Consumer Testing of Boiled Potato 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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ABSTRACT

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

Content

Boiled potato from different varieties was tested for consumer acceptability in Kabale and Rakai in South Western and Central Uganda, respectively. A multifaceted methodology consisting of Hedonic, Just About Right (JAR) and Check All That Apply (CATA) tests was used. With samples from Kabale, two distinct groups of overall liking emerged, one consisted of Rwangume, Kachpot 1 and Kinigi varieties with an overall liking score of 7 (like moderately) and another included Victoria variety with a score of 4.2 (dislike slightly). Similarly, in Rakai, dichotomous groups were obtained for the boiled potato varieties with Kasumali and Deodeo in the score of 7 ('like moderately') overall in one, and then Victoria and Kabale (5 – 'neither like nor dislike') in another. In both locations, the liked varieties were rated JAR for 'colour', 'potato taste', 'softness' and 'mealiness' while Victoria which was commonly disliked in both regions was regarded as 'too light', 'not enough potato taste', 'too soft' and 'not mealy enough'.

Overall, consumers showed inclination towards boiled potatoes that were 'mealy', 'yellow', 'good potato smell', 'firm' and 'good potato taste'. These were associated with the varieties Rwangume, Kachpot 1, Kinigi, Deodeo and Kasumali according to PCA analysis. On the contrary, disliked boiled potatoes were 'white', with 'no potato taste', 'watery', 'no potato smell' and 'tasteless' with attribution to Victoria and Kabale potato varieties. These results provide a foundation upon which sensory objective measurements can be developed to improve breeding programmes.

Key Words: boiled potato, 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.

Potato is widely consumed in Uganda mostly in the boiled form. The current study was conducted in Kabale (South western) and Rakai (central) districts of Uganda. These are major potato producing areas in Uganda. The consumer tests were conducted both in rural and urban locations. Four varieties were selected from each location including local and improved. The four varieties selected for consumer tests in Kabale were : Victoria (improved), Kachpot 1 (improved), Kinigi (local) and Rwangume (NAROPOT 4) (improved) whereas those for Rakai were; Kasumali (local), Kabale (local), Victoria (improved) and Deodeo (NAROPOT 4) (improved).

Boiled potato preparation method was based on protocols developed during Activity 4 involving processors. A 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

The products made by the processors from varieties with different quality characteristics during the Activity 4 "Processing diagnosis", were tested by 249 consumers. Amongst the consumers, 114 were women while men were 135 (Table 1). The activity was conducted in Kabale (South-West) and Rakai (Central) districts of Uganda in December 2019. In Kabale the sites constituted of rural villages (Rwakizamba, Munkombe and Nyabumba) and Kabale town. In Rakai the rural villages were; Kanyegenyege, Byakabanda, Kamukalo and Kitemba, in addition to Kyotera town.

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

	Total	Kabale		Rakai	
		Kabale rural	Kabale town	Rakai rural	Kyotera town
Number of Consumers	249	63	92	32	62
Women	114	28	38	16	32
Men	135	35	54	16	30

The four varieties selected for consumer tests in Kabale were; Victoria (improved), Kachpot 1 (improved), Kinigi (local) and Rwangume (NAROPOT 4) (improved) whereas those for Rakai were; Kasumali (local), Kabale (local), Victoria (improved) and Deodeo (NAROPOT 4) (improved). These were selected based on preference data obtained from Activity 3 and 4.

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 = 249) from different locations in rural and urban areas were asked individually to look/touch/smell/taste each product sample, one after the other, in a random order, and score the overall liking using a nine-point hedonic scale (from 1. "dislike extremely, to 9. "like extremely").

Consumers were also asked to assess how they perceive the intensity of 4 characteristics identified as important in the previous Activities 3 & 4, 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") for each of the boiled potato samples. The 4 characteristics chosen were 'colour', 'potato taste', 'softness' and 'mealiness'. These characteristics had been identified during the gendered food mapping and especially the participatory processing demonstrations with processors as being important drivers of preference among consumers of boiled potato.

Consumers were then asked to select the quality characteristics that better describe each boiled potato sample, among a list of 25 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 boiled potato samples. The CATA quality characteristics are shown in Table 2.

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

	Quality characteristics of the ready to eat product
List of **the most liked** characteristics	Appearance - Attractive - Vitamins - Yellow - Cream odour - Good potato smell Texture when touching - Firm Taste - Good Potato taste Texture in mouth - Dry - Mealy - Thick - Smooth in the Mouth Aroma Aftertaste
List of the least liked characteristics	Appearance - Blackish - Non homogeneous colour - White Odour - No Potato smell Texture when Touching - Hard - Non uniform texture - Sticky between finger Taste - Tasteless - No potato taste Texture in mouth - Too soft - Fibrous - Watery Aroma Aftertaste - Bad after taste

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

2.3 Data analysis

An analysis of variance (ANOVA) was carried out to identify significant differences in overall liking scores between the 4 boiled potato as tested by 155 and 94 consumers in Kabale and Rakai respectively. Multiple pairwise comparisons were applied using the Tukey test, with a confidence interval of 95% at $p < 0.05$ (n=155 and n=94 consumers). An Agglomerative Hierarchical Clustering (AHC) analysis was used to categorise 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 boiled potato sample, the number of consumers who judged each specific characteristic either Just All Right (JAR), Too weak or Too strong was counted, and the percentage of consumers (out of 155 and 94) was determined. A Principal Component Analysis (PCA) was conducted on the count of citations for all the CATA quality characteristics, with boiled potato 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 2014 software (Addinsoft).

3 RESULTS

3.1 Overall liking of the product samples

Overall liking of boiled potato samples from Kabale and Rakai varied as shown in **Tables 3** and **4** respectively.

According to consumers of boiled potato in Kabale, Rwangume, Kachpot 1 and Kinigi were the most liked with overall liking close to 7 ('like moderately') (**Table 3**). Victoria was scored 4 ('dislike slightly') and this was significantly different from the former three ($p<0.05$, one-way ANOVA).

Table 3: Mean overall liking scores for the four boiled potato samples tested in Kabale

Product samples	Mean Overall liking scores* (n=155 consumers)	Groups**	
Rwangume	7.1	A	
Kachpot 1	6.9	A	
Kinigi	6.7	A	
Victoria	4.2		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 ($p<0.05$).

In Rakai, Kasumali and Deodeo had better overall liking close to 7 (like moderately) and this was significantly different from Victoria and Kabale (neither like nor dislike) (**Table 4**).

Table 4: Mean overall liking scores for the four boiled potato samples tested in Rakai

Product samples	Mean Overall liking scores* (n=94 consumers)	Groups**	
Kasumali	6.7	A	
Deodeo	6.6	A	
Victoria	5.4		B
Kabale	5.2		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 ($p<0.05$).

Victoria was not liked by consumers in both regions. Most of them indicated that it was sticky in the hands, watery and not mealy.

3.2 Segmentation of consumers into groups of similar overall liking

The aim of an Agglomerative Hierarchical Clustering (AHC) analysis is to create homogeneous clusters of consumers who have similar overall liking scores. It is useful to classify consumers who have been interviewed randomly, into similar groups.

Using an Agglomerative Hierarchical Clustering analysis of the mean overall liking scores for Kabale, three groups of consumers were identified namely; "Victoria dislikers", "Kinigi and Rwangume likers" and "All likers" **(Figure 1 and 2)**. These three clusters contained 61%, 16% and 23% of all the consumers interviewed respectively.

Figure 1: *Clustering of the consumers based on their overall liking scores of the boiled potato products (Kabale)*

Figure 2: Mean overall liking of the boiled potato samples by consumer cluster type (%) – Kabale

Agglomerative Hierarchical Clustering analysis of the mean overall liking scores for Rakai identified three groups of consumers namely; "All likers", "Kabale dislikers" and "Deodeo and Kasumali likers" **(Figure 3 and 4)**. These three clusters constituted 60%, 18% and 22% of all the consumers interviewed respectively.
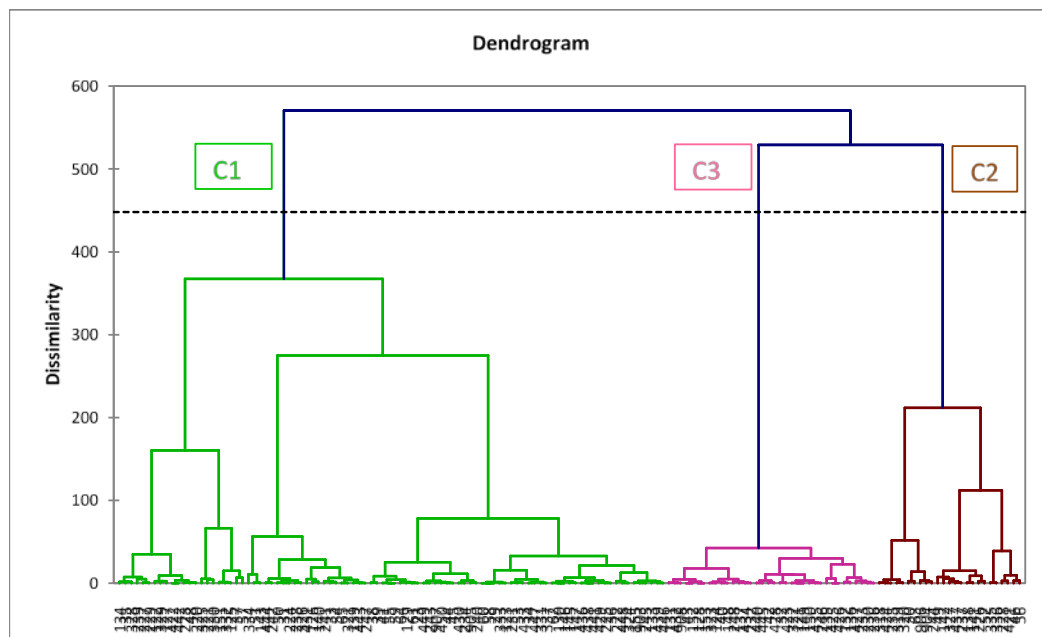

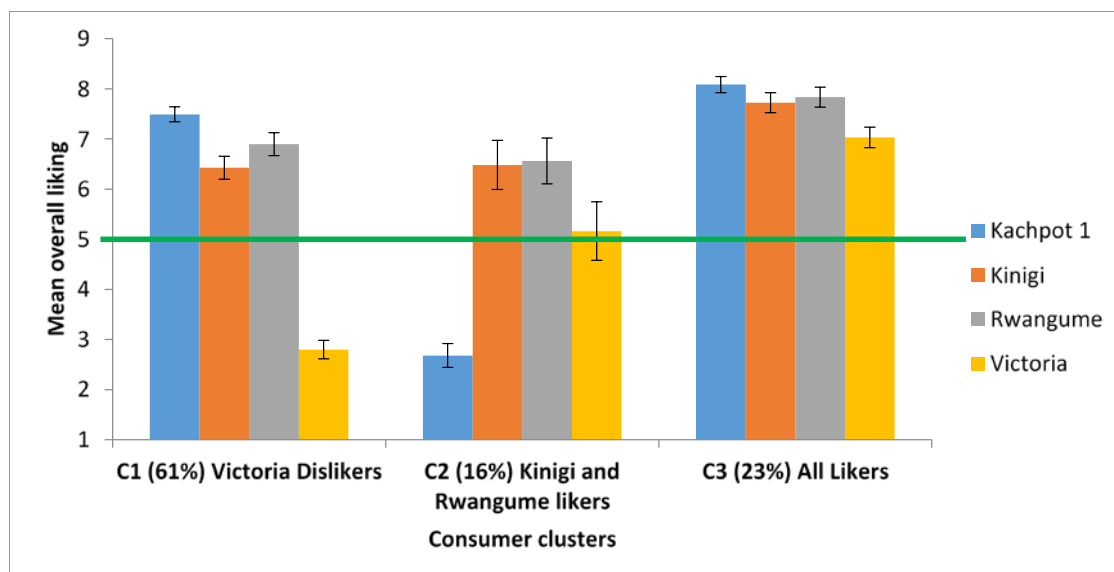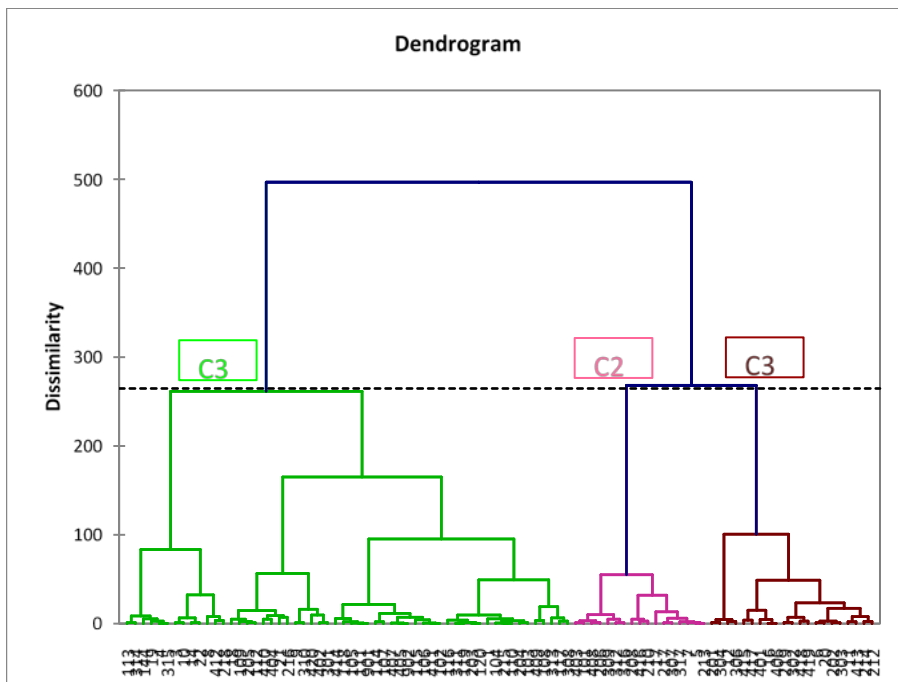**Figure 3**: Clustering of the consumers based on their overall liking scores of the boiled potato products (Rakai)
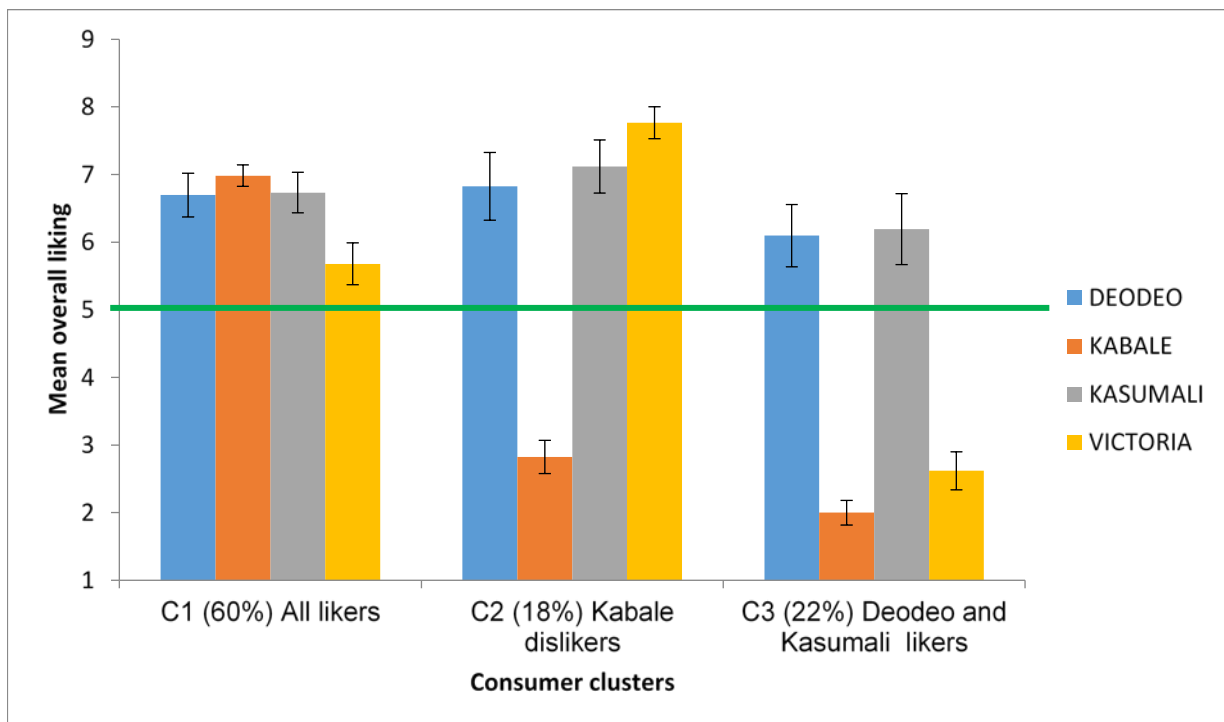
Figure 4: Mean overall liking of the boiled potato samples by consumer cluster type (%) - Rakai

3.2.1 Demographic data of the consumers interviewed

Demographic categorisation and clustering of consumers in Kabale are shown in **Table 5**. Among the 155 consumers interviewed in Kabale, 43% were women and 57% were men. Majority of consumers (32%) were 18-25 years old. Most of them were farmers (44%) of the Bakiga ethnic group (91%). Consumers were also mostly married (60%) and considered themselves to be in the low income category (59%). Respondents who participated in the consumer test were mostly from Kabale town (59%).

Clustering of consumers shows that men and women were mostly Victoria dislikers (≥60%). Kinigi and Rwangume likers had slightly more women than men and the opposite was true amongst the "All likers" (**Table 5 and Figure 5**).

Table 5: Demographic differences of the consumers with respect to cluster division - Kabale

		Percentage of consumers (n=155)	C1 Victoria Dislikers	C2 Kinigi and Rwangume Likers	C3 All Likers	Chi-square (p≤0.05)
Consumers		100%	61	16	23	
Location	Kabale Town	59%	66	16	17	0.10
	Kabale Rural	41%	52	16	32	
Nationality	Rwanda	2%	67	33	0	0.52
	Uganda	98%	61	16	24	
Gender	Female	43%	62	18	20	0.62
	Male	57%	60	15	26	
Ethnicity	Bafumbira	1%	100	0	0	0.29
	Bakiga	91%	59	16	26	
	Banyankore	3%	100	0	0	
	Banyarwanda	5%	57	43	0	
	Banyole	1%	100	0	0	
Age group	18-25	32%	63	20	16	0.82
	26-35	26%	60	18	23	
	36-45	20%	58	16	26	
	46-55	12%	61	11	28	
	≥56	11%	59	6	35	
Occupation	Student	8%	67	17	17	0.59
	Artisanship	10%	53	20	27	
	Civil service	2%	33	33	33	
	Trading business	18%	75	21	4	
	Employed	15%	54	13	33	
	Unemployed	3%	60	20	20	
	Farmer	44%	59	13	28	
Marital situation	Single	38%	68	15	17	0.16
	Married	60%	56	16	28	
	Widow(er)	1%	100	0	0	
	Living with parents/elders	1%	0	100	0	
Wealth Status	High income	3%	80	20	0	0.33
	Middle income	37%	57	12	31	
	Low income	59%	62	18	20	

All the age groups in the study were mainly Victoria dislikers (≥58%). There were more Kinigi and Rwangume likers among the majority 18-25 age group compared to the others. The farmers were also mostly "Victoria dislikers" (59%) with slightly more "All likers" than the other occupation categories. This observation was similar for the majority Bakiga ethnic group, the married and low income consumers. Consumers were unanimous in their dislike for the Victoria variety. Nonetheless, differences in terms of clustering among the various demographic categories in Kabale were not significantly different (p>0.05, Chi-square test).

Figure 5: Percentage of consumer cluster type by gender – Kabale

Demographic categorisation and clustering of consumers in Rakai are shown in Table 6. Of the 94 consumers interviewed in Rakai, women were 51% and men 49%. Most of the consumers were in the age group 26-35 years (32%), Baganda by ethnicity (82%), farmers (37%), married (67%) and perceived themselves to be in the low income category (46%). The consumers assessed were mostly from Kyotera town (66%).

Table 6: Demographic differences of the consumers with respect to cluster division - Rakai

		Percentage of consumers (n=94)	C1 All likers (% of total)	C2 Kabale dislikers (% of total)	C3 Deodeo and Kasumali likers (% of total)	Chi-square (p≤0.05)
Consumers		100%	60	18	22	
Location	Kyotera town	66%	58	19	23	0.89
	Rakai (rural)	34%	63	16	22	
Nationality	Burundi	2%	100	0	0	0.08
	Rwanda	2%	0	0	100	
	Uganda	96%	60	19	21	
Gender	Female	51%	67	15	19	0.36
	Male	49%	52	22	26	
Ethnicity	Bafumbira	1%	100	0	0	0.79
	Baganda	82%	58	19	22	
	Bagisu	1%	100	0	0	
	Bakiga	1%	100	0	0	
	Banyankore	5%	60	20	20	

		Percentage of consumers (n=94)	C1 All likers (% of total)	C2 Kabale dislikers (% of total)	C3 Deodeo and Kasumali likers (% of total)	Chi-square (p≤0.05)
	Banyarwanda	2%	0	0	100	
	Banyoro	4%	50	25	25	
	Basoga	1%	100	0	0	
	Other (Burundian)	2%	100	0	0	
Age group	18-25	27%	56	24	20	0.99
	26-35	32%	63	17	20	
	36-45	30%	61	14	25	
	46-55	5%	60	20	20	
	≥56	6%	50	17	33	
Occupation	Student	3%	67	0	33	0.74
	Artisanship	9%	38	38	25	
	Civil service	4%	75	25	0	
	Trading business	29%	52	22	26	
	Employed	18%	59	12	29	
	Farmer	37%	69	14	17	
Marital situation	Single	26%	54	2	21	0.19
	Married	67%	62	13	25	
	Widow(er)	6%	67	33	0	
	Living with parents/elders	1%	0	100	0	
Wealth Status	High income	11%	80	0	20	0.10
	Middle income	44%	54	29	17	
	Low income	46%	60	12	28	

Of the cluster distribution, more women were "All likers" (67%) compared to men (52%) (**Table 6 and Figure 6**). On the contrary, there were slightly more men among "Kabale dislikers" as well as "Deodeo & Kasumali likers" than the women. The majority age group among consumers (26-35) were mostly "All likers" (63%) followed by Deodeo and Kasumali likers (20%) and Kabale dislikers (17%). This was similar for the other age groups except the 18-25. Similarly, the Baganda ethnic group, the farmers, married and low-income consumers followed the same trend as the 26-35 age group. Just like in Kabale, cluster differences among the various demographic categories in Rakai were not significantly different (p>0.05, Chi-square test).
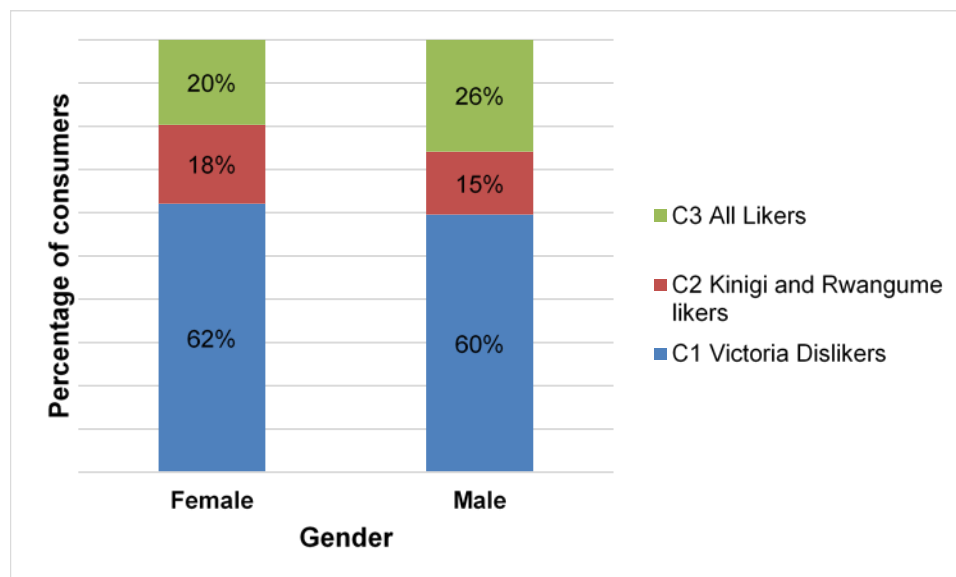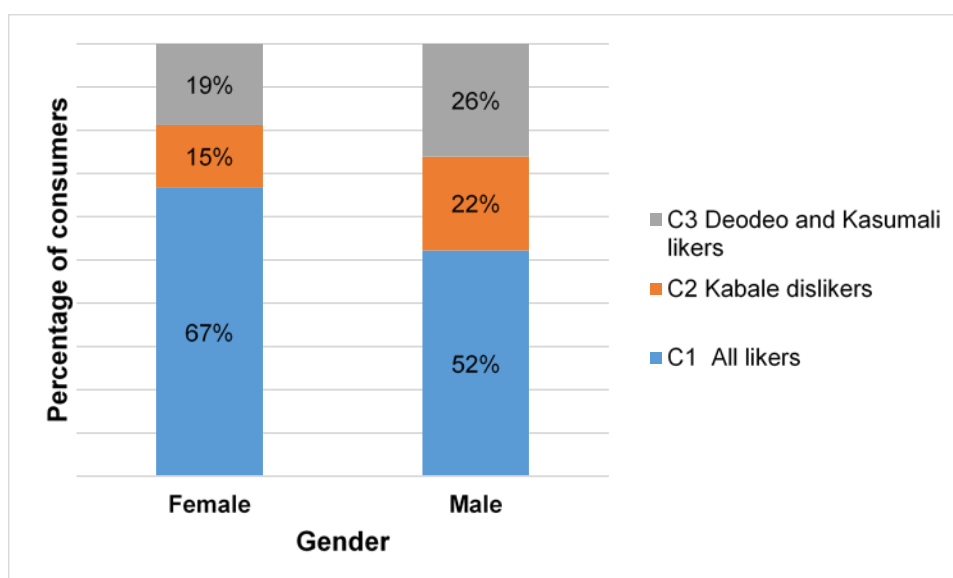
Figure 6: Percentage of consumer cluster type by gender - Rakai

3.2.2 Consumption attitudes

Most of consumers interviewed in Kabale reported consumption of boiled potato several times a week (54%) followed by 41% on a daily basis and lastly 5% who consumed once a week (**Table 7**). The differences in clusters among the consumption frequencies were significant (p≤0.05, Chi-square). The most common form of consumption was "Katogo (Added with beans/groundnuts and ingredients – spices" (86%) followed by "Plain - dry snack" (12%) and finally "With other sauce served separately - greens, beans, groundnuts (2%). Similar to consumption frequency, differences among consumer clusters regarding consumption form were also significant. Regarding the occasion of consumption, boiled potato was mostly consumed at Lunch (58%), Breakfast (27%), Dinner (14%) and In between meals (1%). In this case the consumer clusters were not significantly different.

Table 7: Consumption attitudes of the consumers– Kabale

Consumption Habits		Percentage of consumers (n=155)	C1 Victoria Dislikers	C2 Kinigi and Rwangume Likers	C3 All Likers	Chi-square (p≤0.05)
Consumption frequency %	Every day	41%	50	27	23	*0.02
	Once a week	5%	63	25	13	
	Several times a week	54%	69	7	24	
Form of consumption	Katogo (Added with beans/groundnuts and ingredients – spices etc)	86%	65	13	22	*0.01
	Plain (Dry Snack)	12%	26	42	32	
	With other sauce served separately (greens, beans, groundnuts)	2%	67	0	33	
Occasion of consumption	Breakfast	27%	69	17	14	0.62
	Dinner	14%	50	23	27	
	In between meals	1%	100	0	0	
	Lunch	58%	59	14	27	

Consumers in Rakai mostly consumed boiled potato several times a week (51%), once a week (21%), once a month (11%), everyday (10% and several times a month (7%) (**Table 8**). Similar to Kabale, consumers in Rakai indicated that their favourite consumption form of boiled potato was

Katogo (Added with beans/groundnuts and ingredients – spices) - 55% followed by "Plain (Dry Snack)" - 37% and "With other sauce served separately (greens, beans, groundnuts)" - 7%. More so, time of consumption followed a similar pattern where boiled potato was mainly consumed at lunchtime (65%) followed by breakfast (19%), dinner (15%) and in between meals (1%).

Table 8: Consumption attitudes of the consumers– Rakai

Consumption Habit		Number of consumers (n=94)	C1 All likers	C2 Kabale dislikers	C3 Deodeo and Kasumali likers	Chi-square (p≤0.05)
Consumption frequency %	Every day	10%	56	22	22	0.85
	Once a month	11%	70	20	10	
	Once a week	21%	50	20	30	
	Several times a month	7%	43	14	43	
	Several times a week	51%	65	17	19	
Form of consumption (first) %	Katogo (Added with beans/groundnuts and ingredients – spices etc)	55%	60	17	23	0.12
	Plain (Dry Snack)	37%	69	14	17	
	With other sauce served separately (greens, beans, groundnuts)	7%	14	43	43	
Time of the day %	Breakfast	19%	56	22	22	0.42
	Dinner	15%	57	36	7	
	In between meals	1%	100	0	0	
	Lunch	65%	61	13	26	

The differences in consumer clusters among the various consumption habits were not significant in Rakai (p>0.05, Chi-square).

3.3   A Just About Right test (JAR)

Just about right (JAR) scale was used to determine the optimum level of intensity as perceived by the consumers for some important sensory quality characteristics of the *boiled potato samples*. This "descriptors' diagnostic" helped to understand why consumers liked or disliked the various boiled potato samples. Consumers were asked to give their perception of the 'colour', 'potato taste', 'softness' and 'mealiness' of each boiled potato sample, by using a 3-point JAR scale (1 = "too low, too weak, not enough", 2= "Just About Right" and 3 = "too high, too strong, too much").

Results for the JAR test among boiled potato consumers in Kabale are shown in **Figure 7**. Boiled potato samples from the three varieties namely; Rwangume, Kinigi and Kachpot 1 were rated JAR for 'colour', 'potato taste', 'softness' and 'mealiness' by more than 50% of the consumers. Victoria boiled potato was deemed "too light" (75%), "not enough potato taste" (68%), "too soft" (51%) and "not mealy enough" by 83% of the consumers. Not surprisingly, Victoria had the lower overall liking score (4.2 or dislike slightly) among the four boiled potato varieties subjected to the consumer test.
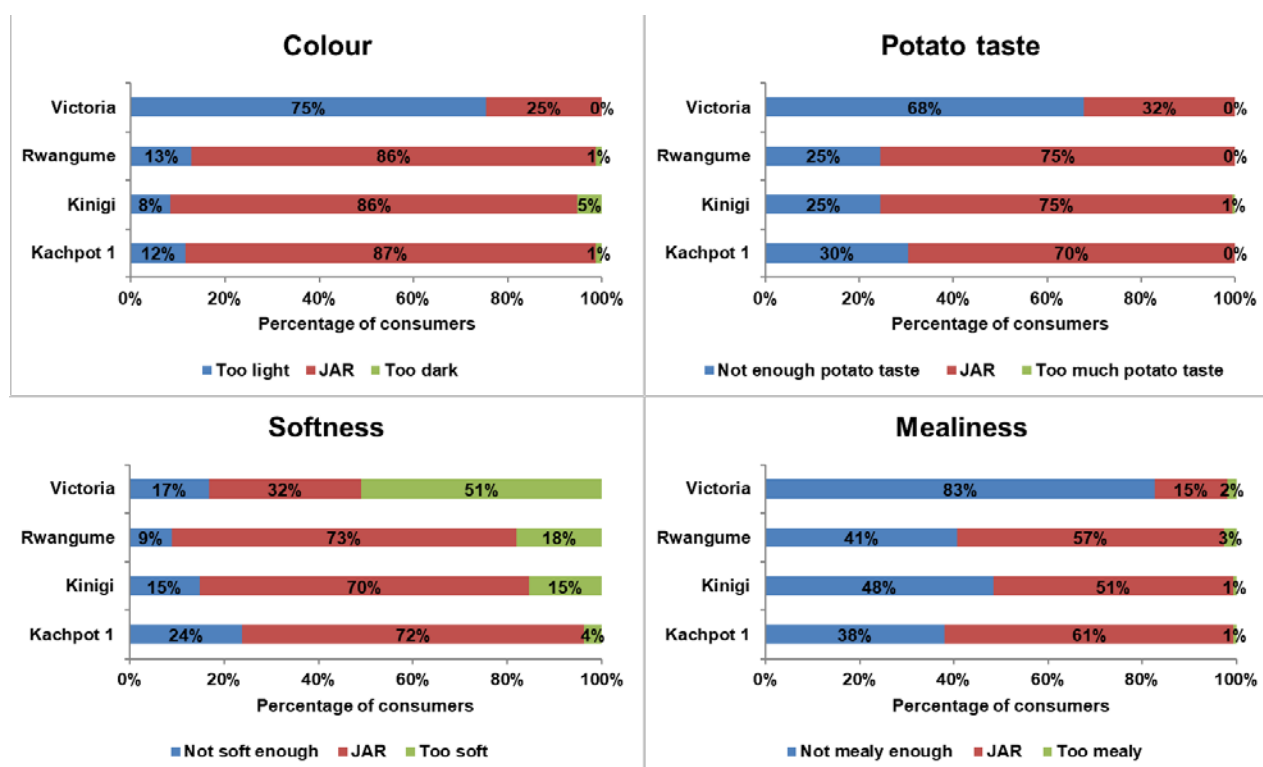
Figure 7: Percentage of consumers who scored the four specific quality characteristics - Kabale

The JAR test among boiled potato consumers in Rakai revealed that Kasumali boiled potato was scored JAR by more than 50% of consumers for colour, potato taste, softness and mealiness (**Figure 8**). This was similar for Deodeo however, 51% of consumers indicated that it was not mealy enough. Victoria was scored "not enough potato taste" and "not mealy enough" by 53% and 74% of consumers respectively however, it was JAR for colour (57%) and softness (51%). Kabale boiled potato was scored "too light" (56%), "not enough potato taste" (60%) and "not mealy enough" by 78% of consumers. Nonetheless, 52% rated it JAR for softness.

Figure 8: Percentage of consumers who scored the four specific quality characteristics - Rakai

This could explain the observed result in the overall liking scores where the four varieties were split into two distinct groups. Kasumali and Deodeo in the "like moderately" category; Victoria and Kabale in the "neither like nor dislike". Victoria and Kabale could have been scored lower for overall liking (5.4 and 5.1 respectively) because of having "not enough potato taste" and "not mealy enough".

3.4 Check All That Apply (CATA) test

The objective of the CATA test is to show the relationships between hedonic overall liking scores for each product sample and the frequencies of citation of each CATA sensory characteristic by all the consumers. After scoring the Overall liking and the perception of some specific sensory characteristics, consumers were invited to choose the most appropriate terms among 25 sensory characteristics that better describe each boiled potato sample.

The number of citations given by consumers in Kabale to describe each boiled potato sample were calculated (**Table 9**). The sensory characteristics most frequently cited by the consumers were considered important for describing the boiled potatoes. "attractive", "mealy", "yellow", "good potato smell" and "good potato taste" had the highest citation frequency between 300 and 400, followed by "firm", "sticky between fingers", "vitamins", "white" and "smooth in the mouth" with a number of citations between 200 and 300. The least used terms were "fibrous", "blackish" and "thick". Rwangume, Kinigi and Kachpot 1 boiled potatoes were described as "attractive", "mealy", "yellow", "good potato smell" and "good potato taste" by consumers with more than 80 citations. Victoria boiled potato was described as "white" (126 citations), "no potato taste" (74 citations), "watery" (71 citations), "no potato smell" (70 citations) and "tasteless" (69 citations). This further corroborates the JAR test results ("too light", "not enough potato taste", "too soft" and "not mealy enough"), the cluster C1 with many Victoria dislikers (61% of consumers) and low overall liking score of 4.2.

Table 9: Frequency of citations of each quality characteristic by all the consumers - Kabale

Quality characteristics	Rwangume	Kinigi	Victoria	Kachpot 1	Total
Attractive	108	110	32	109	359
Bad after taste	9	12	30	12	63
Blackish	1	1	1	2	5
Dry	40	36	17	58	151
Fibrous	0	0	1	1	2
Firm	84	82	26	103	295
Hard	6	16	8	25	55
Mealy	95	84	26	106	311
Non homogeneous colour	52	54	24	58	188
Non uniform texture	7	15	15	16	53
Sticky between finger	55	52	56	46	209
Tasteless	12	18	69	19	118
Thick	8	12	6	12	38
Too soft	16	11	59	4	90
Vitamins	69	64	19	57	209
Watery	23	20	71	9	123
White	33	29	126	26	214
Yellow	108	114	2	98	322
No potato taste	15	21	74	20	130
No Potato smell	19	26	70	24	139
Smooth in the Mouth	74	77	67	65	283
Cream	34	27	10	32	103
Good potato smell	113	106	58	102	379

Quality characteristics	Rwangume	Kinigi	Victoria	Kachpot 1	Total
Good Potato taste	111	109	54	113	387
Soft	63	57	46	32	198
Mean Overall liking	7.1	6.7	4.2	6.8	

The frequency of citations given by consumers in Rakai to describe each boiled potato sample were calculated (**Table 10**). "attractive", "firm", "good potato smell" and "good potato taste" had the highest citations between 200 and 300, followed by "dry", "mealy", "yellow", "vitamins", "white", "smooth in the mouth" and "soft" with citations between 100 and 200. The least cited characteristics were "fibrous", "blackish" and "bad aftertaste". Boiled potatoes from Deodeo and Kasumali were described as "attractive", "firm", "good potato smell", "good potato taste", "mealy", "yellow" and "vitamins". Kabale was described as "white" (64 citations), "firm" (48), "smooth in the mouth" (45), "good potato smell" (42), "good potato taste" (44) however, more consumers also described it as "no potato taste" (34 citations) and "no potato smell" (30). This observation was similar for Victoria boiled potato. This trend of citation of both positive and negative characteristics could explain the median overall liking score of 5.1 and 5.4 ("neither like nor dislike"), for Kabale and Victoria respectively.

Table 10: Frequency of citations of each quality characteristic by all the consumers – Rakai

Quality characteristics	Deodeo	Kasumali	Kabale	Victoria	Total
Attractive	78	73	37	47	235
Bad after taste	2	4	10	10	26
Blackish	0	0	2	2	4
Dry	24	40	28	18	110
Fibrous	1	0	1	1	3
Firm	51	59	48	47	205
Hard	6	24	18	18	66
Mealy	49	49	22	25	145
Non homogeneous colour	13	26	21	26	86
Non uniform texture	6	13	11	13	43
Sticky between finger	22	18	24	29	93
Tasteless	13	12	26	31	82
Thick	18	20	12	13	63
Too soft	16	6	9	16	47
Vitamins	41	39	9	23	112
Watery	25	8	24	30	87
White	3	12	64	33	112
Yellow	73	76	8	19	176
No potato taste	16	14	34	26	90
No Potato smell	11	14	30	30	85
Smooth in the Mouth	55	51	45	47	198
Cream	12	15	28	29	84
Good potato smell	70	71	42	53	236
Good Potato taste	64	66	44	48	222
Soft	40	21	38	31	130
Mean Overall liking	6.6	6.7	5.2	5.4	

3.5 Sensory mapping of the sensory characteristics

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

The PCA plot (99.3% of sensory variance) for boiled potatoes tested among consumers in Kabale is shown in **Figure 9.** A positive mean overall liking was associated with 'good potato taste', 'yellow' 'good potato smell', 'mealy', 'firm' and 'cream'. These sensory characteristics were closely associated with Kinigi, Rwangume.and to a lesser extent Kachpot 1.
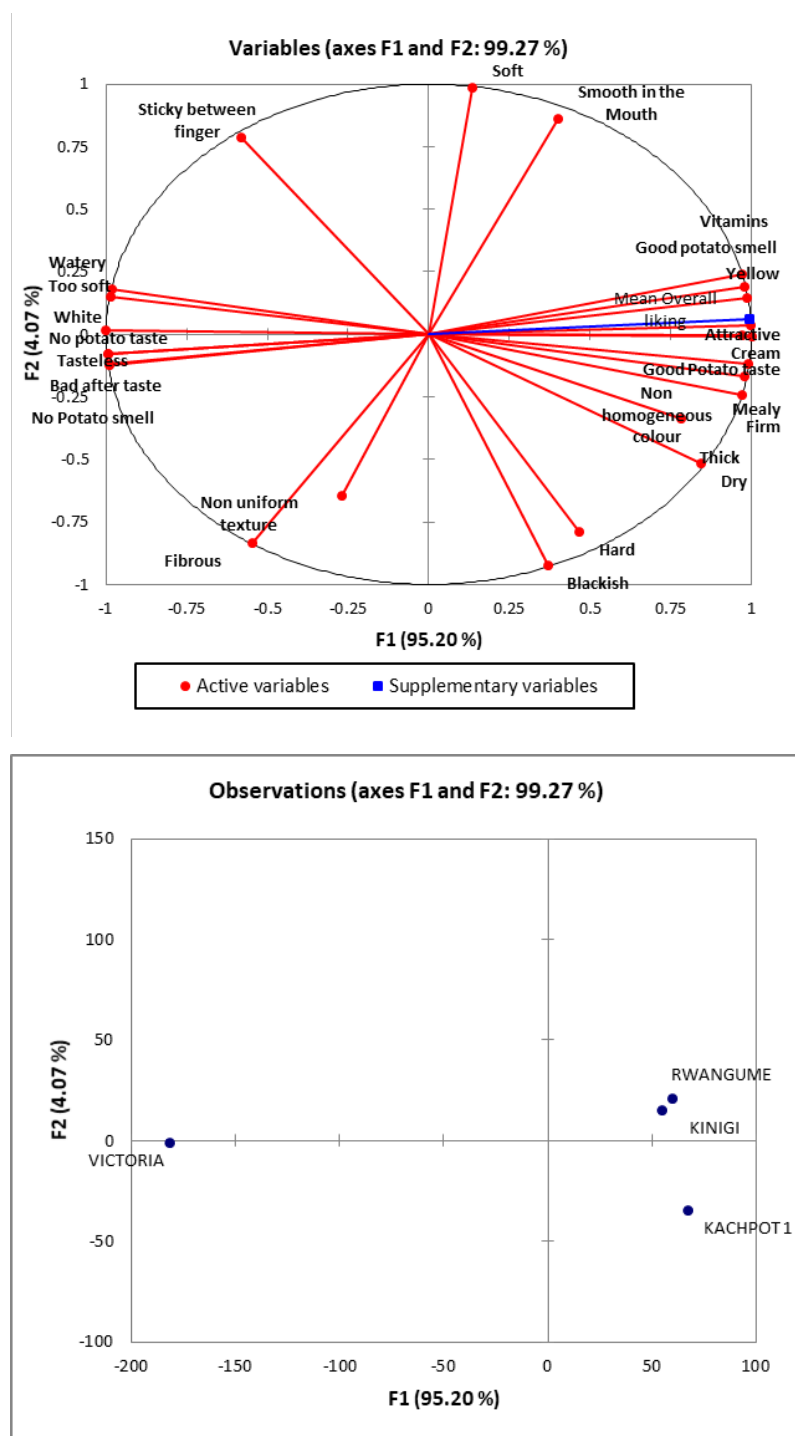

Figure 9: Mapping of the sensory characteristics and the overall liking of the boiled potato samples – Kabale

Boiled potato samples from the slightly disliked variety Victoria were associated with 'white', 'No potato taste', 'no Potato smell', 'tasteless', 'bad after taste', 'too soft' and 'watery.

The PCA plot (96.40% of sensory variance) for boiled potatoes tested among consumers in Rakai is shown in **Figure 10.** A positive mean overall liking was associated with 'yellow', 'good Potato taste', 'good potato smell', 'mealy', 'thick' and 'smooth in the mouth'. These characteristics were linked to boiled potatoes from Deodeo and Kasumali varieties.
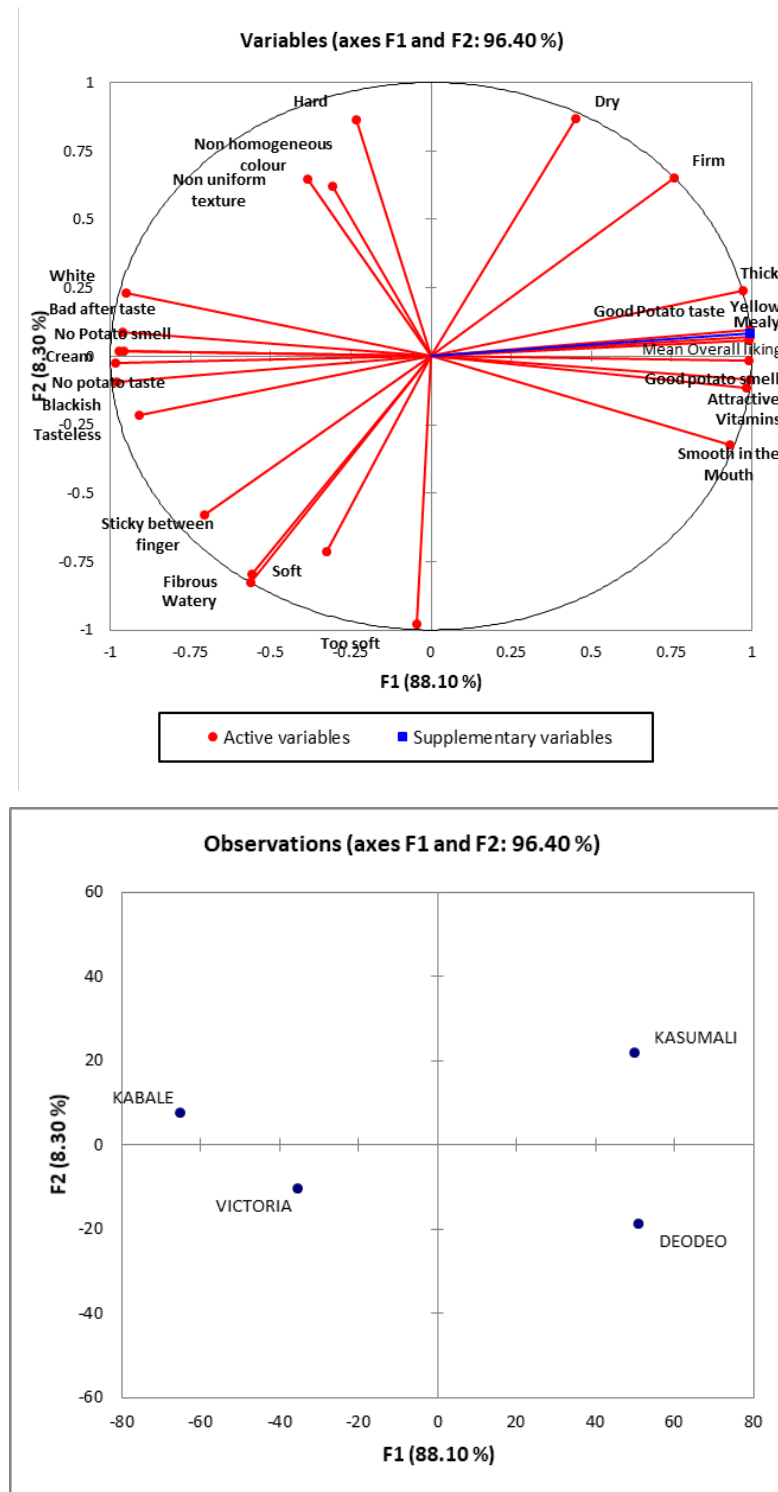

Figure 10: Mapping of the sensory characteristics and the overall liking of the boiled potato samples - Rakai

On the other hand, boiled potatoes from the Victoria and Kabale variety were on the opposite side of the plot characterised by 'no potato taste', 'blackish', 'no Potato smell', 'bad after taste', 'cream', 'white', and 'tasteless'.

4 DISCUSSION AND CONCLUSION

The boiled potatoes from Kabale and Rakai were assessed differently by the consumers. In Kabale, two distinct classes emerged, one consisted of Rwangume, Kachpot 1 and Kinigi with an overall liking score of 7 ('like moderately') and another had Victoria with a score of 4.2 ('dislike slightly'). The former three were described by most consumers as having the four JAR characteristics that is; colour, potato taste, softness and mealiness. More so, boiled potato samples from these varieties were described as being, "mealy", "yellow", "good potato smell" and "good potato taste". These findings were confirmed in the sensory mapping analysis where the aforementioned characteristics were associated with positive mean overall liking. On the contrary, Victoria was disliked by most consumers having been termed as "too light", "not enough potato taste", "too soft" and "not mealy enough" and was specifically defined by "white", "no potato taste", "watery", "no potato smell" and "tasteless" in lieu of the sensory mapping.

Similarly, in Rakai, dichotomous groups were obtained for the boiled potato varieties with Kasumali and Deodeo with an overall liking score of 7 ('like moderately') in one group, and then Victoria and Kabale (5 'neither like nor dislike') in another. Kasumali and Deodeo varieties were JAR for the specific characteristics of 'colour', 'potato taste', 'softness': Deodeo was marginally deemed 'not mealy enough'. Nonetheless, descriptors that defined positive mean overall liking such as "firm", "good potato smell", "good potato taste", "mealy" and "yellow" were attributed to the two varieties by PCA analysis. Victoria and Kabale had a relatively lower overall liking score possibly due to the "not enough potato taste" and "not mealy enough" rating by most consumers in the JAR test. This was confirmed by descriptors such as, 'no potato taste', and 'no Potato smell, bad after taste', 'white 'and 'tasteless' which were attributed to them. Interestingly, some consumers also felt they were somehow "firm", "smooth in the mouth", "good potato smell" and "good potato taste". This could explain their median score for overall liking.

Agglomerative Hierarchical Clustering of consumers in Kabale produced three groups namely; "Victoria dislikers", "Kinigi and Rwangume likers" and "All likers". Victoria dislikers constituted the largest percentage followed by "All likers" and "Kinigi and Rwangume likers". The dislike for Victoria was probably due to its pale/white colour, being too soft, and lack in terms of distinctive potato taste and mealiness. This pattern carried through to the various demographics such as gender, ethnicity, age group, occupation and wealth status. Similarly in Rakai, three groups arose majority of whom were "All likers" followed by "Deodeo and Kasumali likers" and lastly "Kabale dislikers". Kabale was particularly disliked for its pale/white colour), this was a deficiency regarding both potato taste and mealiness. This classification was also carried over into the various demographic segments.

Consumption habits were similar among boiled potato consumers both in Kabale and Rakai. Boiled potato was mostly consumed several times a week, in the 'katogo' form and more so at lunch time. Katogo represents convenience in terms of preparation whereby potatoes are boiled together with other ingredients such as beans/ground nuts and/or vegetables.

In conclusion, consumers showed inclination towards boiled potatoes that were; "mealy", "yellow", with "good potato smell", "firm" and "good potato taste". These were associated with the varieties Rwangume, Kachpot 1, Kinigi, Deodeo and Kasumali. On the contrary, disliked boiled potatoes were "white", with "no potato taste", "watery", "no potato smell" and "tasteless" with attribution to Victoria and Kabale potato varieties. This study is a foundation on which WP2 could build to refine these sensory descriptors and made them into objective measurements to guide breeding programs.

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