mouthfeel”, “mouldable”, “good matooke taste”, “appealing (attractive)” with a frequency of citation (>60% of 131 consumers), followed by “easy to digest” and “sticky between fingers” with a frequency of citation between 50 and 60%. The least used terms were “brownish” and “watery”.

In Mbarara, Matooke from Kibuzi was described as “soft”, “appealing” by 124 consumers (94%) and having “good matooke taste”, “nice smell”, “mouldable”, “smooth mouthfeel” (120 citations), “easy to digest (106 citations), “deep yellow” (101 citations). The NARITA 2 matooke sample was qualified as “has particles/grainy texture” (104 citations), “cools quickly”, “hard” (99 and 96 citations respectively), “not compact” (87 citations), and with a “pale yellow” or “mixed colour” (78 and 76 citations, respectively) (Table 7a).

Table 7a :Count of citations of each quality characteristics by all the consumers in Mbarara (n=132)

Quality characteristic	Kibuzi	Nakitembe	M30	NARITA 2	Total
Mixed colour	16	22	56	76	170
Soft	124	110	65	26	326
Does not harden quickly	94	83	37	13	227
Deep yellow	101	87	21	4	213
Nice smell	120	110	80	56	366
Blackish	6	8	17	40	71
Smooth mouthfeel	120	110	65	29	324
No smell	7	11	32	45	95
Not compact	8	10	65	87	170
Moldable	120	114	64	31	329
Flat taste	6	11	37	43	97
Has particles/grainy texture	16	20	75	104	215
Good matooke taste	120	111	87	60	378
Cools quickly	17	24	75	99	215
Sap like taste (astringent)	4	15	35	53	107
Uniform/even texture	90	93	42	7	232
Brownish	3	6	5	12	26
Easy to digest	106	98	62	24	290
Mild sugary taste	23	10	11	7	51
Watery	12	10	4	5	31
Hard	3	17	54	96	170
Pale yellow	13	25	85	78	201
Sticky between fingers	82	72	68	58	280
Appealing (attractive)	124	110	60	34	328
Mean Overall liking	**7.7**	**7.3**	**5.9**	**4.7**	

In Nakaseke, Matooke from Mpologoma was described as having a “smooth mouthfeel” and “nice smell” by 116 customers (93.5%); “good matooke taste”, “soft” by 114 customers; “mouldable”, “deep yellow” (112 and 109 citations respectively) and “appealing”, with a “uniform texture” (104 and 100 citations). Consumers used the same characteristics to describe M30 with almost the same frequency of citation. NARITA 21 was described as “mixed coloured”, “sticky between fingers” (121 and 100 citations); “a sap like taste” (astringent), “no smell” and “soft” (90 to 87 citations); “brownish”,

"flat taste", and "has particles/grainy texture" (83 to79 citations). Nakitembe was described as "pale yellow" (85 citations, 69%), "sticky between fingers" (81 citations, 65%), "nice smell" with "good matooke taste" (78 citations, 63%), "smooth mouthfeel" (76 citations, 61%) and "soft" (74 citations) (Table 7b).

Table 8b: Count of citations of each quality characteristics by all the consumers in Nakaseke (n=124)

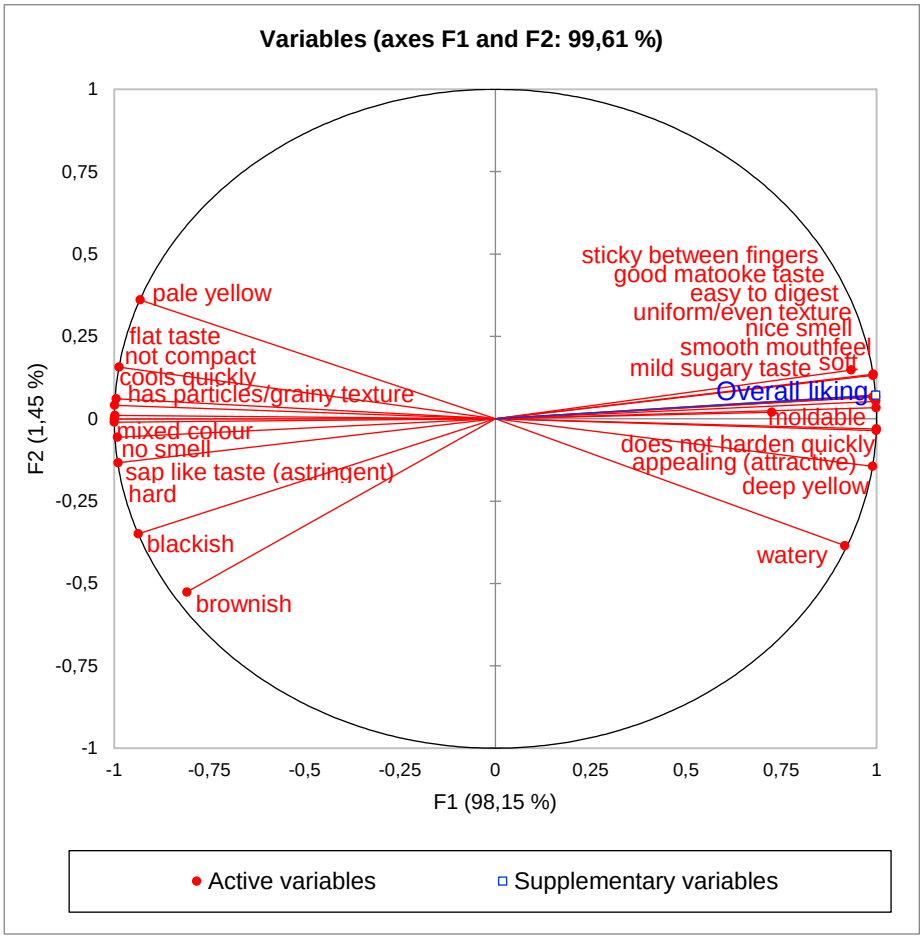
Quality characteristic	Nakitembe	NARITA 21	M30	Mpologoma	Total
Mixed colour	24	121	10	2	157
Soft	74	87	115	114	390
Does not harden quickly	42	54	78	85	259
Deep yellow	18	1	88	109	216
Nice smell	78	7	111	116	312
Blackish	11	35	3	1	50
Smooth mouthfeel	76	40	116	117	349
No smell	31	88	6	7	132
Not compact	50	45	9	4	108
Moldable	64	53	106	112	335
Flat taste	31	82	3	5	121
Has particles/grainy texture	68	79	15	10	172
Good matooke taste	78	11	115	114	318
Cools quickly	74	42	24	18	158
Sap like taste (astringent)	29	90	12	3	134
Uniform/even texture	32	6	90	100	228
Brownish	7	83	4	4	98
Easy to digest	64	29	85	91	269
Mild sugary taste	13	7	14	17	51
Watery	8	45	4	6	63
Hard	33	11	2	0	46
Pale yellow	85	5	20	7	117
Sticky between fingers	81	100	78	82	341
Appealing (attractive)	51	6	102	104	263
Mean Overall liking	**6.2**	**2.1**	**7.9**	**8.2**	

3.7 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.

In Mbarara, the PCA plot explained 99.61% of the variance of the sensory characteristics, the first and second axes accounting for 98.15% and 1.45% respectively. All the variance was explained by the first axis (X). The loading of sensory characteristics on PCA plan (Figure 8a) shows that axis 1 was explained positively by the terms such as "deep yellow", "does not harden quickly", "appealing", "moldable", "mild sugary taste", "soft", "smooth mouthfeel", "nice smell", "uniform/even texture", "easy to digest", "good matooke taste" and "sticky between fingers" related to the most liked Matooke samples (Kibuzi and Nakitembe). Axis 1 was explained negatively by the terms such as "hard", "sap like taste", "no smell", "mixed colour", "has particles/grainy texture", "cools quickly", "not compact", "flat taste" and also "pale yellow", "blackish" and "browish" related to the matooke hybrids M30 and NARITA 2.

A high mean overall liking scored by consumers was related to the high-quality characteristics (here on the right part of the PCA plan) which were associated to the most liked matooke samples Kibuzi and Nakitembe. At the opposite, a lower mean overall liking by the consumers were related to the lower quality characteristics (here on the left part of the PCA plan), which were associated to the matooke hybrids (NARITA 2 and M30 scored 4.7 'neither like nor dislike' and 5.9 'like slightly' respectively).



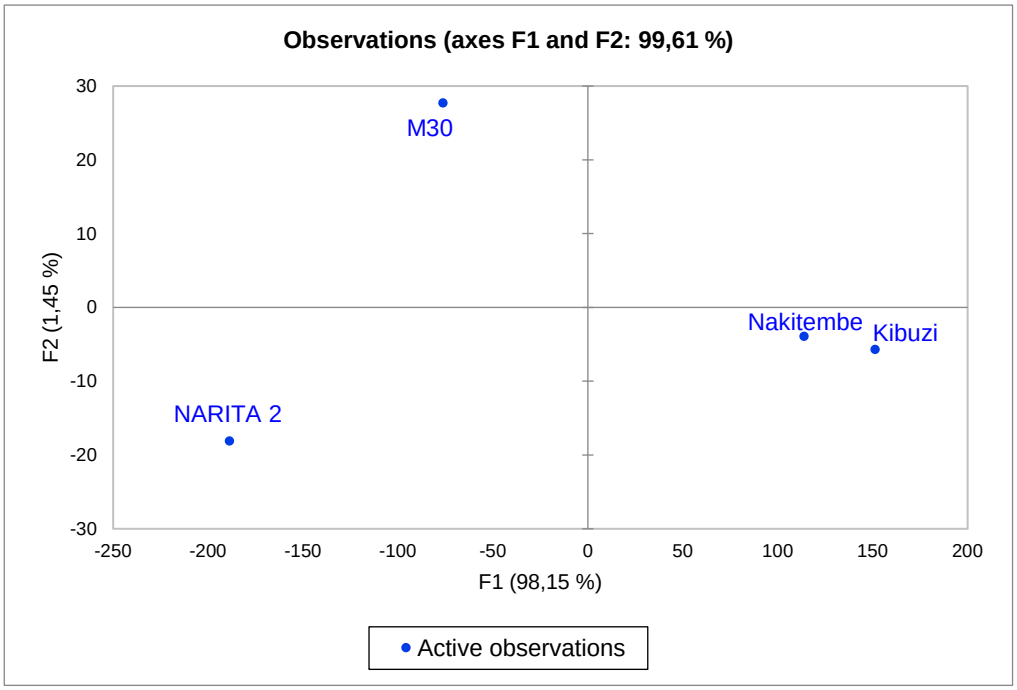
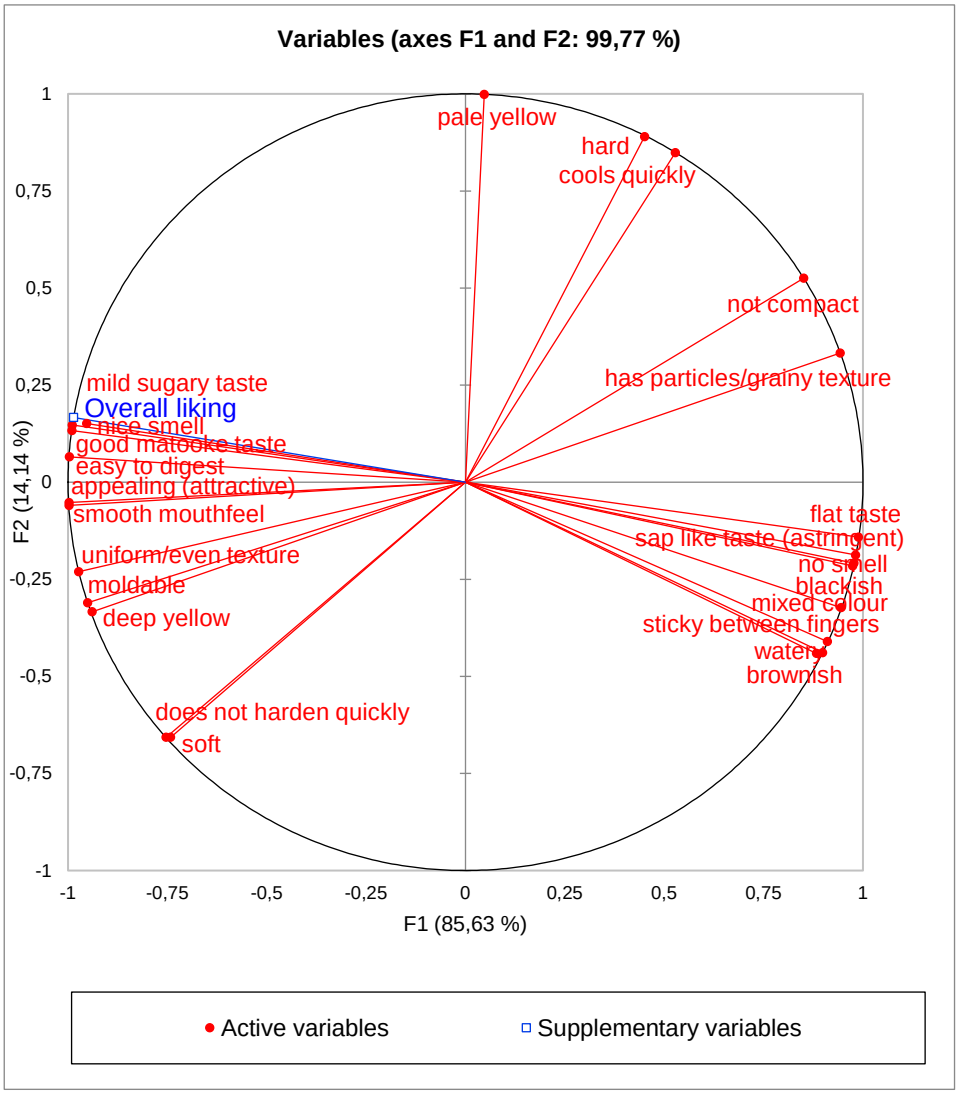


Figure 8a: Mapping of the sensory characteristics and overall liking of the steamed Matooke in Mbarara

In Nakaseke, the PCA plot explained 99.77 % of the variance of the sensory characteristics, the first and second axes accounting for 85.63 % and 14.14 % respectively. Most of the variance was explained by the first axis. The loading of sensory characteristics on PCA plan (Figure 8b) shows that axis 1 was explained positively by the terms such as “deep yellow”, “moldable”, “uniform texture”, “smooth mouthfeel”, “appealing (attractive)”, “easy to digest”, “good matooke taste”, “nice smell”, “mild sugary taste” and also “does not harden quickly” and “soft”, related to the most liked matooke samples (Mpologoma and M30). Axis 1 was explained negatively by the terms such as “sap like taste (astringent)”, “flat taste”, “no smell”, “blackish”, “mixed colour”, “has particles/grainy texture”, “watery”, “brownish”, “sticky between fingers” and also “not compact” related to the least liked matooke sample (NARITA 21). Axis 2 was explained negatively by the terms such as “pale yellow”, “hard” and “cools quickly” related to the Nakitembe matooke sample.

A high mean overall liking scored by consumers was related to the high-quality characteristics (here on the left part of the PCA plan), which were associated to the most liked matooke samples (Mpologoma and M30). At the opposite, a low mean overall liking by the consumers were related to the low-quality characteristics (here on the right part of the PCA plan), which were associated to the least liked sample (NARITA 21).



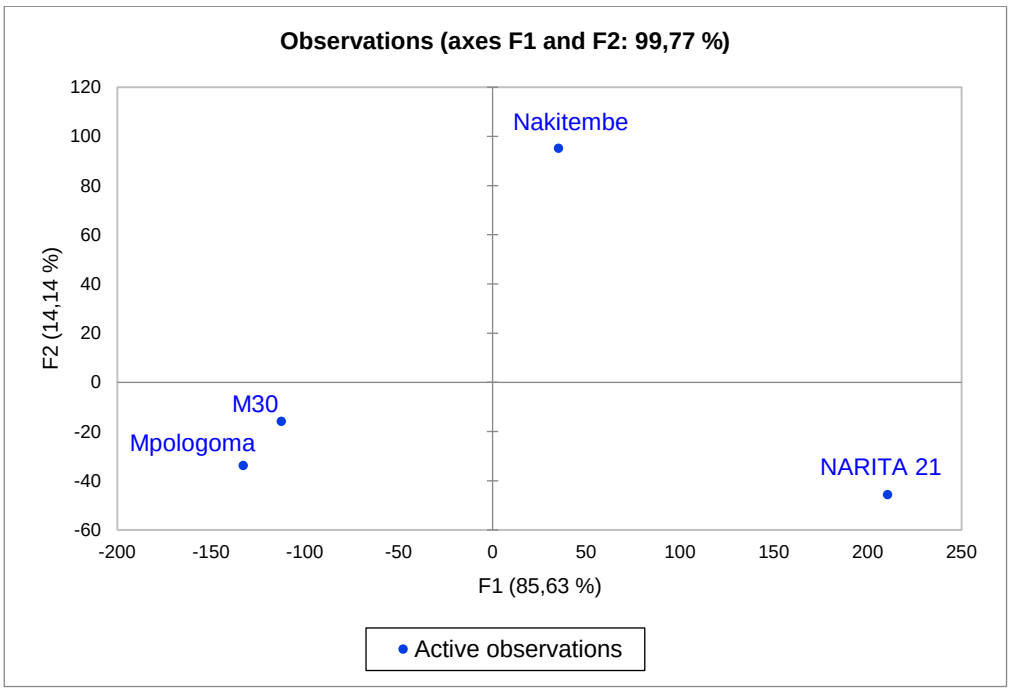


Figure 8b: Mapping of the sensory characteristics and the overall liking of the steamed Matooke in Nakaseke

4 DISCUSSION AND CONCLUSION

Four matooke products prepared from four different varieties in each of the two sites (Mbarara and Nakaseke) were perceived differently by consumers.

In Mbarara, the most liked were the matooke prepared from Kibuzi and Nakitembe with a mean overall liking score of 7.7 (close to 8 or 'like very much') and 7.3 (close to 7 or 'like moderately') respectively. The hybrid matooke samples NARITA 2 and M30 got a medium mean overall liking score, between 4.7 (close to 5 or 'neither like nor dislike') and 5.9 (close to 6 or 'like slightly').

In Nakaseke, the most liked matooke were made from the local variety Mpologoma and the matooke hybrid M30 with a mean overall liking score of 8.2 and 7.9 (both close to 8, 'like very much') respectively. The least liked matooke sample was the matooke hybrid NARITA 21 with a mean overall liking score of 2.1 (close 2 or 'dislike very much'). Nakitembe, a local variety with an overall mean score of 6.2 (close to 6 or 'like slightly') was evaluated as an intermediate quality matooke product.

The CATA test confirmed colour, mouthfeel and textual properties (softness) as the most important characteristics of cooked matooke and land race varieties especially kibuzi and Nakitembe which were the most liked varieties with respect to the mentioned characteristics. The JAR test confirmed that the colour, mouthfeel, and the softness of landrace varieties; Nakitembe, Kibuzi and Mpologoma were superior to the hybrids with the exception of M30 and were all scored just as the end-users want.

The overall liking of the matooke made from those varieties is clearly related to the sensory characteristics of the products. The study shows the important consumer characteristics of cooked matooke are present in land race varieties; Nakitembe and Kibuzi. We therefore recommend that work package two dissects these characteristics (colour, softness and the mouthfeel) to understand their biochemical underpinnings for recommendation to WP3(NIRS) and subsequently to WP4(Breeding).

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