Field Scientific Report

Consumer Testing of Boiled Cassava in Rural and Urban Areas of 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

Recent developments with the CGIAR have led cassava variety development to increasingly focus on assessing clones based on end-user acceptance of the crop and of finished product(s). Consumer testing of boiled cassava was carried out in rural areas (Luweero and Apac) and urban areas (Kampala) of Uganda. Consumers were invited to test boiled products from several cassava varieties and give their opinion about the products using various methods including overall liking (9-point hedonic scale), Just-About-Right (JAR) and Check-All-That-Apply (CATA) tests. Using these methods, consumers indicated their preferred sensory attributes for boiled cassava. Results showed that consumers preferred local varieties Bao, Bwanjule and Nabwangu, which possessed good quality attributes namely; 'mealiness', 'sweetness', 'softness', 'nice aroma', 'whiteness', 'firmness' and 'sticky'. Newly improved varieties and Alanyo Deri- a local variety - were least preferred because boiled cassava product resulting had poor qualities such as; 'dry', 'bitterness', 'watery', 'hard', 'tastelessness', 'yellow', 'fibrous' and 'odourless'. This information gathered in this activity will be key for WP2 to determine appropriate physicochemical evaluations to assess cassava clones' qualities.

Key Words: Boiled cassava, overall liking, Just-About-Right, Check-All-That-Apply, Uganda, Luweero, Apac, Kampala

1 STUDY CONTEXT AND GENERAL OBJECTIVES

WP1 of the RTBfoods project aims at understanding the quality characteristics of boiled cassava in Uganda, as defined by local consumers. Another aim is to provide WP2 with a clear and visual mapping of the most liked products associated with high quality characteristics and high overall liking scores, and of the least liked products associated with low quality characteristics and low overall liking scores.

Accordingly, an in-depth description of quality characteristics of boiled cassava and steps taken to process the product were respectively documented under Activities 3 & 4 of WP1. Processing steps (from Activity 4) were used to prepare boiled cassava, which was thereafter evaluated by the consumers using the quality characteristics, identified as important by the respondents during Activity 3 “Surveys” and by the processors during Activity 4 “Participatory processing diagnosis” when processing different varieties in quality characteristics. Boiled cassava was made from four local and four improved varieties that were selected by both processors and NaCRRI scientists. The local varieties selected included Bao, Alanyoderi, Bwanjule and Nabwangu, while improved varieties were NASE14, NAROCASS 1, TME14 and NASE1. This varietal selection represented diverse quality characteristics appropriate for this study

2 METHODOLOGY

2.1 Sampling

A total of 276 consumers selected from three districts, Apac, Luweero and Kampala districts, participated in consumer testing (Figure 1).

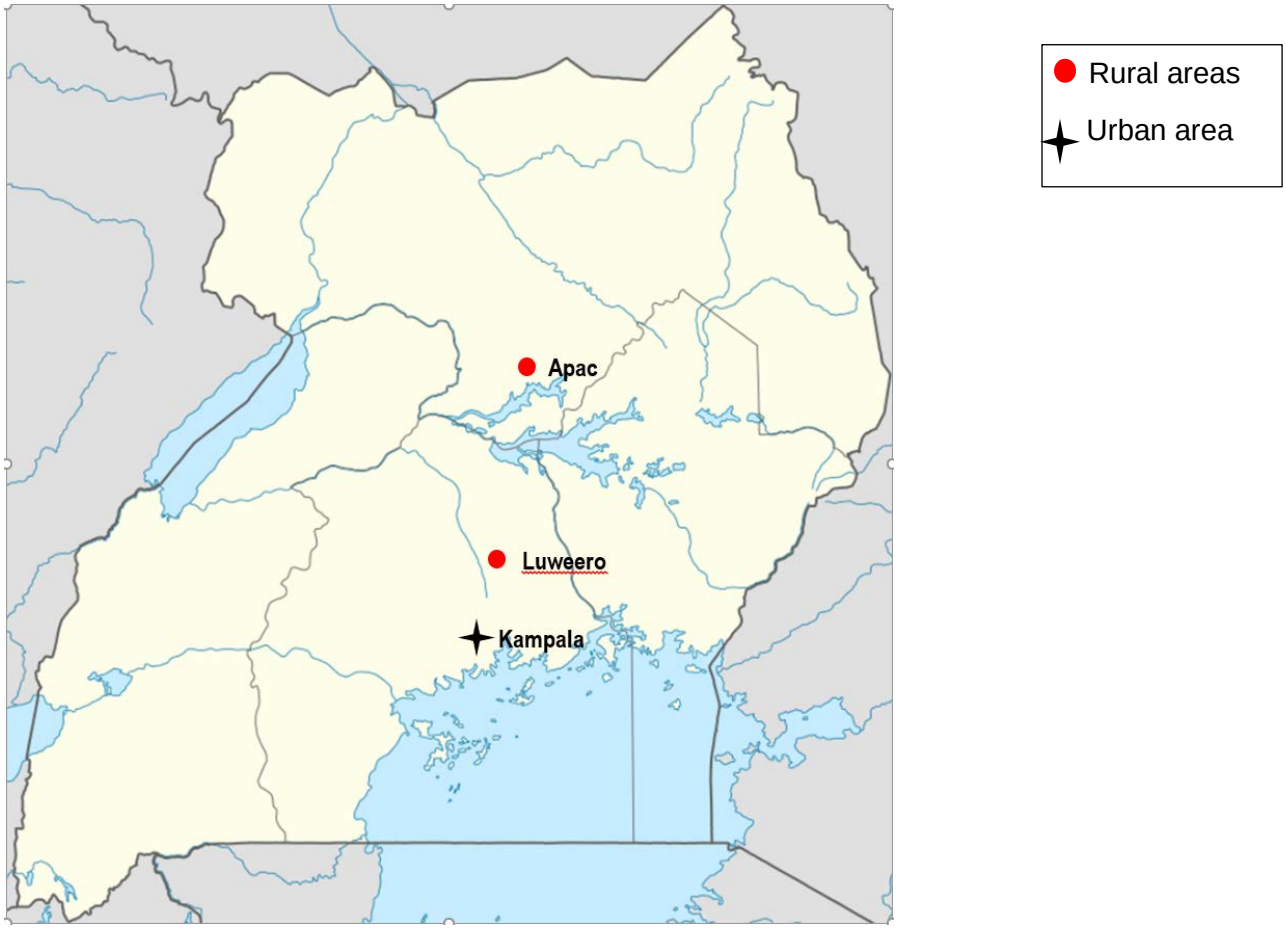


Figure 1. Map of Uganda showing the geographical locations where Activity 5 was conducted

Apac and Luweero districts represented rural locations, where Activities 3 & 4 were conducted. On the other hand, Kampala district represented the urban community. Men and women of different age groups were invited to participate in the consumer testing (Table 1).

Table 1. Number of men and women interviewed in the rural and urban areas

District	Parish	Village	Count of Women	Count of Men
Luweero	Butuntumula	Butuntumula	7	9
	Bwaziba	Kakala	4	3
		Kabelenge	7	9
	Kabakedi	Kasoma	0	1
		Kasozi	3	1
		Kibula	5	2
		Kijjukira	0	2
		Kibelenge	0	1
		Butuntumula	1	1
	Ngolo	Butuntumula	11	16
		Kasoma	0	1
		Kiiya	0	1
		Kabike	0	2
Sub-total Luweero			38	49
Apac	Akere	Ogei	13	15
		Amaleng	0	1
	Atana	Angu A	0	1
		Awir	7	20
		Ayegero	2	4
	Atig Lwok	Adagayela	2	2
		Adwil	0	3
		Anywargiki	1	1
		Arwot Nyap	0	3
		Awi Nyeko	1	0
	Chegele	Adagayela	1	0
		Angek B	1	0
		Anyabagyi	2	0
		Anyambazi A	3	1
		Anyambazi B	3	6
		Arwot Nyap	1	0
Sub-total Apac			37	57
Kampala	Nangabo	Gayaza	11	3
	Kalerwe	Kalerwe	12	15
	Kasubi	Kasubi	17	22
	Nakawa	Nakawa	13	2
Sub-total Kampala			53	42

2.2 Consumer testing

The consumers were invited to a common place at rural and urban level where consumer testing was conducted. The varieties which were evaluated by consumers in different locations are shown in Table 2. In Apac, five varieties were evaluated, while four varieties were evaluated in Luweero and Kampala. Boiled cassava was prepared following steps documented in Activity 4 of WP1. Individual consumers were invited to fill a questionnaire that captured information on both demographic and consumption habits. One product (boiled cassava of a specific variety) was presented at random until all test varieties were completed. Consumers were requested to taste each product and score the overall liking using a nine-point hedonic scale (1. “Dislike extremely, 9. “Like extremely”). In addition, they were requested to score the intensity of three specific descriptors

identified as important in Activities 3 and 4, using the 3-point JAR "Just About Right" scale (1 = "Too low, too weak, or not enough"; 2 = "JAR"; and 3 = "Too high, too strong, too much"). Furthermore, consumers were asked to choose sensory characteristics (Table 3) that best describe the product from the Check-All-That-Apply (CATA) table, which included sensory descriptors collected during Activities 3 & 4 (Fliedel et al., 2018).

Table 2. Cassava varieties evaluated by consumers in the three target districts of Uganda

District	Variety name	Variety Description
Apac	Alanyoderi	Local
	Bao	Local
	NAROCASS 1	Improved[R]
	TME 14	Improved[I]
	NASE 14	improved[I]
Luweero	Nabwangu	Local
	Bwanjule	Local
	NASE 13	Improved[I]
	NASE 14	Improved[I]
Kampala	Bwanjule	Local
	Nabwangu	Local
	NAROCASS 1	Improved[R]
	NASE 14	Improved[I]

R= recently released varieties, I= officially released obtained from the breeding program. Evaluations were undertaken during the first growing season of 2019.

Table 3 shows the quality characteristics which were identified during previous activities and used to build the CATA table. Finally, consumers were asked to give an opinion on the most preferred variety and the attributes that determined this choice.

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

List of the most liked characteristics	List of the least liked characteristics
Appearance	**Appearance**
Attractive	Not attractive
White colour	Yellow
Odour	Watery
Nice odour	**Texture in the hand**
Texture in the hand	Fibrous
None fibrous	**Taste**
Sticky	Bitter
Taste	**Texture in the mouth**
Sweet	Hard
Tasteless	Woody
Not bitter	
Texture in the mouth	
Soft	
Mealy	
None fibrous	

2.3 Data analysis

All data collected were entered and cleaned in Microsoft Excel. Subsequent data analysis was done using R-statistics software. Tukey's test was thereafter performed to determine if the overall liking of the boiled cassava products significantly differed between the varieties at a significant level of $p<0.05$ (n=274 consumers). In addition, consumers were segmented into groups of similar overall liking for the boiled cassava varieties using Agglomerative Hierarchical Clustering (AHC) analysis.

Sociodemographic characteristics of each cluster were analysed to understand whether they significantly differed using a Chi-square test.

For each boiled product 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 was determined by location. Data generated from Check all that apply (CATA) was subjected to Principal component analysis (PCA) to describe the relationships between number of citation of CATA sensory characteristics and the visual representation of each boiled cassava variety. Furthermore, to understand the consumers' opinion on preferred varieties and related characteristics, a percentage was computed from the counts of consumers who preferred a variety for a given sensory characteristic.

3 RESULTS

3.1 Overall liking of boiled cassava

Highly significant differences in overall liking were noticed among varieties in Apac (P-value=1.33e-07 ****), Luweero (3.325e-13***) and Kampala (2.2e-16***) at p<0.05 (Table 4). In Apac, Bao had the highest mean score for overall liking (6.0 = like slightly) followed by NASE 14 (5.3 = neither like nor dislike), while Alanyoderi had the lowest mean score (3.7 = dislike slightly). In Luweero and Kampala, Bwanjule had the highest score (7.4 = like moderately and 7.9 = like very much, respectively), while NASE 14 and Nabwangu had the lowest scores (4.6 = neither like nor dislike in Luweero for NASE 14 and 3.7 = dislike slightly in Kampala for Nabwangu respectively). All improved varieties had intermediate scores in Apac (from 4.4 to 5.4) and in Luweero (from 4.6 to 5.8). In addition, improved varieties TME14 and NAROCASS 1 were grouped together in Apac, while NASE 13 was grouped together with a local variety Nabwangu in Luweero.

NASE 14 evaluated in the three districts was judged differently in score from one district to another. There was received a score of "like moderately" in Kampala while in Luweero and Apac districts, the score is close to 5 (neither like nor dislike). In both districts (Apac and Kampala) NASE 14 received a higher score compared to NAROCASS 1. A similar trend was observed between Bwanjule and Nabwangu, with a higher score for Bwanjule in Luweero and Kampala districts. These results showed that from one district to another, the tendency of consumer perception can be considered similar though the score level is very different.

Table 4. Mean overall liking scores for the varieties tested in Apac, Luweero and Kampala

District	Boiled cassava varieties	Mean overall liking score	Standard deviation	Groups*
Apac	Bao	6.0	2.6	a
	NASE 14	5.3	2.9	ab
	TME14	4.5	2.9	bc
	NAROCASS 1	4.4	2.6	bc
	Alanyoderi	3.7	2.5	c
Luweero	Bwanjule	7.4	2.4	A
	NASE 13	5.8	2.2	B
	Nabwangu	5.7	2.6	B
	NASE 14	4.6	2.4	C
Kampala	Bwanjule	7.9	7.9	A
	NASE 14	6.8	3.7	B
	NAROCASS 1	6.4	6.4	B
	Nabwangu	3.7	6.8	C

**Different letters per box (=location) show significant differences in overall liking. Tukey test at p<0.05.*

3.2 Segmentation of consumers into groups of similar overall liking

Agglomerative Hierarchical Clustering (AHC) analysis was done on the overall liking scores of the boiled cassava varieties to get insights about similarities and/or differences in consumers' overall liking. Consumers in Apac, Luweero and Kampala district were grouped into three clusters. (Figure 2).

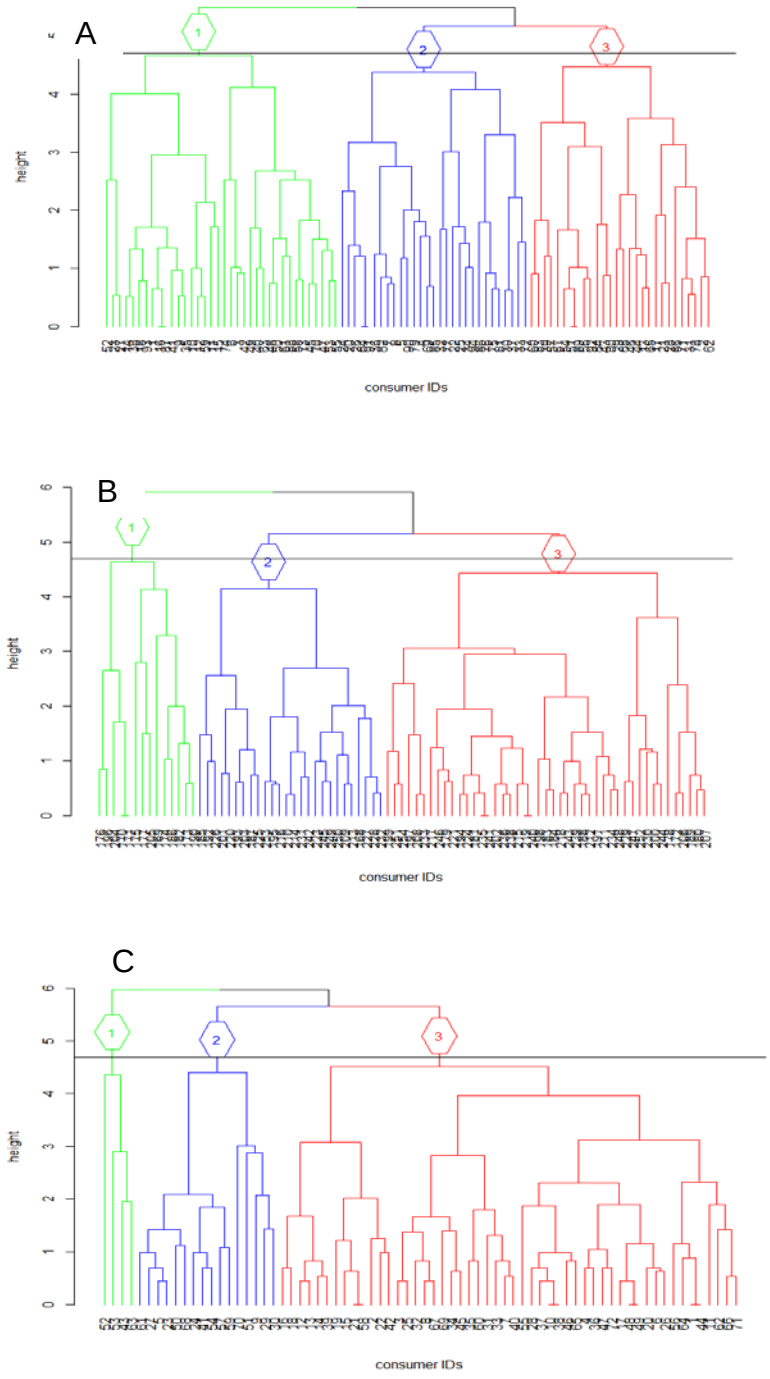
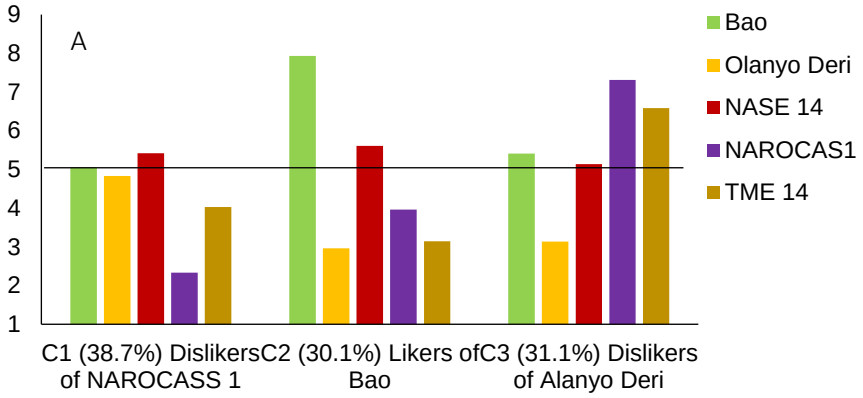
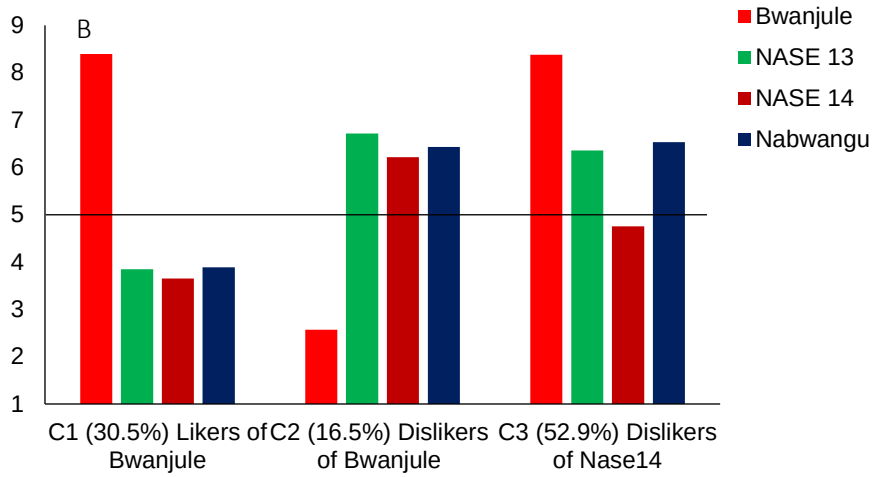


Figure 2. Clustering of consumers based on overall liking scores in (A) Apac, (B) Luweero and (C) Kampala

In Apac, three groups of consumers namely “NAROCASS 1 & TME 14 dislikers”, “Bao likers”, and “Alanyoderi dislikers” were identified. These three clusters contained 38.7%, 30.1% and 31.1% of the consumers interviewed, respectively. TME14 and NAROCASS 1 were liked by consumers in Cluster 3 who disliked Alanyoderi (Figure 3 A). In Luweero, three groups of consumers namely “Bwanjule likers”, “Bwanjule dislikers”, and “NASE 14dislikers” were identified. These three clusters contained 30.5%, 16.5% and 52.9% of the consumers interviewed respectively. The local variety Bwanjule was liked by consumers in Clusters 1 and 3, yet it was disliked by consumers in Cluster 2 who liked NASE 14, NASE 13 and Nabwangu. NASE 14 was judged as ‘neither like nor dislike” by the Cluster 3-consumers (Figure 3 B). In the urban community (Kampala), three groups of consumers including “NASE 14 dislikers”, “Bwanjule & NAROCASS & likers”, and “NASE 14 likers” were identified. These three clusters contained 58.5%, 31.9% and 10.6% of the consumers interviewed respectively. There was general liking of Bwanjule and NAROCASS 1 by consumers in Clusters 1 and 2. A minority of consumers (consumers in Cluster 3) liked NASE 13 (Figure 3 C). Overall, local varieties such as Bao and Bwanjule were liked by consumers in Apac, Luweero and Kampala regions, while improved varieties such as NAROCASS 1, TME 14, NASE 14 and NASE 13 was liked by limited numbers of consumers across locations.





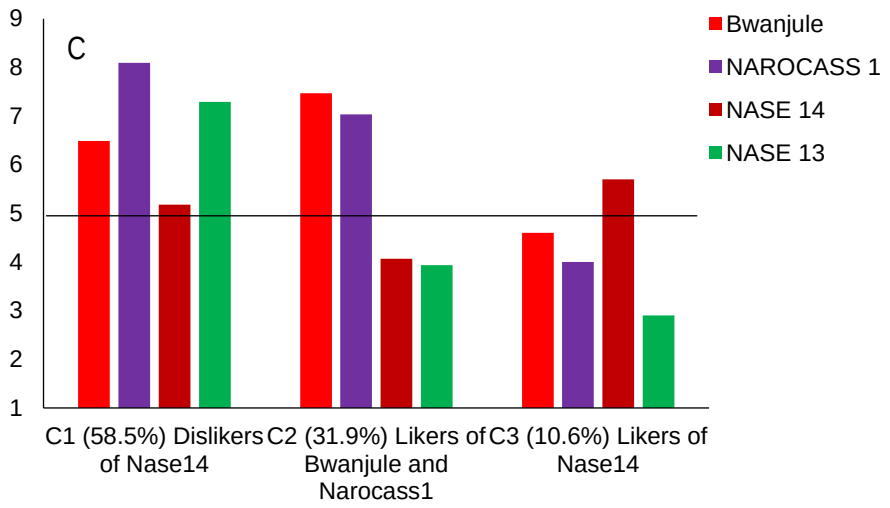


Figure 3. Composition of consumers in different clusters in (A) Apac, (B) Luweero and (C) Kampala

3.2.1 Demographic data of the consumers interviewed

Significant differences in sociodemographic characteristics of clusters at p-Value <0.05 were not found in Apac and Luweero. On the other hand, in Kampala, the three clusters differed significantly by age (p-value= 0.002). To a limited extend, significant differences at p-Value <0.1 were also found for gender (p-value= 0.096), and wealth status (P-Value= 0.087). (Table 5).

Cluster 1 consumers seem a bit less discriminatory than the other clusters in Kampala because the overall liking of the varieties was 5 or more: there were more men compared to women, more middle-class, and a higher proportion of older people (over 36 year-old) in cluster 1 called 'dislikers of Nase14'.(Table 5).

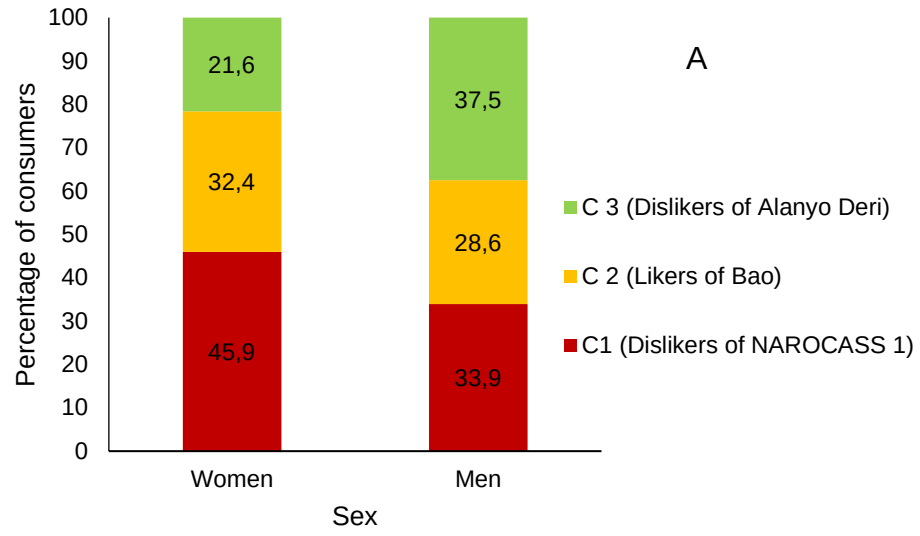
Disaggregation by sex and cluster regarding liking of variety showed no differences between men and women Figure 4. Accordingly, in Apac Bao was the preferred variety for both men and women while Bwanjule was the preferred variety in Luweero. In Kampala, men and women preferred Bwanjule and Narocass 1. It suffices to note that, Narocass 1 was disliked men and women in Apac. Thus, likeness of a variety may be location dependant.

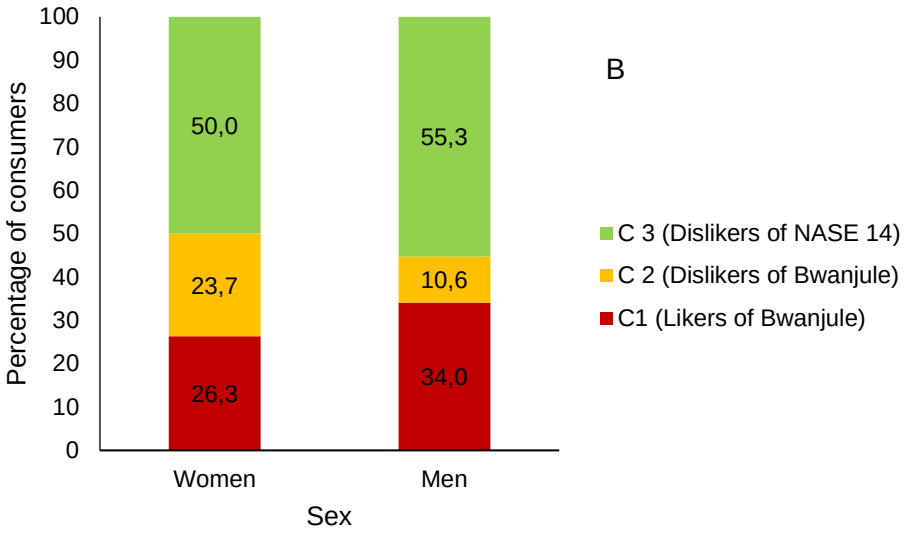
Table 5. Demographic differences of consumers in Apac, Luweero and Kampala with respect to cluster division

	Apac (n=94)					
			Count by cluster			
Category	Variable	Total of consumers	Cluster 1	Clustrer 2	Cluster 3	p-value (Chi-square test)
Sex	women	37	17	12	8	0.259
	men	56	19	16	21	
Marital status	Divorced	2	0	2	0	0.101
	Married	75	32	21	22	
	Single	13	3	3	7	
	Widow	3	1	2	0	
Education level	None	6	3	2	1	0.944
	Primary	46	18	15	13	
	Secondary	28	11	7	10	
	Tertiary	13	4	4	5	
Wealth status	Poor class	21	8	7	6	0.258
	Middle class	31	15	6	10	
	Upper class	6	4	0	2	
Age	16-20	5	2	1	2	0.498
	21-35	37	7	11	19	
	36-80	51	27	16	8	
	Luweero (n=87)					
			1	2	3	
Sex	Female	38	10	9	19	0.26
	Male	47	16	5	26	
Marital status	Divorced	3	1	0	2	0.561
	Married	43	15	7	21	
	Single	32	9	7	16	
	Widow	7	1	0	6	
Education level	None	4	1	1	2	0.46
	Primary	43	9	8	26	
	Secondary	30	13	3	14	
	Tertiary	7	2	2	3	
Wealth status	Poor	35	10	3	22	0.266
	Middle	33	11	9	13	
	Upper class	5	1	0	3	

	Apac (n=94)					
			Count by cluster			
Category	Variable	Total of consumers	Cluster 1	Clustrer 2	Cluster 3	p-value (Chi-square test)
Age	18-20	14	4	5	5	0.451
	21-35	34	11	2	21	
	36-	37	11	7	19	
	Kampala (n=95)					
Sex	Female	53	26	19	8	0.096
	Male	42	29	11	2	
Marital status	Divorced	1	1	0	0	0.283
	Married	54	37	13	4	
	Single	36	14	16	6	
	Widow	1	1	0	0	
	Widower	3	2	1	0	
Age	18-20	5	1	3	1	0.02
	21-35	48	26	17	5	
	36-	43	28	11	4	
Education level	None	3	2	1	0	0.937
	Primary	41	26	11	4	
	Secondary	39	21	14	4	
	Tertiary	12	6	4	2	
Wealth status	Middle class	51	31	15	5	0.087
	Poor class	15	7	7	1	
	Rich class	3	2	0	1	

* significant at p<0.05





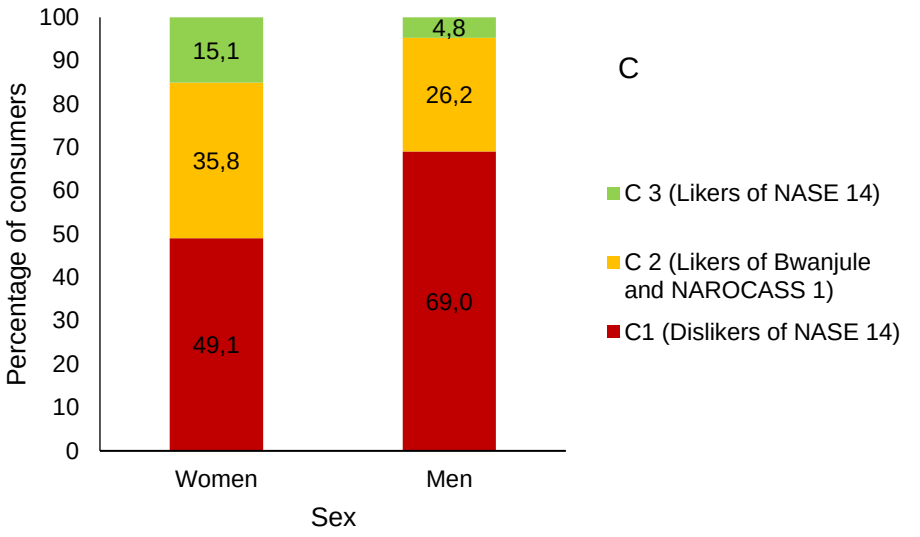


Figure 4. Percentage of consumers in cluster type by sex A) Consumers in Apac, B) Consumers in Luweero, C) Consumers in Kampala.

3.2.2 Consumption attitudes

In both rural and urban communities Apac, Luweero and Kampala, a majority of people consume boiled cassava frequently (Table 6).

Table 6. Boiled cassava consumption patterns by men and women in Luweero, Apac and Kampala

How often do you consume boiled cassava	Sex	Every day	Several times a week	Once a week	Several times a month	Once a month	Others	Total (n)
Counts of men and women								
Luweero (n=87)	Female	9	13	6	2	0	8	38
	Male	11	24	6	0	0	8	49
Apac (n=94)	Female	25	7	2	0	0	3	37
	Male	36	18	1	0	1	1	57
Kampala (n=95)	Female	10	25	7	1	4	6	53
	Male	10	21	4	0	1	5	42
Total		101	108	26	3	6	31	276
Average (%)		36.6	39.1	9.4	1.1	2.2		

Most consumers (75.7%) consumed boiled cassava every day to several times a week. A minority of consumers consumed boiled cassava less: 9.4% once a week, 1.1% several times a month, 2.2% once a month.

Overall, the first form of cassava consumption was as a plain snack (65.2%) then as a mixture of cassava and other stew locally know as a *Katogo* (40.9%) and then as a meal served with other stew such as beans, ground nuts (37.0%). Boiled cassava is mainly consumed at breakfast for 66.7% of consumers interviewed, then at lunch 28.3%, and at dinner 4.3% (data not shown).

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 important sensory quality characteristics of boiled cassava samples. Such "descriptors' diagnostic" may help understand why consumers like or dislike those products.

The JAR test was done on the three important characteristics namely, softness, sweetness and mealiness. The percentage of consumers who evaluated each characteristic as JAR or Not JAR (Too weak or Too strong) are counted for each boiled cassava variety in the three districts.

Results from Apac showed that softness was perceived JAR for the varieties of boiled cassava TME 14 and Bao by 57.4 and 56.4 % of consumers respectively. NAROCASS 1 and Alanyoderi were perceived 'not enough soft' by 62.8% of consumers. For sweetness, only Bao was perceived JAR (60.6% of consumers), while all the other varieties were perceived 'not enough sweet' (from 54.3 % for NASE 14 to 64.9 for NAROCASS 1). Alanyoderi, NAROCASS 1 and NASE 14 were evaluated as 'not enough mealy' (by 67.0, 63.8 and 55.3% of consumers respectively). TME 14 and Bao were found JAR for their mealiness by only 54.3 and 51.1% of consumers. Bwanjule variety had the best score in Luweero and Kampala for softness, sweetness and mealiness (judged as JAR by >80% of consumers). In Luweero, NASE 14 was scored as 'not mealy and sweet enough' by 68.6% and 44.2% consumers respectively. In addition, NASE 13 was scored as 'not soft enough' by 43% consumers. In Kampala, NAROCASS 1 variety was scored as 'not soft and mealy enough' by 47.4 and 48.4 consumers respectively. Nonetheless, the all varieties evaluated in Kampala were generally sweet (Figure 5).

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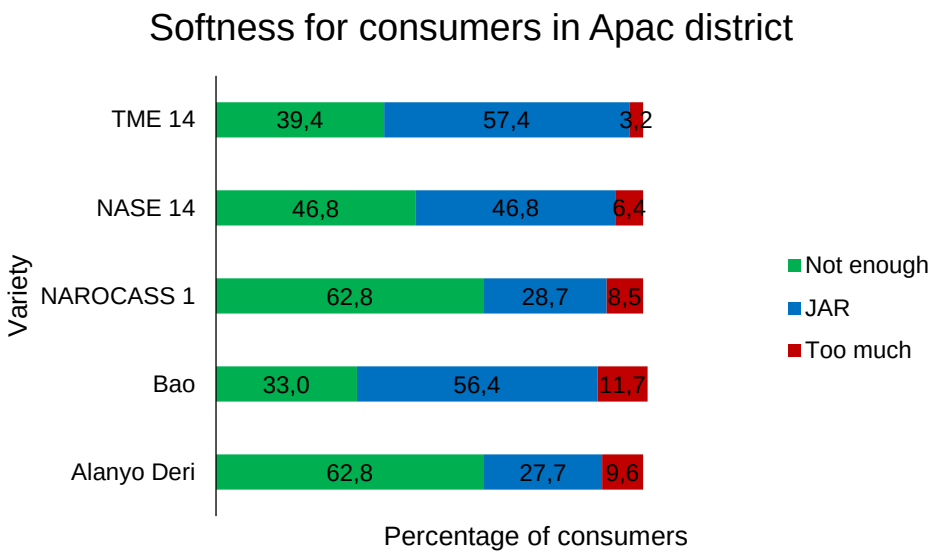
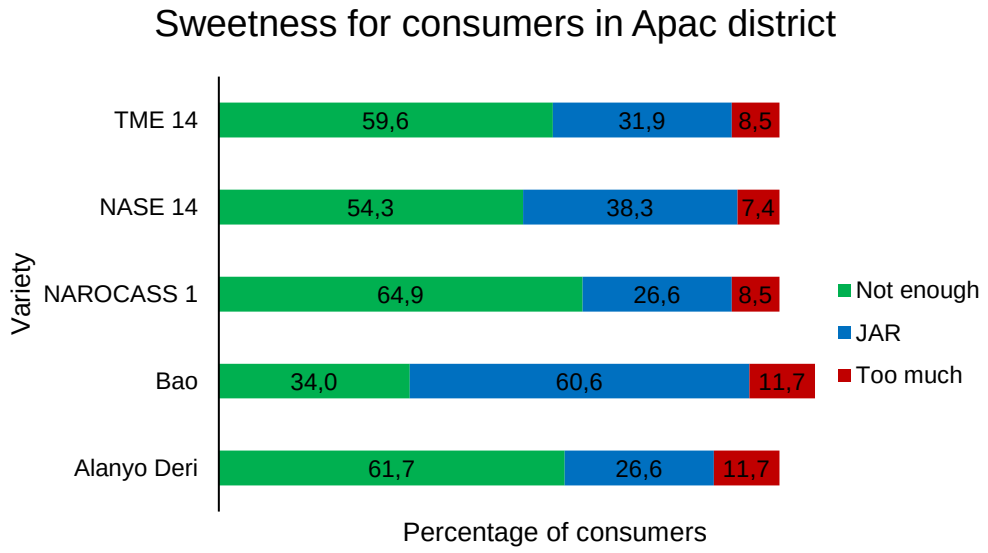
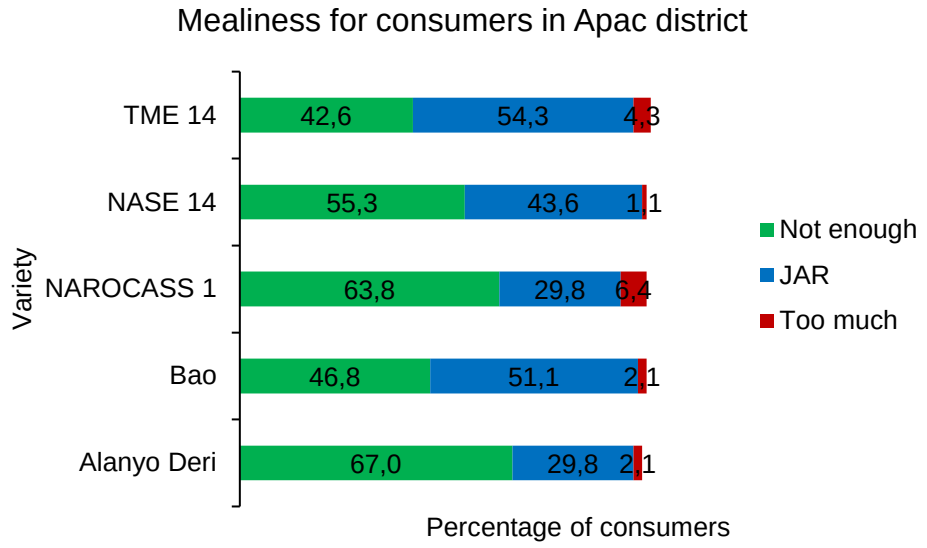
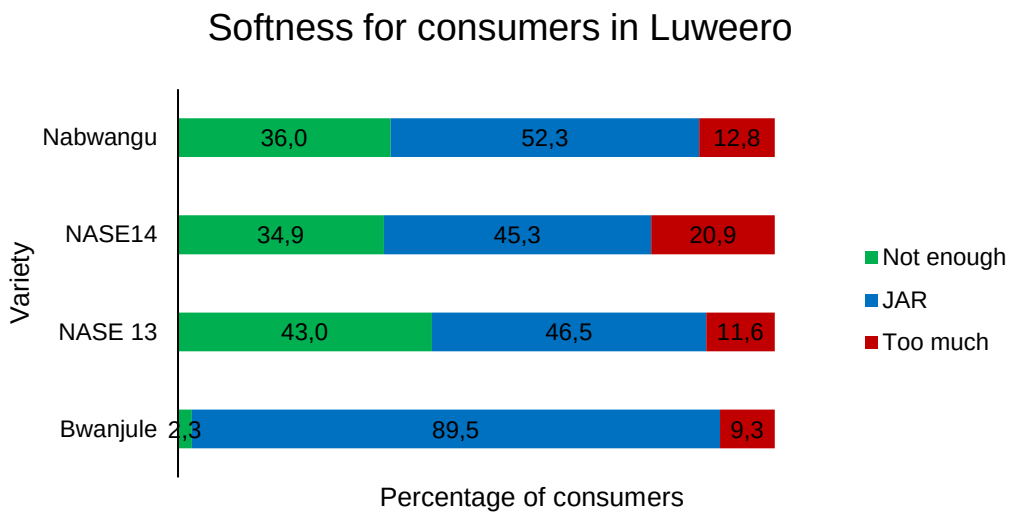
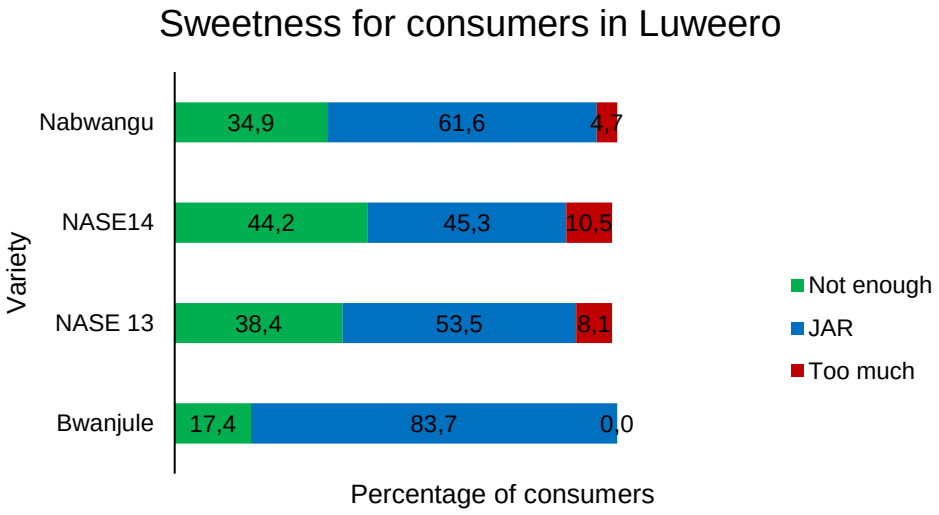
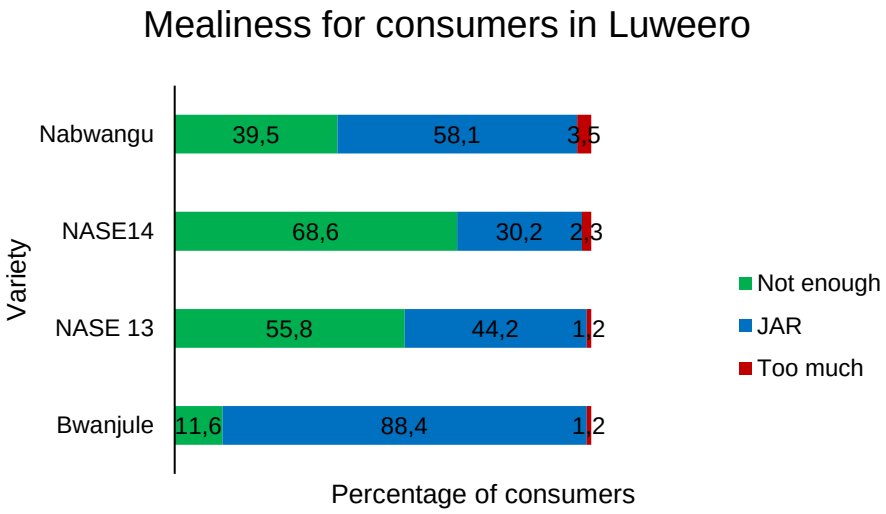

Softness for consumers in Apac district
TME 14
NASE 14
NAROCASS 1
Bao
Alanyo Deri
Variety
39,4
57,4
3,2
46,8
46,8
6,4
62,8
28,7
8,5
33,0
56,4
11,7
62,8
27,7
9,6
Not enough
JAR
Too much
Percentage of consumers

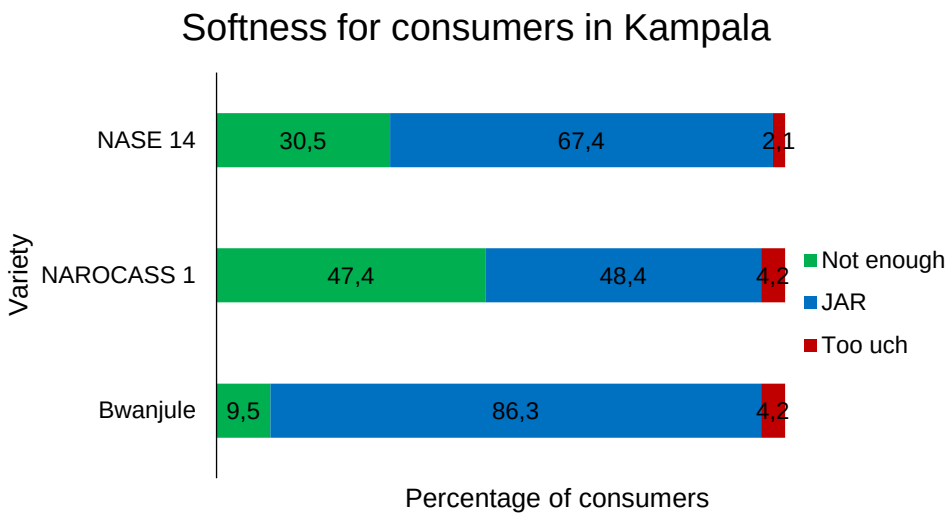

Sweetness for consumers in Apac district
TME 14
NASE 14
NAROCASS 1
Bao
Alanyo Deri
Variety
59,6
31,9
8,5
54,3
38,3
7,4
64,9
26,6
8,5
34,0
60,6
11,7
61,7
26,6
11,7
Not enough
JAR
Too much
Percentage of consumers

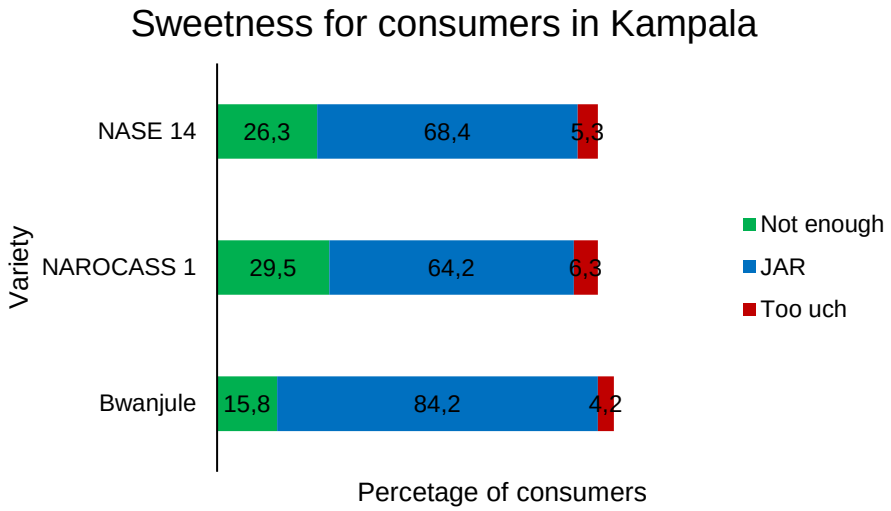

Mealiness for consumers in Apac district
TME 14
NASE 14
NAROCASS 1
Bao
Alanyo Deri
Variety
42,6
54,3
4,3
55,3
43,6
1,1
63,8
29,8
6,4
46,8
51,1
2,1
67,0
29,8
2,1
Not enough
JAR
Too much
Percentage of consumers


Softness for consumers in Luweero
Nabwangu
NASE14
NASE 13
Bwanjule
Variety
36,0
52,3
12,8
34,9
45,3
20,9
43,0
46,5
11,6
2,3
89,5
9,3
Not enough
JAR
Too much
Percentage of consumers


Sweetness for consumers in Luweero
Nabwangu
NASE14
NASE 13
Bwanjule
Variety
34,9
61,6
4,7
44,2
45,3
10,5
38,4
53,5
8,1
17,4
83,7
0,0
Not enough
JAR
Too much
Percentage of consumers


Mealiness for consumers in Luweero
Nabwangu
NASE14
NASE 13
Bwanjule
Variety
39,5
58,1
3,5
68,6
30,2
2,3
55,8
44,2
1,2
11,6
88,4
1,2
Not enough
JAR
Too much
Percentage of consumers





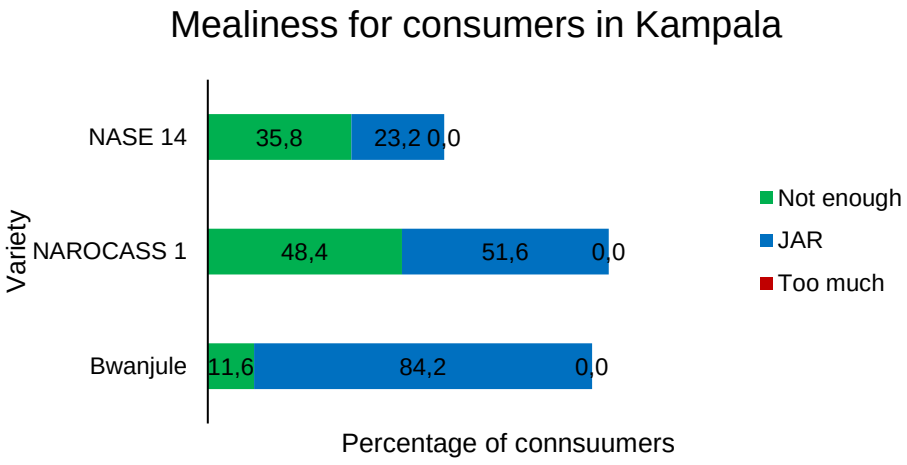


Figure 5: Percentage of consumers in Apac, Luweero, and Kampala who rated the three specific characteristics (softness, sweetness, mealiness) using the JAR test

3.4 Check All That Apply (CATA) test

Consumers were invited to choose the most appropriate terms that better describe each product sample among 20-25 sensory characteristics.

Consumers described varieties using a CATA table comprising 18 sensory characteristics of boiled cassava (Tables 7, 8 and 9).

Table 7. Frequency of citations of each quality characteristic by all the consumers

Variety	Bao	NASE 14	Alanyo Dyer	TME 14
White Colour	44	38	24	33
Sweet	58	43	40	28
Good taste	54	37	18	31
Bitter	3	19	15	39
Attractive	57	65	64	41
Tasteless	15	12	38	10
Odourless	5	19	24	15
Woody	1	2	1	2
Mealy	31	31	17	36
Soft	50	45	27	49
Nice aroma	44	31	29	28
Hard	32	39	57	37
Yellow	20	40	41	47
Homogeneous	31	18	11	15
Fibrous	7	30	22	28
Not attractive	27	35	41	35

Table 8. Frequency of citations of each quality characteristic by all the consumers in Kampala

Variety	NASE14	NAROCASS1	Bwanjule
White Colour	54	33	82
Sweet	37	60	56
Good taste	38	56	69
Bitter	8	3	10
Attractive	59	76	82
Tasteless	7	9	3
Odourless	12	15	10
Woody	5	2	2
Mealy	0	46	90
Soft	44	38	78
Nice aroma	30	48	68
Hard	26	47	12
Yellow	11	36	11
Homogeneous	14	10	25
Fibrous	4	3	1

Table 9. Frequency of citations of each quality characteristic by all the consumers in Luweero

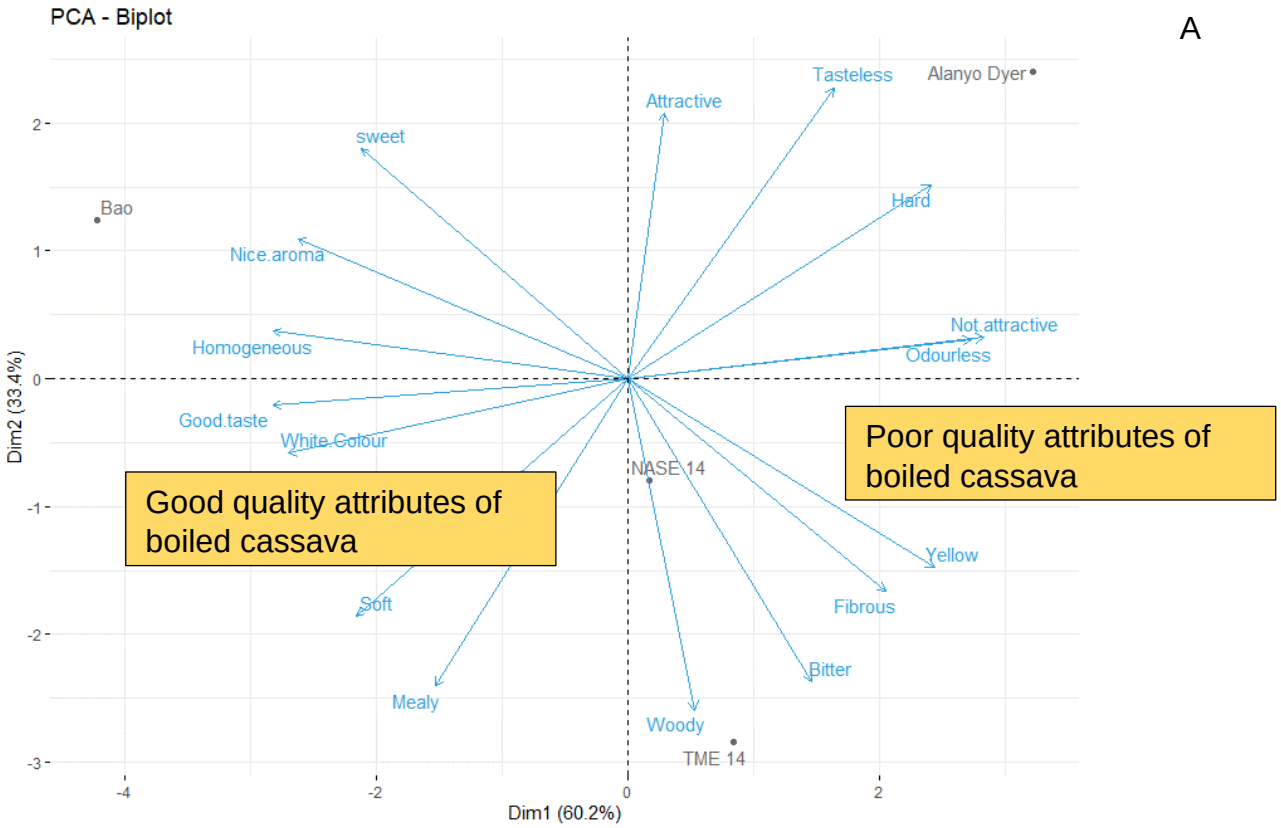
Variety	Nabwangu	Bwanjule	NASE 13	NASE 14
White Colour	44	68	26	8
Sweet	55	67	54	24
Good taste	39	71	36	25
Bitter	10	10	20	2
Attractive	64	70	57	5
Tasteless	11	1	4	8
Odourless	16	5	13	18
Woody	4	0	2	0
Mealy	39	57	24	18
Soft	41	78	38	31
Nice aroma	55	65	42	29
Hard	51	3	55	53
Yellow	21	11	33	43
Homogeneous	29	24	22	9
Fibrous	8	3	6	24
Not attractive	19	4	30	45
Sticky	14	18	16	11
Heterogenous	2	2	2	1

3.5 Sensory mapping of the sensory characteristics

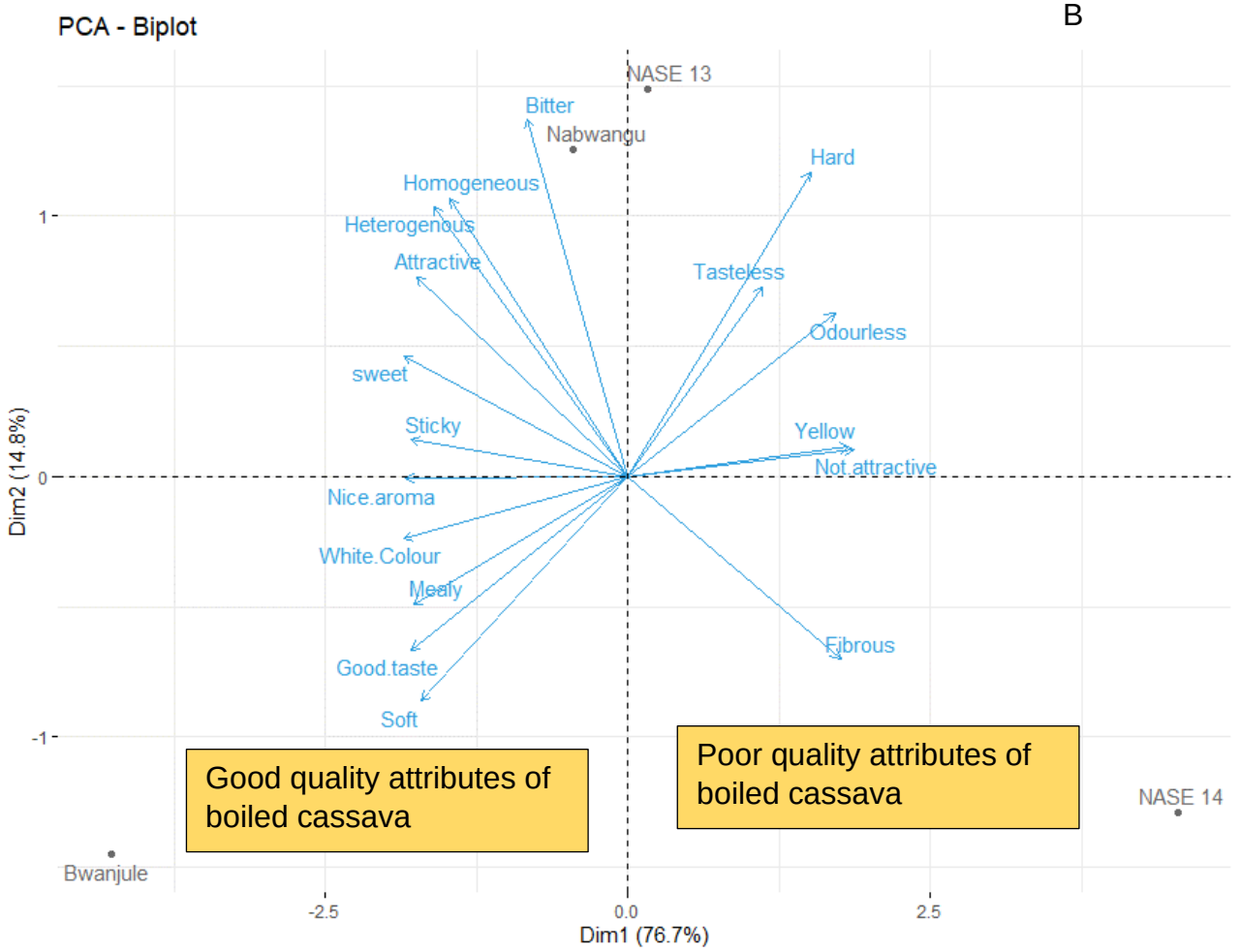
Principal component analysis (PCA) was used to summarize the relationships between CATA sensory characteristics, Product samples, and mean overall liking of each product scored by all the consumers.

The PCA plot explained 93.6%, 91.5 and 100% of the variance of the sensory characteristics in Apac, Luweero and Kampala (Figure 5). Overall, the local land races are plotted in the direction of the end-user trait preferences while the improved varieties are not Figure 6. Accordingly, results from Apac showed that variety Bao was associated with only good quality characteristics such as ‘sweet’, ‘nice aroma’, ‘homogeneous’ of boiled cassava while Alanyo Dyer, NASE 14 and TME 14 were generally associate with poor quality attributes such as ‘hard’, ‘tasteless’ ‘yellow’, ‘bitter’. In Luweero, Nabwangu and Bwanjule are associated with the quality traits of boiled cassava such as ‘homogeneous, sweet, soft, mealy while NASE 13 and NASE 14 are plotted in the direction with the undesirable traits such as yellow, fibrous, hard. Moreover, in Kampala, Bwanjule is plotted in the direction of the good quality attributes such as soft, mealy, nice aroma while NASE 14 and NAROCASS 1 are plotted in the direction of poor quality traits such as woody, yellow, hard, tasteless.

A


PCA - Biplot
Tasteless
Alanyo Dyer
Attractive
sweet
Hard
Bao
Nice.aroma
Not.attractive
Homogeneous
Odourless
Good.taste
White.Colour
NASE 14
Yellow
Soft
Fibrous
Bitter
Mealy
Woody
TME 14
Dim2 (33.4%)
Dim1 (60.2%)
Poor quality attributes of boiled cassava
Good quality attributes of boiled cassava

B


PCA - Biplot
NASE 13
Bitter
Nabwangu
Hard
Homogeneous
Heterogenous
Attractive
Tasteless
Odourless
sweet
Sticky
Yellow
Not.attractive
Nice.aroma
White.Colour
Mealy
Fibrous
Good.taste
Soft
NASE 14
Bwanjule
Dim2 (14.8%)
Dim1 (76.7%)
Good quality attributes of boiled cassava
Poor quality attributes of boiled cassava

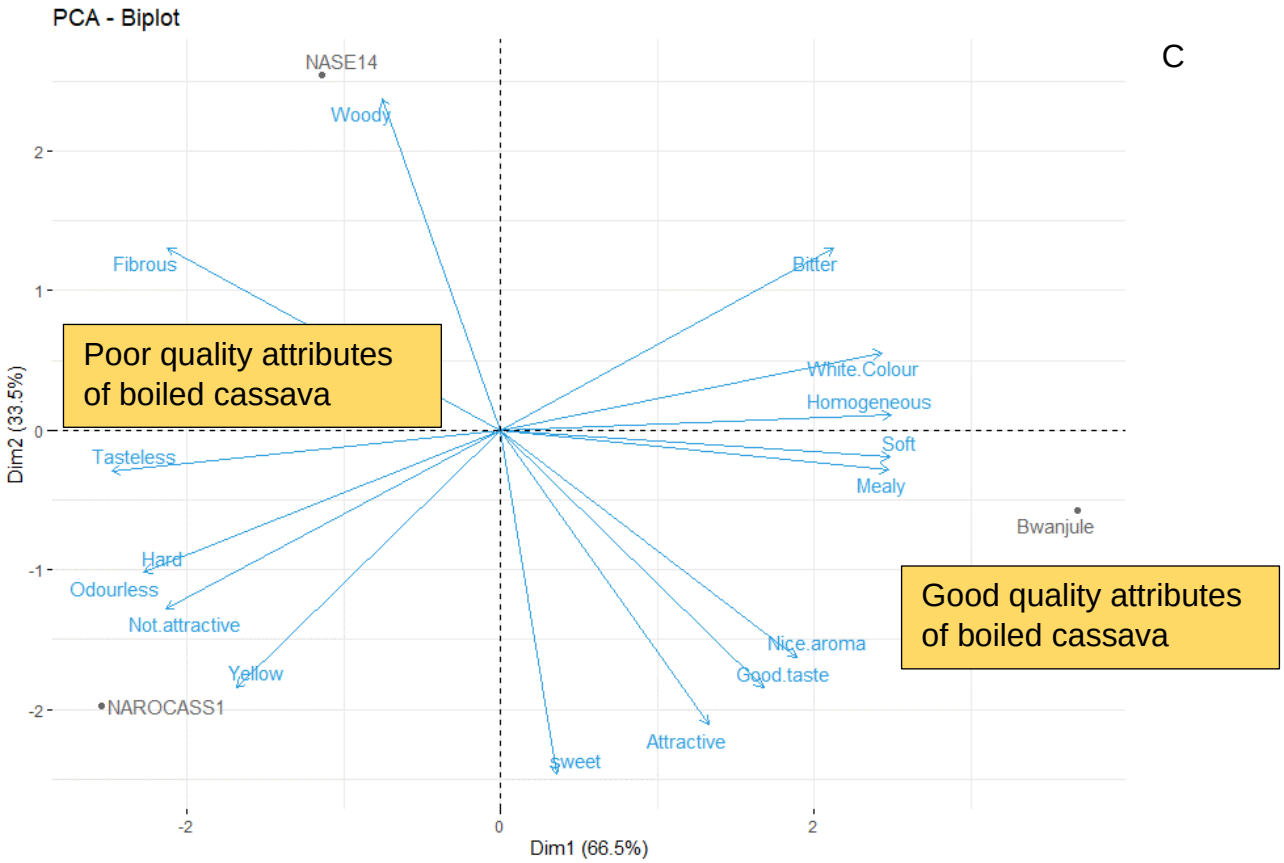


Figure 6. Mapping of boiled cassava varieties and the good and poor quality characteristics across the districts of; A) APac, B) Luweero and C) Kampala**.**

3.6 Description of consumers' opinions and preferences for the boiled cassava products

Results from Apac show that Bao is the most preferred varietie and it possesses quality characteristics such as sweetness and softness (Table 10). In addition, results from Luweero and Kampla showed that Bwanjule was the most preferred variety and it possessed good quality characteristics namely; "*softness", "mealiness", "whiteness of cortex", "nice aroma" and "sweet taste"*

Table 10. Percentage of consumers who explained for what characteristics they liked the boiled cassava variety

Apac					
Variety	White Colour	Sweet	Mealy	Soft	Nice aroma
Bao	46.80851	61.70213	32.97872	53.19149	46.80851
NASE 14	40.42553	45.74468	32.97872	47.87234	32.97872
Alanyo Dyer	25.53191	42.55319	18.08511	28.7234	30.85106
TME 14	35.10638	29.78723	38.29787	52.12766	29.78723
Luweero					
Nabwangu	50.57471	63.21839	44.82759	47.12644	63.21839
Bwanjule	78.16092	77.01149	65.51724	89.65517	74.71264
NASE 13	29.88506	62.06897	27.58621	43.67816	48.27586
NASE 14	9.195402	27.58621	20.68966	35.63218	33.33333
Kampala					
NASE14	56.84211	38.94737	0	46.31579	31.57895
NAROCASS1	34.73684	63.15789	48.42105	40	50.52632
Bwanjule	86.31579	58.94737	94.73684	82.10526	71.57895

4 DISCUSSION AND CONCLUSION

Overall, Bao variety from northern Uganda, Bwanjule and Nabwangu varieties from central Uganda gave good quality characteristics to boiled cassava. The good quality attributes include: 'mealiness', 'sweetness', 'softness', 'nice aroma', 'whiteness', 'firmness' and 'sticky' . On the contrary, Alanyoderi and the improved varieties (NASE 14, NASE 13 and TME 14) gave boiled cassava poor quality characteristics. Poor quality attributes include; 'dry', 'bitterness', 'watery', 'hard', 'tastelessness', 'yellow', 'fibrousness' and 'odourless'. The information generated here provides insights on desired end-user quality characteristics of boiled cassava that could be integrated within cassava breeding to improve consumer acceptance of cassava varieties in Uganda.

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