Consumer Testing of Boiled Yam in Rural and Urban Areas in Benin

Understanding the Drivers of Trait Preferences and the Development of Multi-user RTB Product Profiles, WP1, Step 4

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This report has been written in the framework of RTBfoods project.

Ethics: The activities, which led to the production of this document, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing practices. When external participants were involved in an activity, they were priorly informed about the objective of the activity and explained that their participation was entirely voluntary, that they could stop the interview at any point and that their responses would be anonymous and securely stored by the research team for research purposes. Written consent (signature) was systematically sought from sensory panellists and from consumers participating in activities.

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ABSTRACT

This report is part of the RTBfoods project WP1 outputs, essentially devoted to consumer testing (Step 4) of boiled yam. This activity aims to provide information on the relationships between sensory properties and consumer overall liking of boiled yam. For this purpose, information related to sensory quality characteristics and processing of the boiled yam were collected from previous activities (Step 2 "Surveys" and Step 3 "Processing diagnosis") on boiled yam and used for this consumer testing on boiled yam.

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Boiled yam is the second form of consumption of yam beside pounded yam. Boiled yam is consumed with sauces made from tomato, pepper and oil. The quality of this product as well as the market demand are not well documented. This study aimed at understanding the consumers' demand for quality characteristics of boiled yam. Five yam varieties named *Laboko, Kodjèwé, Gnidou, Paina* and *Kpètè* were processed into boiled yam pieces and evaluated by 301 consumers in three locations: Dassa and Djidja (rural areas), Bohicon (a small town) and Cotonou (a big city), using consumer testing including hedonic, CATA and JAR tests. The overall liking of boiled yam depended significantly on the type of yam variety and consumers' locations (rural areas, small town or city). It was observed that *Laboko* and *Kodjèwé* varieties fulfilled the hedonic expectations of consumers. High quality boiled yam should be white or yellowish, easy to break with the hand, easy to chew, friable/tender, with a good smell of yam, not sticky in mouth and a sweet taste. The overall liking is greatly penalized by dark colour, hard in hand, lack of sweet taste and lack of friability in mouth.

Keywords: boiled yam, CATA (Check All That Apply) analysis, consumers' preferences, consumption habits, quality characteristics, overall liking, penalty analysis.

1. INTRODUCTION

The aim of the consumer testing activity is to understand the consumers' demand for quality characteristics of the boiled yam. 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. Boiled yam is consumed in both rural and urban areas during either breakfast, either lunch or dinner. Some sensory characteristics of the boiled yam were collected during previous Step 2 "Surveys" (Honfozo et al., 2019). In addition, yam varieties suitable and not suitable for processing into boiled yam and their associated quality characteristics were highlighted during Step 5 "Processing diagnosis" (Bouniol et al., 2019). This Step 4 "Consumer testing" aims to provide information on overall liking scores of boiled yam samples, optimum level of intensity for some sensory descriptors, and sensory mapping of sensory characteristics and boiled yam varieties to better understand the relationships between sensory characteristics and consumer overall liking.

2. METHODOLOGY

2.1. Boiled yam samples

Five out of the varieties that were used in the previous processing diagnosis (Bouniol et al., 2019) were processed into boiled yam pieces by one skilled processor at each location following the same procedure. These varieties were *Laboko, Kodjèwé, Gnidou*, *Paina* and *Kpètè*. In order to maintain a warm temperature for the boiled yam samples during the consumer testing activity, batches of boiled yam pieces were made and immediately stored for 5 min in an insulated container before serving (60–65 °C).

2.2. Consumer testing

Consumer testing was carried out with 301 consumers interviewed randomly in different locations (Table 1): 129 in eight rural communities, fifty-two in Bohicon, a small urban town, and 120 in the city of Cotonou and its neighbourhood. Consumers were 18–72 years old and included 57.8% males and 42.2% females.

Table 1: Distribution of respondents by region and gender within consumer testing area

Fieldwork period		Regions	Locations	Number of consumers	
start	end			Men	Women
11th February 2019	22nd February 2019	Dassa	Adihinlidji	4	14
			Igoho	7	8
			Kpekoute	10	5
			Lema	10	6
		Djidja	Hannangbo	4	15
			Lalo	2	13
			Mandjavi	8	9
			Zinkamin	6	8
		Bohicon	Bohicon	28	24
		Cotonou	Cotonou	100	20
		TOTAL		179	122

Boiled yam samples (50–65 g) made from each yam variety were presented one after the other and in a random order to each consumer in a plastic glass coded with a 3-digit label. Mineral water was available for cleaning palate between samples testing. Consumers were asked to score the overall liking of each boiled yam sample using a 9-point hedonic scale (1 = 'Dislike extremely', 9 = 'Like extremely'). The intensity of five quality characteristics identified as important during previous surveys (colour, stickiness and hardness between fingers, friability in mouth and sweet taste) was evaluated using the 3-point 'just about right' (JAR) test (1 = 'TW: too weak' 2 = 'JAR: just about right'

and 3 = 'TS: too strong'). Each boiled yam sample was described using a Check All That Apply (CATA) test by selecting the most appropriate descriptors among the fifteen sensory characteristics (slightly yellow, white, dirty white, pinkish, sticky flesh , sticky on fingers, easy to break with the hand, hard in the mouth, friable/tender, not sticky in the mouth, no fibres, sweet taste, easy to chew, tasteless, slightly bitter) and five emotional terms (attractive, good smell of yam, good to eat, unpleasant to eat, bad taste) in the CATA table. All the terms were selected from aforementioned activities (Step 2 Surveys and Step 3 Processing diagnosis) (Table 2) and then randomised between and within respondents.

Table 2: Sources* of quality characteristics used for building the CATA table

Groups	Characteristics	Step 2	Step 3
	Pinkish colour		×
	White colour	×	×
Appearance	Attractive	×	×
	Slightly yellow colour	×	×
	Dirty white colour		×
	Sticky flesh (mucilage)		×
Texture in hand	Sticky on fingers	×	×
	Easy to break with the hand	×	×
	Hard in the mouth	×	×
Texture in mouth	Friable/tender	×	×
	Not sticky in the mouth		×
	No fibres		×
Odour	Good smell of yam	×	×
	Sweet	×	×
	Good to eat	×	×
	Easy to chew	×	×
Taste	Tasteless (neither sweet, nor bitter)		×
	Unpleasant to eat		×
	Bad taste	×	×
	Slightly bitter		×

Step 2 Surveys (Honfozo et al., 2019) and Step 3 Processing diagnosis (Bouniol et al., 2019).

2.3. Data analysis

The overall liking scores were submitted to variance analysis (ANOVA) with Tukey's test (p-value < 0.05). An Agglomerative Hierarchical Clustering (AHC) analysis was used to group consumers into similar classes of overall liking. JAR test data were analysed for five selected sensory characteristics (colour, stickiness and hardness between fingers, friability in mouth and sweet taste) by counting the percentage of consumers who evaluated each boiled yam sample as JAR 'just about right' or TW 'too weak' or TS 'too strong'. Penalty analysis was performed to identify potential directions for consumers demand on the basis of the five selected sensory characteristics. JAR and overall liking scores of all boiled yam samples were combined to determine important mean drops in overall liking when the characteristics were cited TW or TS by at least 20% of consumers (Pareto principle). For CATA data, Q Cochran's test was carried out to see if the frequency of citations of each characteristic significantly differed between the samples at a significant level of $p<0.05$. Principal component analysis (PCA) was conducted on the frequency of citations for all the quality characteristics with boiled yam samples as the observation labels and the mean overall liking of each sample as a supplementary quantitative variable. All statistical analyses were performed using XLSTAT version 2015.6.08 software (Addinsoft, Paris, France).

3. RESULTS

3.1. Consumption habits of boiled yam

Irrespective of the study areas, consumption of boiled yam occurs at a weekly frequency for 75.7% of respondents (many times a week and once a week for 64.1% and 11.6% of respondents, respectively) or many times a month for 11.3% of respondents (Table 3). The most frequent consumption pattern is boiled yam with sauces made with tomato, pepper and oil (94.4% of answers). However, boiled yam is also consumed alone (25.9%) or with other ingredients (9.7%). Concerning the occasion of consumption, boiled yam is mainly consumed at lunch time or between meals (63.1 and 37.9% of answers, respectively).

Table 3: Consumption habits of boiled yam

Categories	Variables	Frequency (%, n = 301 respondents)
Frequency of consumption	Everyday	2.3
	Many times a week	64.1
	Once a week	11.6
	Many times a month	11.3
	Once a month	3.0
	Rarely	7.3
Consumption patterns	Alone	25.9
	Mashed beans (seasoned)	3.7
	With ingredients (groundnuts, coconut)	6.0
	With tomato sauce, pepper, oil	94.4
Occasion of consumption	At breakfast	18.6
	At lunch	63.1
	Between meals	37.9
	At dinner	14.3

3.2. Overall liking of boiled yam varieties

The overall liking of boiled yam significantly differed between the five varieties and the locations (rural and urban) ($p < 0.05$) (Table 1). *Laboko* is the most liked variety by consumers (score of 7.6, like very much), followed by *Kodjèwé* (score of 7.0, like moderately), while *Kpètè* was scored the least ones (3.7, dislike slightly). *Gnidou* and *Paina* varieties were scored around 6 "like slightly" in the three study areas and can be considered as intermediate varieties. Consumers from rural communities gave higher scores for *Laboko* and *Kodjèwé* and lower scores for *Kpètè* boiled yams when compared to consumers from Bohicon and Cotonou. The score obtained for *Kpètè* in the city seemed higher than in the other localities. This indicated that citizens from urban areas (the small town and big city) seemed to be less able to discriminate the quality differences between boiled yam samples, probably because these consumers are less demanding of specific quality characteristics than consumers from rural areas (villages), and are used to consume many types of boiled yam.

Table 4: Mean overall liking score of boiled yam varieties

Location	Yam varieties				
	Laboko	*Kodjèwé*	*Gnidou*	*Paina*	*Kpètè*
Rural areas (n=129)	7.79[a1]	7.17[b1]	5.98[c1]	6.02[c1]	3.33[d1]
Small town (Bohicon, n=52)	7.44[a2]	7.17[a1]	6.38[b1]	6.23[b1]	3.60[c1,2]
City (Cotonou, n=120)	7.51[a2]	6.73[b2]	6.35[bc1]	6.28[c1]	4.11[d2]
Mean overall liking score	7.62[a]	6.99[b]	6.20[c]	6.16[c]	3.68[d]

Mean scores with different letters in the same line are significantly different (p<0.05);
For each variety in column, means followed with different upper figures are significantly different at 5% level.

3.3. Segmentation of consumers into groups of similar overall liking

The Agglomerative Hierarchical Clustering (AHC) analysis using Ward's method and automatic truncation indicated that consumers were clustered into three clusters as illustrated in Figure 1. All varieties except *Kpètè* were highly liked (scores between 6.8 and 7.8) by the consumers in Cluster 1 which represents the first largest group "*Kpètè* dislikers" (55% of the consumers). Cluster 2 "*Laboko* likers" grouped 26% of consumers. Consumers in Cluster 3 "*Laboko* and *Kodjèwé* likers" represents the smallest group of consumers (19%) who disliked very much *Kpètè* and had a slight dislike for *Paina* varieties. Although the three clusters scored *Laboko* and *Kodjèwé* varieties above 6, some consumers liked other varieties such as *Gnidou* or *Paina* (in Cluster 1); therefore, *Laboko* and *Kodjèwé* varieties are not the only ones that fulfil the sensory and hedonic expectations of consumers.
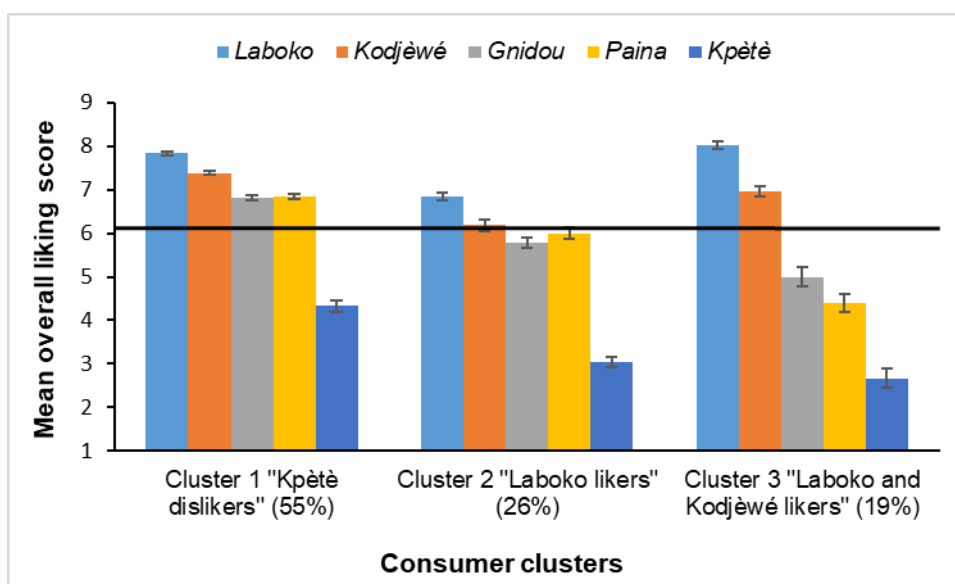

Figure 1: Mean overall liking scores of boiled yam by consumer clusters

3.4. Socio-demographic characteristics of the consumers interviewed

Consumers' socio-demographic characteristics (Table 5) indicated gender disparity (59.5% of men and 40.5% of women) among the 301 consumers interviewed. These informants belonged to different age's groups, however there were more young adults (18-35 years old, 62.5%) as compared to middle aged adults (36-55 years old, 31.2%) and older adults (> 56 years old, 6.3%). A great diversity of ethnic groups was found in the study areas (Adja, Aïzo, Bariba, Boko, Dendi, Fon, Goun, Haoussa, Idaasha, Lokpa, Mahi, Mina, Nago, Péda, Popo, Sahouè, Sèto, Toffin,Tori, Wémè, and Yoruba) among which Fon ethnic group was the most representative (> 50% of total consumers investigated). The majority of respondents was married (70.8%) as compared to singles (24.9%), those living with their parents (3.0%) and widowers (1.3%). Regarding informants' occupation, all of them had an occupation and artisanship was the main group of workers (29.9%) contrary to civil servants and employees of the private sector (7.6%). Boiled yam is mainly consumed at a weekly frequency (many times a week and once a week for 64.1% and 11.6% of respondents, respectively) either alone (25.9%) or with tomato, pepper and oil (94.4%). The main occasion for boiled yam consumption is lunch time or between meals (63.1 and 37.9% of answers, respectively) followed by breakfast and dinner times (18.6% and 14.3%, respectively). Cluster 3 "*Laboko* and *Kodjèwé* likers" was characterized by gender equality (49.1% of men and 50.9% of women) whereas in Cluster 2 "*Laboko* likers" none of respondents lived with their parents. In addition, consumers from Cluster 3

"*Laboko* and *Kodjèwé* likers" consumed more boiled yam at lunch time (84.2%) and breakfast time (21.1%) than between meals (17.5%).

Table 5: Socio-demographic and boiled yam consumption differences of the consumers with respect to cluster division
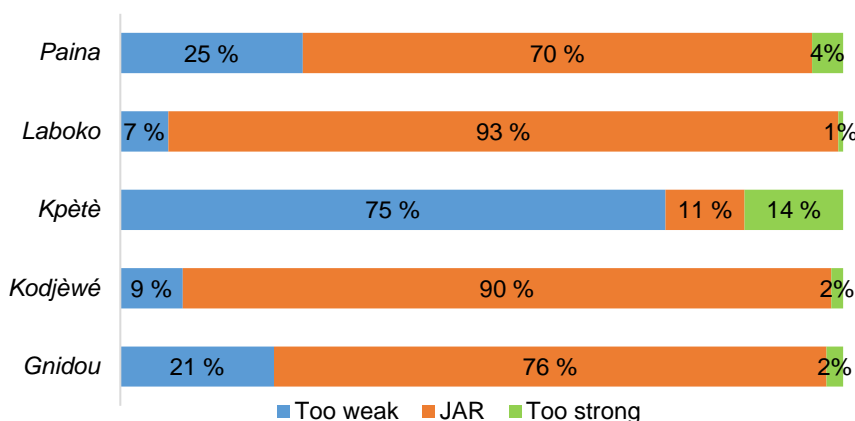
Categories	Variables	Total	Cluster 1 "*Kpètè* dislikers"	Cluster 2 "*Laboko* likers"	Cluster 3 "*Laboko* and *Kodjèwé* likers"
	Number of consumers (n)	301	166	78	57
Gender	Men (%)	59.5	59.6	66.7	49.1
	Women (%)	40.5	40.4	33.3	50.9
Age	18-25 years old (%)	20.6	22.9	20.5	14.0
	26-35 years old (%)	41.9	40.4	35.9	54.4
	36-45 years old (%)	21.9	19.3	25.6	24.6
	46-55 years old (%)	9.3	9.0	12.8	5.3
	> 56 years old (%)	6.3	8.4	5.1	1.8
Ethnicity	Fon (%)	50.5	53.6	42.3	52.6
	Idaasha (%)	13.3	8.4	10.3	31.6
	Mahi (%)	7.6	7.8	10.3	3.5
	Mina (%)	5.3	5.4	5.1	5.3
	Goun (%)	5.0	6.0	5.1	1.8
	Other	18.3	18.7	26.9	5.3
Marital status	Single (%)	24.9	25.3	32.1	14.0
	Married (%)	70.8	69.9	66.7	78.9
	Widower (%)	1.3	1.2	1.3	1.8
	Living with parents	3.0	3.6	0.0	5.3
Occupation	Student (%)	17.9	18.1	21.8	12.3
	Artisanship (%)	29.9	31.3	23.1	35.1
	Civil servant (%)	7.6	9.0	9.0	1.8
	Traders (%)	16.3	13.9	17.9	21.1
	Farmers (%)	20.6	19.9	17.9	26.3
	Employed in private sector (%)	7.6	7.8	10.3	3.5
Frequency of consumption	Everyday (%)	2.3	3.6	1.3	0.0
	Many times a week (%)	64.1	66.9	57.7	64.9
	Once a week (%)	11.6	11.4	12.8	10.5
	Many times a month (%)	11.3	8.4	15.4	14.0
	Once a month (%)	3.0	3.0	1.3	5.3
	Rarely (%)	7.3	6.0	11.5	5.3
Consumption patterns	Alone (%)	25.9	20.5	29.5	36.8
	Mashed beans (seasoned) (%)	3.7	3.6	5.1	1.8
	With ingredients (groundnuts, coconut) (%)	6.0	7.8	2.6	5.3
	With tomato sauce, pepper, oil (%)	94.4	91.0	98.7	98.2
Occasion of consumption	At breakfast (%)	18.6	17.5	19.2	21.1
	At lunch (%)	63.1	50.0	75.6	84.2
	Between meals (%)	37.9	48.2	30.8	17.5
	At dinner (%)	14.3	16.3	9.0	15.8

3.5. Penalty analysis based on JAR test to identify drivers of liking and direction of boiled yam quality improvement
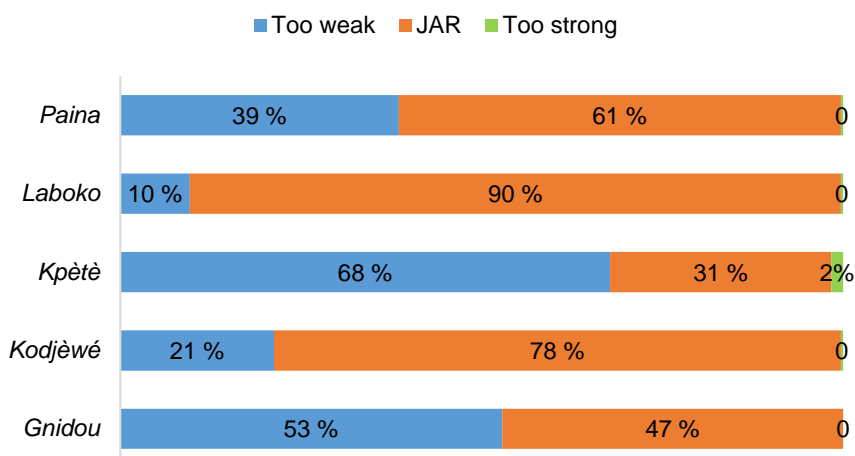
The percentage of consumers who evaluated the colour, stickiness on fingers, hardness in hand, friability in mouth and sweetness of boiled yam samples as JAR or not JAR varied with the five yam cultivars (Figure 2). With regards to Pareto principle (using a cut-off value of 20% of consumers), all
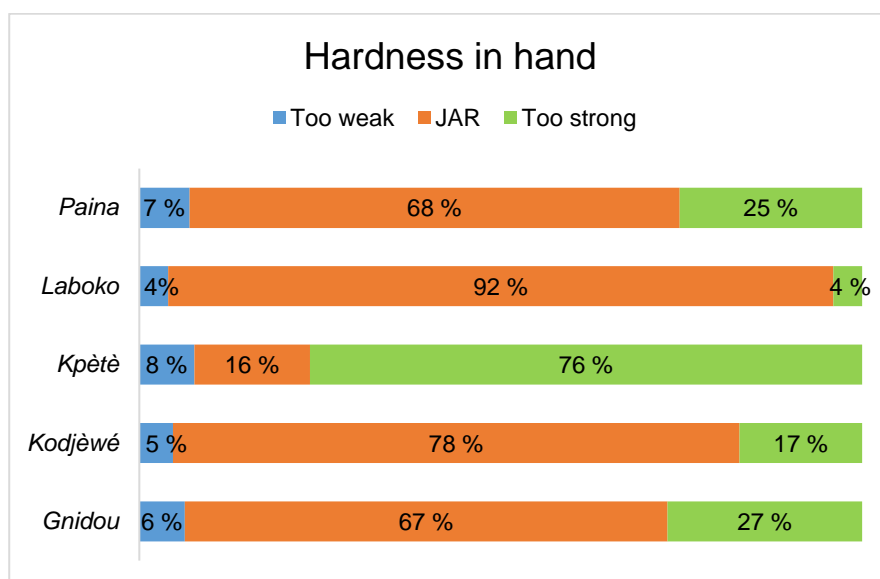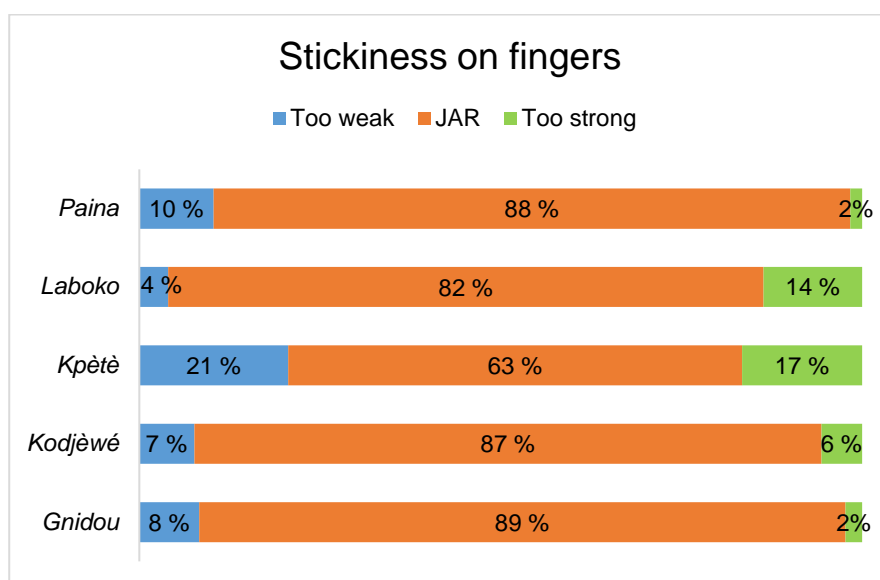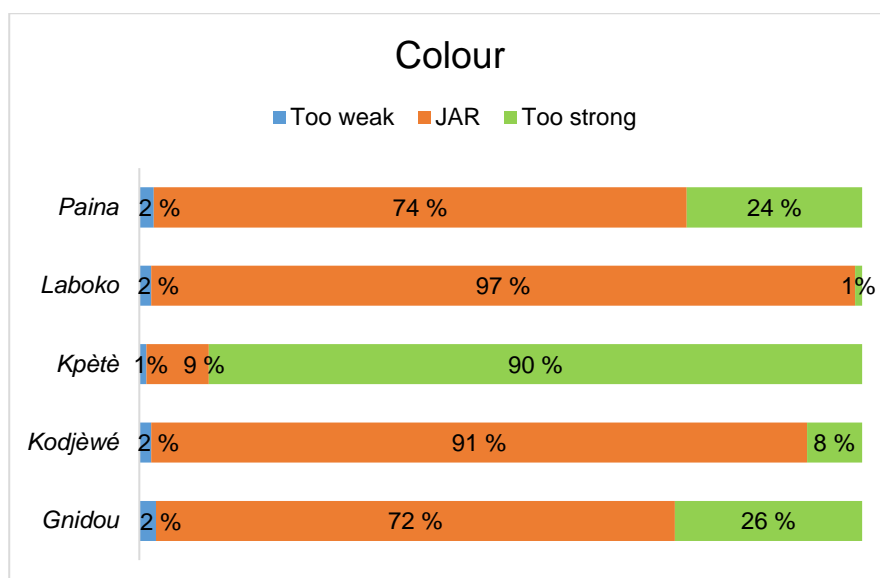
selected sensory descriptors of *Laboko* were considered "JAR" by 82 to 97% of the consumers. This suggests that this variety is liked for each of the five characteristics by a majority of consumers (Table 4). The sweetness of *Kodjèwé*, *Paina* and *Gnidou* were considered "not JAR" by 21%, 39% and 53% of the consumers, respectively. However, the five sensory characteristics are liked by a high percentage of consumers (78 to 91%) for *Kodjèwé*. *Paina* and *Gnidou* were found "not enough friable in mouth" by 25 and 21 % of consumers, respectively. The variety *Kpètè* was rejected by a high percentage of consumers who considered it as "not enough sweet" (68% of consumers), "not enough friable in mouth" (75% of consumers), "too hard in hand" (76% of consumers) and "too dark in colour" (90% of consumers). The "stickiness on fingers" was the only characteristic found JAR by more than 50% of consumers (63% precisely) for this variety. This variety got the lowest score of overall liking (3.7). Thus, the sweetness, friability in mouth, softness in hand, and clear colour appear determinant in overall liking of boiled yam.

Colour

	Too weak	JAR	Too strong
Paina	2 %	74 %	24 %
Laboko	2 %	97 %	1%
Kpètè	1%	9 %	90 %
Kodjèwé	2 %	91 %	8 %
Gnidou	2 %	72 %	26 %

Stickiness on fingers

	Too weak	JAR	Too strong
Paina	10 %	88 %	2%
Laboko	4 %	82 %	14 %
Kpètè	21 %	63 %	17 %
Kodjèwé	7 %	87 %	6 %
Gnidou	8 %	89 %	2%

Hardness in hand

|	Too weak	JAR	Too strong
Paina	7 %	68 %	25 %
Laboko	4%	92 %	4 %
Kpètè	8 %	16 %	76 %
Kodjèwé	5 %	78 %	17 %
Gnidou	6 %	67 %	27 %

Figure 2: Percentage of consumers who scored the specific sensory characteristics JAR or Not JAR

Penalty analysis (Figure 3) was performed to point out how many scores of overall liking were significantly lost because the characteristic was not evaluated JAR by at least 20% of the consumers. The penalty values of boiled yam ranged from 0.2 to 1.6. The descriptors TS-colour (too strong

colour i.e. dark), TS-hardness in hand (too hard in hand), TW-sweet taste (not enough sweet i.e. fade) and TW-friability in mouth (not enough friable in mouth) received the highest mean decreases in the overall liking score (penalty higher than 1.2 and for more than 68% of consumers). The JAR test showed that this characteristic "not enough friable in mouth" did not penalise greatly the overall liking of *Kpètè*. However, *Kpètè* and *Gnidou* varieties were highly penalised by the TW-sweet taste. This might be explained by the fact that the consumers grant greater importance to sweet taste in comparison with dark colour. This observation was confirmed by the TW-sweet taste (not sweet enough) cited by 21% of consumers for *Kodjèwé*, but with the lowest penalty value (0.2). The variety *Laboko* was considered as the best by processors and consumers and was not penalised by any descriptor which were all the five evaluated JAR in the consumer test. In addition, stickiness on fingers was evaluated as not-JAR category by least than 20% of the consumers. Stickiness on fingers did not penalise any product and cannot be considered as a driver of liking.
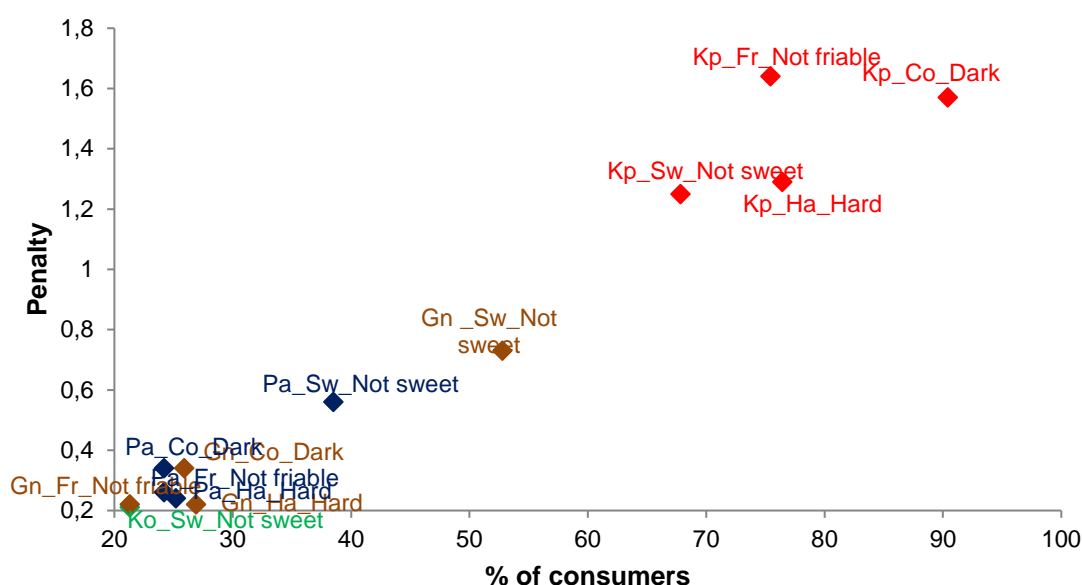
Figure 3: Penalties of overall liking per cent of consumers

Legend: Variety_Descriptor_not JAR category (ex: Pa_Sw_Not sweet)
Varieties: Paina (Pa), Gnidou (Gn), Kodjèwé (Ko), Kpètè (Kp)
Sensory characteristics: Colour (Co), Friability in mouth (Fr), Hardness in hand (Ha), Sweet taste (Sw) Not-JAR levels: TW (TW too weak); TS (TS too strong)

3.6. Sensory mapping of quality characteristics of boiled yam and relationship with overall liking

The Q Cochran's test revealed significant differences in the frequency of citations of each characteristic used by consumers to describe each boiled yam sample (P-value < 0.05) (Table 5). The most frequent characteristics used to describe the five samples were descriptors including attractive, good smell of yam, easy to break with hand, not sticky in mouth, easy to chew, friable/tender, no fibres, sweet and good to eat. Figure 4 depicts a Principal component analysis (PCA) of the five yam varieties and frequency of citations of CATA characteristics, with mean overall liking as supplementary variable (Table 2). Three groups of varieties were established. Boiled yam samples made from *Laboko* and *Kodjèwé* varieties were qualified as high-quality products and were specifically described as attractive (with a slightly yellow colour for *Laboko* and white colour for *Kodjèwé*), easy to break with hand, easy to chew, friable/tender, good smell of yam, good to eat, not sticky in mouth and sweet taste. Boiled yam from *Paina* and *Gnidou* were characterised by dirty white colour, slightly bitter, not sticky on fingers and with fibres. *Kpètè* was characterised specifically by the pinkish colour, sticky flesh (mucilage), hard in mouth, bad taste, tasteless and unpleasant to eat. This result matches with overall liking and confirms that *Laboko* and *Kodjèwé* boiled yam samples were the most liked, followed by *Paina* and *Gnidou* while *Kpètè* was the least liked (Figure

4). Thus, the sensory characteristics associated with *Laboko* and *Kodjèwé* could be considered as the drivers of consumers' liking while the sensory characteristics associated with *Kpètè* could represent a reason for consumers' rejection.

Table 6: Frequency of citations of quality characteristic by consumers during CATA test

| Quality characteristics | Boiled yam samples | | | | | Total | P-value Q Cochran's test |
	Gnidou	*Kpètè*	*Kodjèwé*	*Laboko*	*Paina*		
Pinkish colour	3	251	2	1	18	275	< 0..0001
Attractive	201	46	269	293	211	1020	< 0..0001
Sticky flesh (mucilage)	4	159	15	13	11	202	< 0.0001
Hard in mouth	43	182	29	3	59	316	< 0..0001
Not sticky in mouth	245	168	235	221	241	1110	< 0.0001
Easy to break with hand	224	53	242	266	209	994	< 0.0001
Unpleasant to eat	27	188	7	1	42	265	< 0.0001
White colour	76	2	198	116	90	482	< 0.0001
Bad taste	20	96	1	0	23	140	< 0.0001
Dirty white colour	171	18	65	14	171	439	< 0.0001
Tasteless (neither sweet, nor bitter)	69	103	24	8	41	245	< 0.0001
Sticky on fingers	45	65	103	191	54	458	< 0.0001
Slightly bitter	74	61	21	8	100	264	< 0.0001
Slightly yellow colour	37	2	32	167	7	245	< 0.0001
No fibres	196	252	213	229	180	1070	< 0.0001
Good smell of yam	244	109	291	292	251	1187	< 0.0001
Sweet	145	76	236	268	168	893	< 0.0001
Good to eat	236	78	279	291	238	1122	< 0.0001
Easy to chew	264	89	275	287	236	1151	< 0.0001
Friable/tender	229	38	274	286	232	1059	< 0.0001
Mean overall liking	6.20	3.68	6.99	7.62	6.16	6.13	
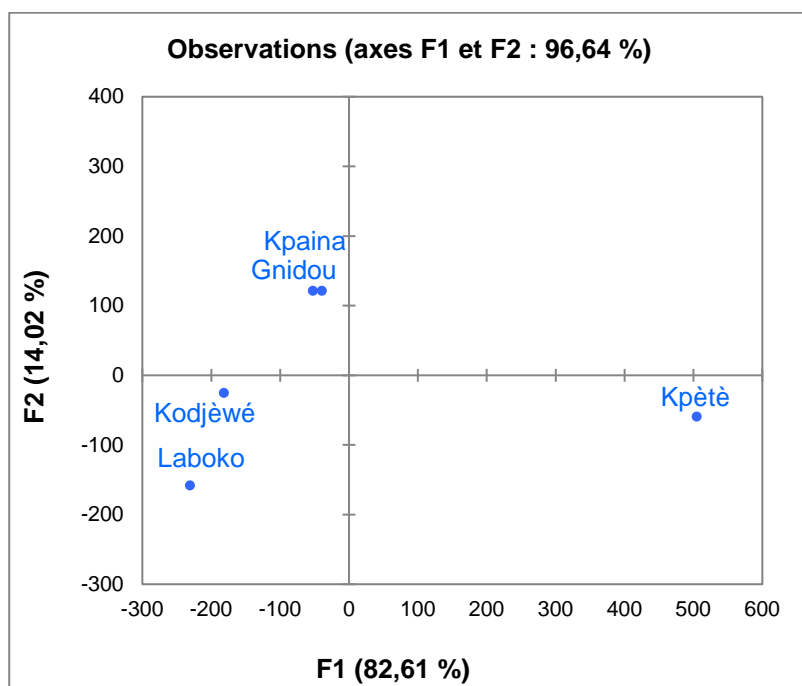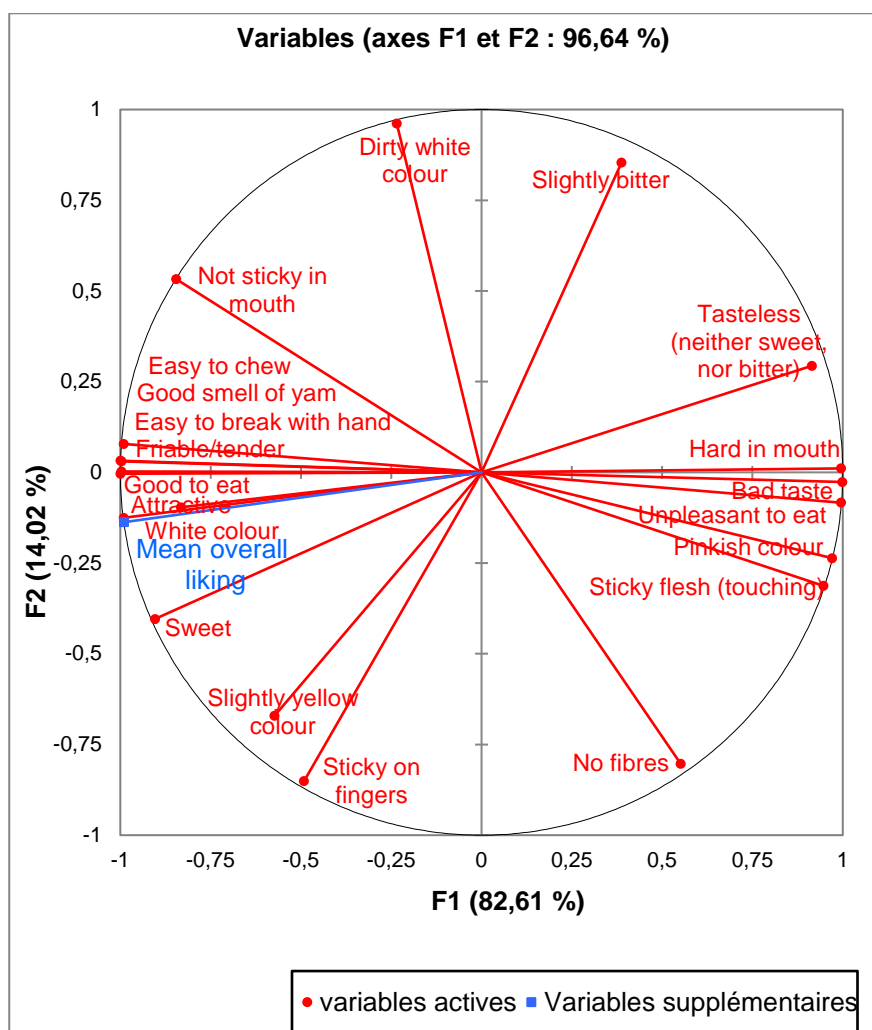
Figure 4: Sensory mapping of quality characteristics of boiled yam and the overall liking scored by the consumers using principal component analysis

4. CONCLUSION

The sensory quality characteristics of boiled yam are strongly related to the varietal adoption by the producers, processors and consumers. Field surveys and the processing diagnosis provided reliable descriptors that were mapped with overall liking scores to better understand the consumers' expectations. These consumer expectations can be met by an understanding of both of the high- and low-quality characteristics of specific varieties. Three classes of consumer's liking were identified with the five yam varieties studied. This study revealed that the texture is very important in boiled yam quality perception, mainly the easiness to break with hand, easiness to chew and friability. Regarding the colour, both white and slightly yellow colour are the most liked, while the dirty white or dark colour are sources of rejection. The sweet taste was recognized as a driver of overall liking while the tasteless characteristic is considered as a sign of poor quality. Apart from *Laboko*, and to a lesser extent *Kodjèwé*, all other yam varieties, in particular *Kpètè*, which obtained the lowest score of overall liking, tested by a large number of consumers - were penalised for some of their quality characteristics and this needs to be addressed by biochemists and yam breeders/geneticists in order to produce more acceptable varieties in the future.

5. REFERENCES

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