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Consumer Preferences for Boiled and Fried Sweet Potato in Central and Northern Côte d'Ivoire, West Africa

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Authors' contributions

This work was performed with collaboration among all the authors. Author GAYK performed the statistical analysis, wrote the protocol and the first draft of the manuscript. Author MJHK managed literature searches and the sensory analyses of the study. Author BEKD designed the study and the setting up of farm. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study evaluated the sensory properties and consumer acceptability of orange-fleshed sweet potato and local sweet potato among households of Central and Northern Côte d'Ivoire.
Study Design: Selection of sweet potato cultivars, determination of nutritional properties, cooking process, and evaluation of hedonic testing and consumer acceptability.
Place and Duration of Study: Bouake and Korhogo district in Central and Northern Côte d'Ivoire, for three years 2018, 2019, and 2020 (July to November).
Methodology: Sensory evaluation and acceptability were performed using a nine-point hedonic

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scale. The relationships between the sensory attributes and the sweet potato cultivars were analyzed using a Principal Component Analysis plot. Biochemical standard methods were used to determine the dry matter, sugar, total carotenoid contents, and mineral composition of sweet potato cultivars tested by the sensory panel.

Results: All twelve sweet potato cultivars were accepted based on sensory attributes with the different traits of preference. In Bouake district, white (Sanfo Figui 1 and Sanfo Figui 2) and yellow cultivars (Fatoni 2) were most preferred for their texture and yam-like taste, while in Korhogo locality, OFSP (Covington TIB-440060, CIP-199062-1 and Irene) and yellow cultivar (Gotchan) were most accepted because of their attractive appearance and their sweet taste. The OFSP cultivars recorded low dry matter and high sugar content compared to white and yellow varieties. Also, OFSP showed the highest content of carotenoid (181.70 to 351.47 µg/g dw), while local variety recorded low content. All the sweet potato cultivars tested contain mineral components.

Conclusion: This study shows that the local and OFSP varieties were successfully accepted by the consumer with the different quality traits. The main quality traits that determine consumer preference are appearance, texture, and taste (none or sweet taste). Understanding consumer quality traits can increase the effectiveness of breeding programmes, increase yield and adoption of new varieties.

Keywords: Orange-fleshed sweet potato; sensory evaluation; consumer acceptability; Côte d'Ivoire.

1. INTRODUCTION

Sweet potato [*Ipomoea batatas* (L.) Lam.] is a hardy food crop with great potential to contribute to reducing hunger in the world [1]. In developing countries, it complements cassava and yams and competes with other starchy crops such as maize and plantain to supplement household income [2]. Sweet potato is produced biannually in Côte d'Ivoire and is mainly grown in the central and northern regions [3]. Annual production of sweet potato, self-consumed, is approximately 52 232 tons (FAOSTAT, 2019), and was ensured mainly by women in households. Generally, sweet potato varieties currently grown and consumed in Côte d'Ivoire are the traditional varieties such as cream, white- and yellow-fleshed cultivars which contain none or little beta-carotene. It is generally consumed boiled, fried or roasted [4,5]. It is mostly used as snack food commonly sold in urban centres and rural markets, mainly as fried products with palm oil refined, groundnut oil refined.

Despite giant strides made in releasing high nutritional properties sweet potato varieties such as biofortified orange-fleshed sweet potato (OFSP) source of vitamin A in Africa, sweet potato has remained an untapped food crop in Côte d'Ivoire. Thus, the production of biofortified orange-fleshed sweet potato varieties of the Ivoirian household is recent. They were introduced in northern, north-east, and central Côte d'Ivoire through development of project [3,6] to combat vitamin A deficiency, because of its high content of ß-carotene. Indeed, a recent national survey indicated that nutritional deficiency consists of an important problem in Côte d'Ivoire, especially in the regions of central, north and north-east of country where 30% of preschool children were vitamin A deficient and about 60% of children under 5 years are still at risk of being deficient in vitamin A [7]. Most research are documented an impact of assessment studies has indicated that OFSP could make a major contribution to reducing vitamin A deficiency in sub-Saharan Africa and that daily addition of the diet could prevent vitamin A in children, pregnant and lactating mothers [8–11]. In this context, the promotion of the released orange-fleshed sweet potato cultivars in Côte d'Ivoire could benefit to alleviating vitamin A deficiency.

However, the decision to adopt a new variety remains complex and depends to yield performance as well consumer acceptability in terms of both utilization and sensory characteristics [12,13]. Dery et al. [14] have well documented that sensory attributes such as appearance, sweetness, flavour and texture are critical in consumer preference and can influence acceptability of varieties and consumption amongst households. Reports of Allan et al. [15] indicated also that dry matter and sugar contents are attributed to agronomic amongst others, which are associated to sensory that affect consumer preference in most of sub-Saharan Africa countries. Also, it has been known that the consumer preference of the OFSP varieties differs considerably with cultural and demographic factors and this acceptability

increase in areas where it was promoted [16,17]. There is high variability in terms of quality of attribute and agronomics traits which require greater attention to understanding the quality characteristics preferred by the consumer. However, few studies have been published on the relationship between sensory acceptability in the choice of sweet potato varieties grows in Côte d'Ivoire.

The primary aim of this current study aim was to investigate the sensory acceptability of boiled and fried introduced OFSP and local sweet potato cultivars in Central and Northern Côte d'Ivoire. Also, the nutritional properties of these varieties were evaluated and compared.

2. MATERIALS AND METHODS

2.1 Study Sites

The research was conducted in Central and Northern Côte d'Ivoire, specifically in Attrokro, Brobo and Kongondékro locations in Bouaké district and Dyelokaha, Kounontonvogo and Sambalakaha locations in Korhogo district (Fig. 1). These rural sites were selected based on their high sweet potato production and consumption. Bouaké district is the second-largest city in Côte d'Ivoire, located in the central region about 350 kilometers north of Abidjan, the economic capital and 100 kilometers northeast of Yamoussoukro, the capital of the country. The district features a tropical wet and dry climate with a long season spanning the months of March through October, and a shorter harmattan-influenced dry season that covers the remaining four months. Korhogo is located in northern Côte d'Ivoire, mainly in Savannas region, at a distance of about 650 kilometers of economic capital, Abidjan. It is characterized by Sudanese climate with a unimodal rainy season marked by two rainy peaks (June and September), followed by a long dry season stretching from October to May. In Both locations, predominant activity of the population is agriculture with major crops grown include cotton, mango, rice, millet, peanuts, corn, yams, soy, sweet potato. Diets are mainly cereal-based, maize and rice which cover over 50% of calorie intake, supplemented with starchy roots (yam, cassava, sweet potato), vegetables and beans [18].

2.2 Selected Sweet Potato Cultivars

The study was conducted using twelve (12) sweet potatoes genotypes including five (05) introduced varieties (IV, orange fleshed-sweet potatoes) and seven (07) local varieties (LV) widely grown in the selected localities (Table 1). The roots were acquired from on-farm demonstration trials implanted by the National Centre of Agronomic Research (CNRA) of Côte d'Ivoire in the selected regions for three years (2018 to 2020). Each year, one locality by district is chosen for planting that carried in July and the mature roots were harvested in late November. Only sound sweet potato roots free of diseases or physical damage were chosen for data collection.

Table 1. Characteristics of sweet potato cultivars used in this study

Cultivars	Codes	Status	Country	Fresh color	Yield (t/ha)
Covington	V1	IV	United States (US)	Dark-orange	13.20
TIB-440060	V2	IV	INERA-Burkina Faso	Orange-pale	23.10
CIP-199062-1	V3	IV	INERA-Burkina Faso	Dark-orange	17,00
BF59×CIP4	V4	IV	Burkina-Faso	Orange	17,60
Irene	V5	IV	CIP-Mozambique	Orange	12,60
Gotchan	V6	LV	CNRA-Côte d'Ivoire	Dark-yellow	16,70
Fatoni 2	V7	LV	CNRA-Côte d'Ivoire	Yellow-pale	13,90
Affou 1	V14	LV	CNRA-Côte d'Ivoire	Cream	28,70
Chinois Wosso	V15	LV	CNRA-Côte d'Ivoire	Dark-yellow	5,20
Sanfo Figui 1	V17	LV	CNRA-Côte d'Ivoire	White	16,40
Sanfo Figui 2	V18	LV	CNRA-Côte d'Ivoire	White	22,80
Wesse Pou	V19	LV	CNRA-Côte d'Ivoire	Cream	5,60

** IV: introduced variety; LV: local variety; INERA: Institute of Environment and Agriculture Research; CIP: International Potato Center; CNRA: National Centre for Agronomic Research*

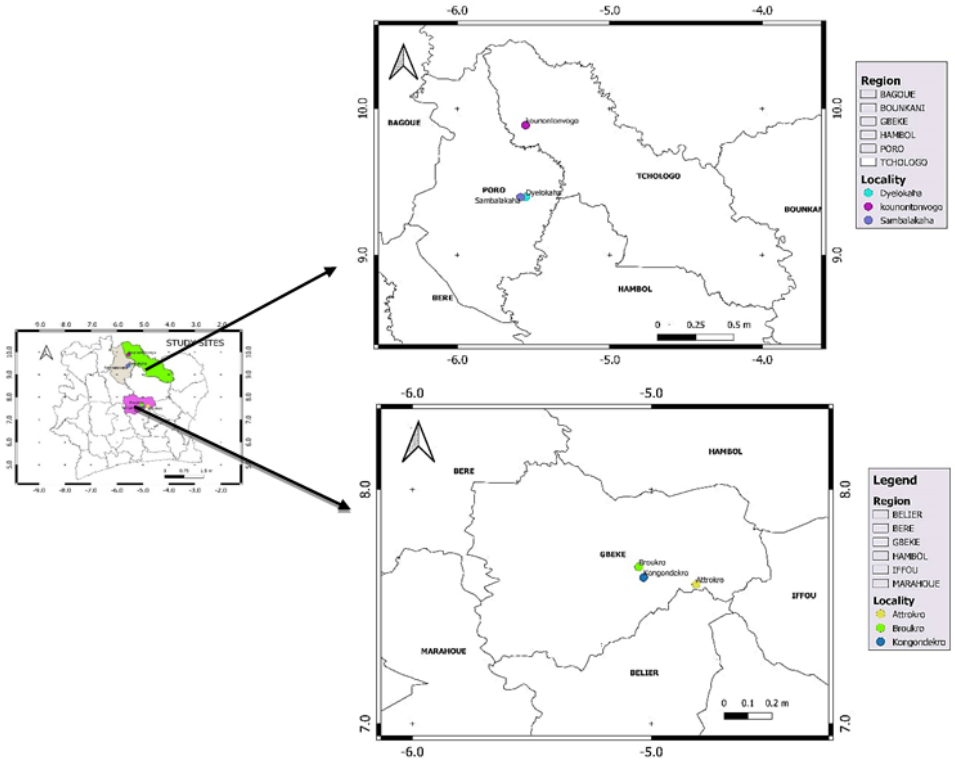

Fig. 1. Map of Côte d'Ivoire showing the study areas

2.3 Samples Preparation and Cooking Process

Fresh roots samples were used to determine the nutritional properties of sweet potato cultivars. Cooked sweet potato samples (boiled and fried) were considered to evaluate the consumers preference.

2.3.1 Raw samples

The roots of each cultivar were sorted to remove diseased and insect-damaged roots, and sound roots were thoroughly washed with tap water. Then cleaned roots were peeled, cut into equal parts with the stainless-steel knife, ground into paste by using a laboratory crusher. Paste samples were thoroughly mixed and packed in plastic zip-lock bags for each cultivar and stored at -18°C before further analysis.

2.3.2 Cooking process

Boiled or fried sweet potatoes samples for consumer testing were prepared under hygienic conditions. For boiled sweet potato, each sample of raw sweet potato cultivar (500 g) was peeled, washed twice, chopped into roughly equal-sized pieces. The portions of roots were immersed in tap water and boiled separately (approximately 20 min) in a saucepan until the texture, as assessed by a knife, was considered tender and suitable for eating [19]. The portions of the raw sweet potato roots were fried for about 10 min in refined palm oil until the texture, as assessed by a knife, was considered good for eating. After cooking, each sample was assigned a code with three numbers to preserve information concerned the varieties evaluating.

2.4 Nutritional Value of Sweet Potato Roots

Standard biochemical methods were used to determine the nutritional value of selected sweet potato varieties. Dry matter and ash contents were evaluated using AOAC methods [20]. Dry matter determinations were assessed by drying triplicate 5 g samples, while total sugar content was evaluated by spectrophotometry using the method described by Dubois et al. [21].

Colorimetric assays were used to evaluate β-carotene content in each sample according to [22]. After extraction, measured absorbance at 450 nm, β-carotene contents were estimated

following the formula described by [23] and expressed µg/g of raw material.

Minerals composition of each sample were assessed by scanning Electron Microscopic (SEM) coupled to an X-ray detector (Oxford Instruments), connected to an Energy Dispersive X-Ray Spectroscopy) (EDS) microanalyzer platform (Inca Dry Cool, without liquid nitrogen). The mineral composition of each sample was expressed as mass percentage of raw material.

2.5 Participant's Profile and Sensory Evaluation

Before starting consumer test, verbal consent was sought from panelists and they were informed that their participation was entirely voluntary and that they could withdraw from the panel at any time. To determine the profile of each participant, short interviews to profile each panelist were conducted using a simple questionnaire. This section included questions on their age, occupation, level of education, consumption of sweet potato, the origin of the sweet potato usually consumed, and usual preparation methods. All questionnaires elaborated in French were translated to the local language.

Sensory evaluation consisted to hedonic rating [19,24], which was conducted in the rural communities selected, with 237 consumers (120 participants in Bouake district and 117 for Korhogo district). A nine-point hedonic scale ranging from extremely dislike (1) to extremely like (9) was used to assess the overall liking of the ten boiled/fried sweet potato products in each locality. A hedonic scale was used to assess four quality characteristics (appearance (color), taste (sweet taste), mouthfeel and texture) identified as important attributes. Each panelist was served with randomly selected and coded cooked varieties and handed a questionnaire to complete.

The index of acceptability (IA) of participants was also calculated according to [25] by using the equation:

$$IA\ (\%) = \frac{score * 100}{9}$$

Where score represented appreciation reported by the participants based on the 9-point hedonic scale.

2.6 Statistical Analysis

All analysis was carried out in triplicates and data were expressed as means ± standard deviation. One-way analysis of variance (ANOVA) and Duncan's multiple range test was carried out to assess significant differences between means (P= .05) using Statistica 7 software. The relationships between the sensory attributes and the sweet potato cultivars were investigate using Principal Component Analysis (PCA) with XLSTAT software (V 2014, Addinsoft).

3. RESULTS AND DISCUSSION

3.1 Sensory Attributes and Overall Acceptability of Different Sweet Preparations

A total of 97 males (40.93%) and 140 females (59.07%) participated to investigate the sensory acceptability of the twelve different sweet potato varieties. In both districts studied, farmers and consumers expressed different reasons for growing and consuming specific varieties. In Bouake locality, the 120 respondents interviewed revealed that the white-fleshed variety is their choice because its ability to adapt to different climate and environment, high yield, its high dry matter content, and high market value. While yellow-fleshed cultivars are increasingly rejected because of their low yield. Men are the main producers, and sweet potatoes are growing biannually. Generally, all harvested produce was sold as fresh roots in the communities. Also, the participants reported that sweet potatoes were consumed mainly as a breakfast dish and snack food including boiled with or without skin, fried, *foutou* with a sauce (Ivoirian dishes).

In Korhogo locality, the survey revealed that women are the main producers. The white- and yellow-fleshed varieties were mostly grown. The choice of these varieties was due to their marketability, sweet taste, and high yield. All the production was sold or autoconsumed in diverse dishes such as fried, boiled, and steamed.

The sensory attributes of the twelve (12) sweet potato cultivars tested in this study were significantly different with respect to variety (P= .05) for all the sensory attributes. Tables 2 and 4 show the means scores for the sensory attributes for both boiled and fried samples by each cultivar. The analysis of variance and Ducan's test indicates that the participants could

discriminate (P= .05) between the cultivars with respect to the sensory attributes (appearance, texture, taste, and mouthfeel). The means of scores for both boiled and fried sweet potato cultivars were mostly greater than 5, and the average acceptance of participants ranged from ''moderately like'' to ''like much''. Also, the results revealed that the participant acceptability for each sweet potato cultivar varied to locality and for the type of preparation. The difference in preference for the varieties per locality is previously highlighted by Birol et al. [17], who reported that acceptability can differ due to cultural and demographic factors.

Considering the district of Bouaké the results of hedonic test of different preparation (boiled and fried) of the sweet potato cultivars tested, showed that fried samples have better sensory attributes among participants (Table 2). The respondents preferred the fried samples because of their good appearance, texture, and taste compared with boiled forms. Most of the participants in Bouaké district preferred white-fleshed cultivars (Sanfo Fig 1, Sanfo Fig 2) which are recorded the high appearance and texture scores. The yellow-fleshed cultivars (Chinois Wosso, Fatoni 2) showed the medium value while the orange-fleshed sweet potato cultivars with the lowest score. The Pearson correlation between the overall acceptability and the other trait shows that attributes appearance, taste and texture constitute the main drivers for the participants final decision in ranking a given cultivar as best or worst (Table 3A and 3B). The preference of the white- and yellow-fleshed varieties show in Bouake district is similar to finding of Ssali et al. [26] who reported that farmers of Kwara (Nigeria) preferred the white- and yellow-fleshed varieties. Baafi et al. [27] mentioned that consumers in Ghana prefer non-sweet sweet potato with high dry matter content. Indeed, it seems that the preference of consumers in Bouake to landraces varieties (selected farmers) is due they constitute the most grown variety in this locality, their short maturity period, and less sweet taste like-yam taste. This would certainly be due to the fact that in the district of Bouaké yam constitute one of mainly food crop most grown and consumed per habitant [28]. However, successful development of orange-fleshed sweet potato requires the promotion of their nutritional benefits amongst consumers and farmers.

For Korhogo district, the results for both tasting approaches show the difference in liking between cultivars sweet potato cultivars for the four different sensory attributes (Table 4). Significant difference (P= .05) is showed between the mean scores of the sensory attributes for the two types of preparations. Most participants preferred fried over boiled sweet potato samples. Table 5 A and 5B revealed that fried samples were strongly correlated to appearance 97%), mouthfeel (95%), and taste (96%), and received higher scores for all attributes. While the acceptability of boiled forms was associated to appearance (88%) and taste attributes (90%). Most participants were appreciated the orange-fleshed variety Covington TIB-440060, CIP-199062-1 and Irene and yellow cultivars Gotchan based on their attractive appearance (flesh color) and sweet taste. The white-fleshed recorded the medium scores (Table 4). Data collected through the interviews carried from the localities of Korhogo indicated the sweet potato was an essential food crop used in the household. The quality traits that determine consumer preference mentioned by respondents were sweet taste and high dry matter which was correlated to the good texture that enhances the quality of processed products [29], and variety such as orange-fleshed cultivars.

In summary, this study shows that all preparations were acceptable for consumption based on the values of the index of acceptability greater than 70% (Table 2 and 4). According to [30], acceptance of product in terms of its sensory properties, must obtain a minimum score of 70%, values obtained in both samples. Also, the fact that the frying sweet potato has good sensory attributes, attractive appearance, mouthfeel, and texture, is probably due to the use of oil as the main ingredient in the preparation [31].

The relationships between the sensory descriptors and the sweet potato cultivars tested are summarized in the Principal Component Analysis (PCA) plots. Figs 2A and 2B depicted PCA of ten sweet potato cultivars tested in Bouake district. The PCA plot, accounting for 84.79% (PC1: 57.22%; PC2: 27.57%) of the total variation, illustrates that the introduced OFSP, yellow, cream, and white-fleshed cultivars widely differ with respect to their sensory characteristics as concern boiled samples tested in Bouake district (Fig. 2A). For the fried samples (Fig.2B), the two first plots accounted 76.89% (PC1: 55.99%; PC2: 20.90%). Based on the weight of the contribution of each variable in the PCA, for the boiled type, appearance, taste, texture and

overall acceptability (positive loading) are strongly associated with the first component (PC1) while, mouthfeel (positive loading) is related to the second component (PC2). As concern fried samples, the appearance, taste, and overall acceptability were positively associated to plot PC1 while PC2 was high positive loading on mouthfeel of sweet potato. Based on the location of the sweet potato cultivars in the plane of coordinates formed by the two components (PCA1 and PCA2), the results showed that the acceptability of white-fleshed cultivars Sanfo Fig 1, Sanfo Fig 2, yellow-fleshed variety Chinois Wosso were associated appearance taste, and texture. The orange-fleshed sweet potato cultivars (Covington, TIB-440060, BF59×CIP4 and Irene) were strongly associated mainly with texture and taste.

Table 2. Scores of acceptability and index of acceptability of participants of Bouake district, based on types of sweet potato preparations

Varieties	Covington	TIB-440060	CIP-199062-1	BF59×CIP4	Irene
Boiled					
Appearance	6.51±0,49d	6.29±0,31d	6.21±0,32d	6.67±0,23cd	6.73±0,27cd
Taste	5.59±0,39de	6.00±0,40bcde	6.30±0,30abcd	5.89±0,69cde	5.22±0,29e
Texture	6.88±0,34a	6.89±0,78a	6.42±0,68b	6.89±0,88a	6.60±0,27ab
Mouthfeel	6.31±0,40ab	6.22±0,22ab	6.48±0,39	6.29±0,68ab	6.68±0,71a
Overall Acceptability	6.34±0,21c	6.35±0,19c	6.35±0,5c	6.44±0,13bc	6.31±0,15c
IA* (%)	70.40	70.58	70.60	71.51	70.08
Fried					
Appearance	7.33±0,12abcd	6.31±0,38e	7.09±0,68bc	6.67±0,30cd	7.20±0,40bcd
Taste	6.34±0,89ab	6.43±0,48ab	5.65±0,40b	6.40±0,76ab	6.14±0,24ab
Texture	6.05±0,80b	6.38±0,56ab	6.04±0,66b	6.00±0,17b	6.49±0,25ab
Mouthfeel	6.23±0,21b	6.79±0,53ab	6.73±0,14ab	6.18±0,95b	6.43±0,46ab
Overall Acceptability	6.74±0,40bc	6.63±0,7bc	6.60±0,23bc	6.51±0,43c	6.81±0,19bc
IA* (%)	74.84	73.65	73.36	72.36	75.72

Table 2. (*Continued*)

Varieties	Fatoni 2	Chinois Wosso	Sanfo Figui 1	Sanfo Figui 2	Wesse Pou
Boiled					
Appearance	6.39±0,22	7.64±0,32a	7.08±0,42bc	7.53±0,41ab	6.69±0,46cd
Taste	6.85±0,19ab	6.61±0,68abc	6.94±0,90a	6.21±0,14abcd	5.55±0,35de
Texture	6.87±0,69a	6.91±0,50a	7.37±0,32a	7.26±0,22a	6.92±0,25a
Mouthfeel	6.41±1,13ab	6.61±0,34a	5.96±0,42b	6.57±0,28ab	6.53±0,37ab
Overall Acceptability	6.63±0,44abc	6.94±0,40a	6.83±0,35ab	6.89±0,18a	6.43±0,12bc
IA* (%)	73.68	77.14	75.94	76.54	71.40
Fried					
Appearance	6.58±0,46cd	7.55±0,36abc	7.87±0,26ab	8.04±0,25a	7.01±0,45bcd
Taste	6.36±0,16ab	6.72±0,29a	6.74±0,68a	6.90±0,14a	6.07±0,34ab
Texture	6.52±0,16aab	7.83±0,72a	7.32±0,24ab	7.58±0,11a	7.21±0,19ab
Mouthfeel	7.15±0,20a	6.93±0,59ab	6.36±0,29ab	7.01±0,16ab	6.35±0,33ab
Overall Acceptability	6.90±0,17bc	7.01±0,21ab	7.07±0,20ab	7.38±0,13a	6.66±0,24bc
IA* (%)	76.70	77.88	78.57	82.02	74.02

*Data are means ± standard deviation. Values with different letters (a, b, c, d…) in the same line are significantly different (P = .05) *IA: Index of acceptability.*

Table 3A. Pearson correlation coefficients between sensory attributes for boiled samples tested in Bouake district

Attributes	Appearance	Texture	Taste	Mouthfeel	Overall acceptability
Appearance	1.00				
Taste	0.26	1			
Texture	0.60	0.41	1		
Mouthfeel	0.23	-0.41	-0.49	1	
Overall acceptability	0.85	0.72	0.69	-0.04	1

Table 3B. Pearson correlation coefficients between sensory attributes for fried samples tested in Bouake district

Attributes	Appearance	Texture	Taste	Mouthfeel	Overall acceptability
Appearance	1				
Taste	0.48	1			
Texture	0.32	0.22	1		
Mouthfeel	-0.09	0.23	0.30	1	
Overall acceptability	0.78	0.74	0.62	0.49	1

Table 4. Scores of acceptability and index of acceptability of participants of Korhogo district, based on types of sweet potato preparations

Varieties	Covington	TIB-440060	CIP-199062-1	BF59×CIP4	Irene
Boiled					
Appearance	7.85±0.66ab	7.32±0.67abc	7.18±0.55abc	6.70±0.45bc	8.12±0.88a
Texture	7.13±0.65a	6.37±0.55ab	7.02±0.20a	6.27±0.54ab	7.39±0.67a
Taste	8.12±0.77a	7.77±0.67ab	7.00±0.50abc	6.31±0.54c	7.94±0;55a
Mouthfeel	7.77±0.45a	6.68±0.22abc	7.36±0.87ab	6.11±0.11c	7.15±0.76abc
Overall Acceptability	7.89±0.17a	7.04±0.34bc	7.14±0.25abc	6.35±0.17c	7.65±0.56ab
IA* (%)	87.68	78.18	79.36	70.50	85.00
Fried					
Appearance	8.57±0.22a	7.55±0.35ab	7.57±0.19ab	6.03±0.49c	8.42±0.45a
Texture	7.01±0.56ab	5.92±0.54b	6.86±0.87ab	7.07±0.55ab	7.28±0.95a
Taste	8.51±0.17a	7.69±0.27abc	7.63±0.70abc	6.84±0.17c	8.27±0.19ab
Mouthfeel	8.21±0.65a	7.04±0.50abc	7.04±0.65abc	6.31±0.36c	7.59±0.75ab
Overall Acceptability	8.07±0.25a	7.05±0.88bc	7.28±0.75abc	6.56±0.25c	7.89±0.35ab
IA* (%)	89.70	78.33	80.85	72.91	87.65

Table 4. (*Continued*)

Varieties	Fatoni 2	Gotchan	Affou 1	Sanfo Figui 1	Sanfo Figui 2
Boiled					
Appearance	6.32±0.22c	6.79±0.32bc	6.10±0.68c	6.31±0.77c	6.23±0.66c
Texture	5.87±0.88b	7.04±0.70a	6.82±0.11ab	6.90±0.89ab	6.82±0.53ab
Taste	6.69±0.87bc	7.16±0.33ab	6.53±0.44bc	6.88±0.11abc	6.53±0.54bc
Mouthfeel	6.58±0.44bc	7.23±0.60abc	7.22±0.19abc	6.36±0.29bc	7.22±0.66abc
Overall Acceptability	6.36±0.68c	6.88±0.23bc	6.67±0.56c	6.61±0.76c	6.70±0.32c
IA* (%)	70.70	76.43	74.09	73.43	74.46
Fried					
Appearance	6.64±0.76bc	7.12±0.64bc	6.52±0.88bc	7.13±0.13bc	6.52±0.54bc
Texture	6.93±0.44ab	7.20±0.11a	6.17±0.16b	7.32±0.77a	6.56±0.25ab
Taste	7.20±0.17c	7.40±0.45bc	7.15±0.36c	7.13±0.17c	7.04±0.37c
Mouthfeel	6.76±0.65bc	6.84±0.52bc	6.50±0.68bc	6.44±0.65bc	6.50±0.25bc
Overall Acceptability	6.88±0.53c	7.14±0.25bc	6.58±0.99c	7.00±0.79bc	6.66±0.25c
IA* (%)	76.48	79.32	73.14	77.82	73.95

*Data are means ± standard deviation. Values with different letters (a, b, c, d…) in the same line are significantly different (P = .05) *IA: Index of acceptability*

Table 5A. Pearson correlation coefficients between of sensory attributes for boiled samples tested in Korhogo district

Attributes	Appearance	Texture	Taste	Mouthfeel	Overall acceptability
Appearance	1				
Texture	0.20	1			
Taste	0.97	0.13	1		
Mouthfeel	0.92	0.15	0.98	1	
Overall acceptability	0.97	0.39	0.96	0.95	1

Table 5B. Pearson correlation coefficients of attributes for fried samples tested in Korhogo district

Attributes	Appearance	Texture	Taste	Mouthfeel	Overall acceptability
Appearance	1				
Texture	0.49	1			
Taste	0.89	0.49	1		
Mouthfeel	0.41	0.67	0.48	1	
Overall acceptability	0.89	0.72	0.90	0.73	1

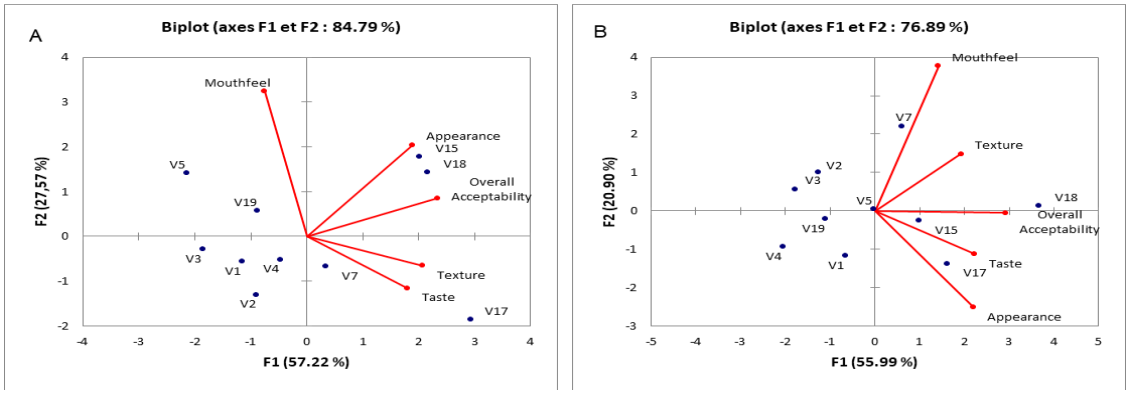

Fig. 2. Principal component plot illustrating the relationship between the sensory descriptors and sweet potato varieties tested on based the type of preparation (Bouake district)

A: represent PCA for boiled type, B: PCA for fried type
V1, V2, V3, V4…and V19 represent the sweet potato varieties tested

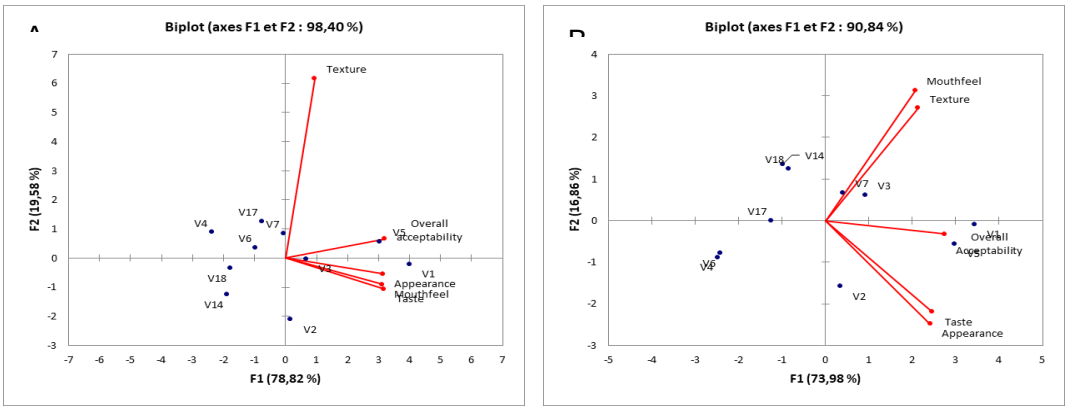

Fig. 3. Principal component plot illustrating the relationship between the sensory descriptors and sweet potato varieties tested on based the type of preparation (Korhogo district)

A: represent PCA for boiled type, B: PCA for fried type V1, V2, V3, V4…and V18 represent the sweet potato varieties tested

As concern Korhogo district, PCA was carried out on the boiled and fried. The plot for boiled sweet potato accounted for 98.40% of the variance (PC1: 78.82%, PC2: 19.58%), while that for the fried accounted for 90.84% (PC1: 73.98 %, PC2: 16.86%). The two maps show that OFSP were associated with the sensory attribute appearance, taste, and the local white-fleshed varieties were associated with texture and mouthfeel. In summary, our acceptance test revealed high scores (means are > 6) for all sweet potato varieties, which indicates that all the varieties are accepted. Overall, the attributes appearance and taste (sweet taste) made a great contribution towards distinguishing the OFSP introduced in households of both districts. The main sensory driver that determines the selection of the white- and yellow varieties is texture and taste (less sweet) attributes. This confirms previous studies which have documented that the key to consumer preference in the adoption of new crop variety is most often influenced by quality sensory attributes such as appearance, taste, and smell amongst others [27,32].

3.2 Nutritional Properties of Different Sweet Potatoes Cultivars Selected

Another possibility for increasing the sensory acceptability of sweet potato variety is nutrition information with combined tasting characteristics has an effective strategy to promote the new variety. In this study, significant differences have been shown among the twelve sweet potato cultivars tested for dry matter, sugar, and carotenoid content (Table 6). The orange cultivar TIB-440006 had the lowest (22.02%) and the highest dry matter content are recorded by Chinois Wosso (33.80%) and Sanfo Figui 1 (33.60%), the white- and yellow-fleshed cultivars, respectively. The released OFSP varieties showed the low dry matter content ranged from 22.02 to 26.30%, compared to the local sweet potato cultivars Considering the sugar content of the sweet potato cultivars tested, it is ranged from 11.81 % to 18.82 %, the orange-fleshed cultivars recorded the high content (reach up 18 %) following the white- and yellow-fleshed cultivars were showed low sugar content. Our findings agree with those of Allan et al [15] and Sali et al. [26], who mentioned that landraces varieties (white and yellow color) were characterized by high dry matter content (reach up 40%) and had low sugar content. Traditionally in West Africa, the consumers prefer high dry matter and slightly sugary taste sweet potato [33]. High dry matter constitutes an important factor that relates to good cooking qualities and extended storage ability. According to Allan et al. [15], high dry matter was correlated positively with sensory texture attribute. However, it is important to note that nutrient composition of sweet potato was highly correlated with the sensory attributes. Thus, in Bouaké the landraces sweet potato varieties (local varieties selected by farmers) were the varieties of the choice by consumers because they have high dry matter associated with good texture (dry, crispy, friable) and a slightly sugary taste.

Our study revealed that orange-fleshed varieties showed low and medium dry matter associated with high sugar content. This confirms the previous study of Hagenimana et al. [34] which indicated that orange flesh storage root colour strongly correlated with the low dry matter in sweet potato, and therefore was not always popular with farmers.

However, the potential value of OFSP due to their high total carotenoids content, a precursor of vitamin A should take into consideration to the farmers preference or characteristics traits.

In this study, the results show a wide variation in carotenoid content, from 0.41 (Sanfo Fig. 1) to 351.47 µg/g dry weight (Covington). High total carotenoid contents were mentioned in orange-fleshed cultivars tested, and the content increases with increased of intensity sweet flesh colour [35]. The range values obtained in this study agreed with those reported by Islam et al. [36] and Teow et al. [37]. Moreover, a considerable amount of carotenoid presented by the released OFSP tested (Covington, TIB-440060, CIP-199062-1, BF59×CIP4 and Irene) represent an important advantage and can be used to addressing vitamin A deficiency amongst the populations of both districts Bouaké and Korhogo in Côte d'Ivoire, where vitamin A prevalence is most important [7]. Successful studies conduct in many countries in Africa, have shown the beneficial effects of OFSP consumption in improving reserves and status [10,11,38].

In the other hand, the mineral composition of sweet potato tested is determined and shown in mustache boxes (Fig. 4A and 4B). For the macro minerals, the highest values of mineral of the sweet potato tested were 7,98 – 24,07 mg/100g (mean: 19,70 g/100g); 12,23 – 48,39 g/100g (mean: 26,22 g/100g); 10,15 – 32,64 g/100g (mean: 18,64 g/100g) and 160,76 – 354,73

Table 6. Mean dry matter, sugar, and total carotenoid contents of sweet potato cultivars tested by the sensory panel

Varieties	Dry matter content (%)	Sugar content (%)	Total carotenoid content (µg/g dw)
Covington	26,30±1;02abc	18,82±0.45a	351,96±1.34a
TIB-440060	22,02±0.90c	18,65±0.33ab	181,70±0.98e
CIP-199062-1	25,39±0.40abc	18,17±0.39abc	242,46±0.67c
BF59×CIP4	24,22±0.67bc	14,30±0.51d	226,42±1.00d
Irene	25,66±0.55abc	16,53±0.67abcd	334,62±1.03b
Gotchan	31,03±0.34ab	11,81±0.87e	15,29±0.60fg
Fatoni 2	25,86±0.56abc	14,46±0.32d	8,31±0.55gh
Affou 1	31,70±1.04ab	16,38±0.98abcd	0,67±0.05h
Chinois Wosso	33,80±0.92a	15,13±à.88bcd	19,82±0.43f
Sanfo Figui 1	33,10±0.67a	16,10±0.11abcd	0,51±0.03h
Sanfo Figui 2	29,80±0;80abc	14,77±0.77cd	0,54±0.00h
Wesse Pou	33,60±1.20a	16,65±0.44abcd	0,53±0.04h

Data are means ± standard deviation. Values with different letters (a, b, c, d…) in the same column are significantly different (P = .05)

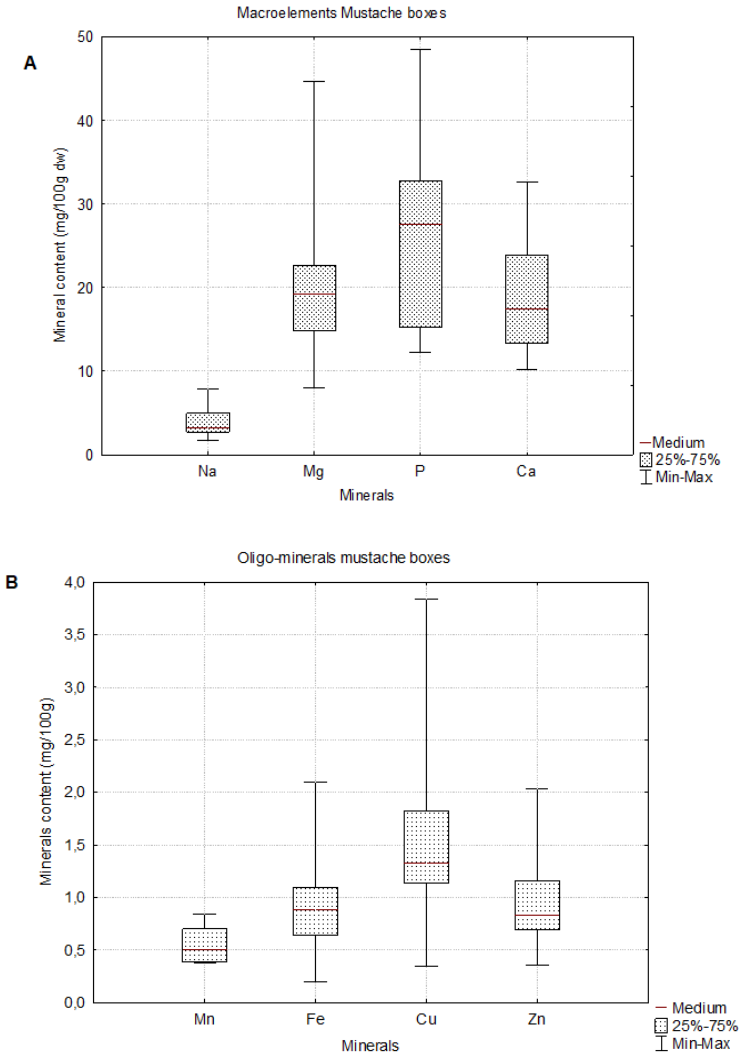

Fig. 4. Minerals Mustache boxes of sweet potato cultivars tested by the sensory panel
A: represent the average obtained for macroelements and B: represent the average obtained for oligominerals

g/100g (mean: 203,10 g/100g) for Mg, P, Ca and K, respectively. The range of iron is to 0,20 – 2,10 g/100g (0,93 g/100g), while zinc content ranged from 0,38 – 2,03 g/100g (0,94 g/100g), shown in Fig. 4B. The presence of a considerable mineral in sweet potato indicates again the nutritional benefit in the adoption of releases cultivars. Indeed, minerals are desirable in the human body for many functions such as the cellular activity of enzymes, nerve responses, muscle contraction, blood clotting [39]. The health benefits of OFSP are important to consider in its promotion amongst farmers. These benefits would help to create positive attitudes towards the behavior of consuming OSPF and increasing the already high acceptability of OFSP.

4. CONCLUSION

Although sweet potato cultivars tested possess diverse sensory attributes affecting consumer preference, all cultivars in this study were acceptable across the locations regardless of the differences in sensory attributes. Our results indicated that in Bouake district, white-fleshed cultivars Sanfo Figui 1 and Sanfo Figui 2 were most popular, followed to the yellow-fleshed cultivars (Chinois Wosso and Fatoni 2). The quality traits that determined participants' choices were good texture (dry, crispy, friable) and slightly sugariness taste (like yam-taste) correlated with their high dry matter and low sugar content, respectively. In Korhogo district, orange-fleshed cultivar (Covington, TIB-440060, CIP-199062-1 and Irene) recorded good appreciation because its sweet taste associated to the attractive appearance (orange color), consumers were also preferred the yellow-fleshed cultivar (Gotchan) based on their appearance and good texture associated to good quality of end-products.

Our study revealed that in both localities, the quality traits that guided participants' choices were taste (sweet or worst and texture associated to high dry matter content.

Also, our results revealed health benefits for all the sweet potato cultivars tested, particularly for OFSP cultivars which shows the high total carotenoid content. Consumption of orange-fleshed sweet potato cultivars exhibits potential for increased adoption of nutritionally improved varieties that match local consumers' sensory preferences. Thus, understanding consumer quality traits can increase the effectiveness of breeding programmes, increase yield and adoption of new varieties.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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