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Sensory Attributes and Consumer Preference of Precooked Vacuum-packaged Yam from Two Varieties of Ghanaian Yam (*Dioscorea rotundata*) in the Accra Metropolitan Area

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Authors' contributions

This work was carried out in collaboration between all authors. Authors CT, SN, MO, PTA, SD and EO designed the study. Authors CT, SN, MO and PTA performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CT, SN, MO, PTA, SD and EO managed the literature searches and all authors read and further approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: The need to preserve and improve availability of yam by processing into more stable and convenient forms has become increasingly attractive because of the high postharvest losses of yams in Ghana.

Study Design: In this study the sensory attributes and consumer preference of precooked vacuum-packaged sliced yams from two white yam (*Dioscorea rotundata*) varieties were assessed.

Place and Duration of Study: CSIR-Food Research Institute-Food Processing and Engineering Division, Accra, Ghana, between March 2012 and June 2013.

Methodology: Thirteen trained panelists who regularly patronize boiled yam and have previous experience in sensory evaluation were made to assess boiled yam slices from the two white yam varieties based on color, aroma, taste, texture and overall acceptability. One hundred and ninety one consumers of yam from diverse socio-economic backgrounds assessed the precooked vacuum-packaged yam from the two varieties for

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their preference. The consumer preference was conducted in a designated area at two major restaurants in Accra. Consumers were required to rate the acceptability of the yam samples on a 7-point Hedonic scale from 1-dislike extremely to 7-like extremely.

Results: Sensory evaluation revealed significant differences ($p>0.05$) in taste and color between boiled slices from *pona* and *dente* yam varieties, although the texture, aroma and overall acceptability did not differ significantly ($p<0.05$). The highest scores for all five attributes studied were recorded for *pona*. Taste and texture of the precooked vacuum-packaged sliced yams for both varieties had a positive influence on overall acceptability. Consumer preference showed a significantly higher preference (6.3) for yam slices from *pona* compared to *dente* (5.7) because of its superior taste and texture.

Conclusion: Sensory evaluation rated taste, colour, texture, aroma and overall acceptability of *pona* cultivar as higher than *dente* cultivar. Although the consumers' acceptability scores for *pona* cultivar was higher than *dente* cultivar it was not influenced by consumers' demographic status. Boiled yam precooked vacuum-packaged of *pona* cultivar was most preferred to *dente* cultivar due to its good taste and superior texture.

Keywords: Yam; food processing; precooked vacuum-packaged; sensory evaluation; consumer preference.

1. INTRODUCTION

The West Africa 'Yam Belt' including Ghana in the year 2000 produced 95-96% of the global yam (*Dioscorea* spp.) production of 30.3 million metric tonnes per year employing about 60 million people in its production and marketing [1-3].

Yam has many health benefits [4]. It is a good source of vitamin B6, vitamin E, potassium, manganese, carbohydrate, dietary fibers and proteins needed for health and vitality compared to other root and tuber crops [5,6]. Diosgenin, which is a unique fat-like substance technically classified as a hormone-like molecule with possibility of anti-cancer effects are abundant in yam.

Yam is an extremely important crop in Ghana and is produced throughout most parts of the country. It derives its prominence from its food use and the role it plays in the economic and socio-cultural lives of producing areas [7]. Yam production has doubled over the past decade, with more than 6.5 million metric tonnes produced in year 2012 [8]. As a result of its excellent taste, white yam (*Dioscorea rotundata*) is mostly preferred to water yam (*Dioscorea alata*) and yellow yam (*Dioscorea cayensis*) and it constitutes about 80% of total yam produced in Ghana [1,9-11]. The crop provides a lot of opportunities to mitigating food security and poverty issues. The tuber is the second most important source of carbohydrate after cassava. Several studies on the postharvest losses of yam ranges between 30 - 40% as a result of sprouting, respiration, rot caused by mould and bacteria, insects, nematodes, rodents and mammals [4,12-17]. Fresh yams are difficult to store due to their high moisture content above 60% making them prone to storage losses through sprouting, loss in weight and spoilage caused by rodent and insect infestation and nematode, virus, bacterial and fungal infection [6,7].

According to Kleih, et al. [18] the popular consumed varieties of white yams stores for a maximum period of three months. This situation threatens the year-round availability of the crop and constrains its food security and economic potential. Processing yams into more

stable forms present an excellent opportunity of extending its shelf-life, adding value and further consolidating its role as a popular staple and reducing the high post-harvest losses. In addition, processed yam contributes to economic growth with increased opportunities of higher income through job creation that engages in value-added products [19-20]. Among the several food uses, boiled yam (*ampesi*) is most widely preferred by Ghanaians [9]. Its preparation involves a number of unit operations and may be cumbersome and time-consuming, which is inconsistent with current demand for convenient foods. Studies by FAO [21] indicated that the demand for food and convenient food forms would soar in Africa due to urbanization and lifestyle changes. According to Gehlhar and Regmi [22], urbanization creates new food markets opportunities and consumers' preferences change from basic commodities to value-added foods. Further, the increased growth in global food markets will be achieved by increased value-added food products and not increased volume of basic staples [22]. Therefore, the need for conveniently packaged pre-cooked *ampesi* cannot be overemphasized. Earlier studies by Tortoe, et al. [23] on pre-treated yam as a convenient food showed wide acceptability among a 20-member trained panel. The study considered three popular varieties of *Dioscorea rotundata* cultivated by farmers in Ghana. The success of developed products, however, largely depends on its acceptability to consumers in terms of sensory and utilization characteristics [24]. Consumer judgment of developed products is important to market success of the products [19,20]. The present study therefore evaluates the sensory attributes and determines the consumer preferences of precooked vacuum-packaged yam from two white yam (*Dioscorea rotundata*) varieties.

2. MATERIALS AND METHODS

2.1 Yam Varieties

Two varieties (*pona* and *dente*) of the white yam (*D. rotundata*) were procured from a local market in Accra and kept in a cool dry place prior to processing. Food grade sodium metabisulphite for the studies was obtained from Mikrite Chemicals, Accra. Air-tight double density polyethylene bags were purchased from Polycare Group, Accra.

2.2 Pretreatment and Yam Processing

The tubers were washed to remove dirt and adhering sand particles and rinsed with clean water at room temperature. The washed tubers were peeled with a stainless steel knife, washed with tap water and cut (under water) into a "half-moon" shape (4 x 7 cm). The shaped slices were immediately immersed in 0.1% sodium metabisulphite solution prepared in distilled water and rinsed in tap water and precooked at 100°C for 3 mins. Blanched yam slices were then vacuum-packaged (Vacuum Sealer, Audion-Vac VM 150H (A1 Packaging Ltd., London, England) in air-tight double density polyethylene bags and blast-frozen in a blast freezer (Foster BCF21, Foster Refrigerator, Norfolk, U.K) set to hard chill (-24°C) according to Tortoe et al. [23]. After blast freezing, samples were kept in a deep freezer (Ocean NJ40TLL, Ocean Br. Overseas S.R.L, Italy) at -20°C until subsequent used. The mid-sections of the tubers were only used to avoid differences in flesh coloration of different sections [24].

2.3 Sample Preparation

Sensory assessment was conducted on boiled yam samples of the precooked vacuum-packaged of the two varieties. Prior to sensory evaluation sliced precooked vacuum-

packaged yam samples were drawn from the deep freezer, unpackaged and dipped in boiling tap water for 2 mins. A 0.1g/100ml sodium chloride was added to the boiling water purposely to taste. The boiled samples were then served to panelists while still warm.

2.4 Sensory Evaluation

Thirteen trained panelists who regularly patronize boiled yam and have previous experience in sensory evaluation were made to assess boiled yam slices from the two white yam varieties based on color, aroma, taste, texture and overall acceptability. A 7-point Hedonic scale (1 representing dislike extremely and 7 representing like extremely) was used for the evaluation [25]. Panelists were also given the option to make general comments about the samples. The evaluation was conducted in individual sensory booths. Samples were presented to panelists after coding using randomized design matrix (XLSTAT 2012, Statsoft, France) [26,27]. Panelists were instructed to clean their mouths with a piece of unsalted cream cracker biscuit and rinse with drinking water before tasting subsequent samples. Individual scores from the panelists were averaged and data analyzed using SPSS 17.0.1, [28]. Statistical significance was set at 95% level confidence interval.

2.5 Consumer Preference

One hundred and ninety one consumers of yam from diverse socio-economic backgrounds assessed the precooked vacuum-packaged yam from the two varieties for their preference. The consumer preference was conducted in a designated area at two major restaurants in Accra, Ghana. The boiled yam slices prepared as above were served to panelists on plastic platter while still warm and identified with a 3-digit code using randomized design matrix (XLSTAT 2012, Statsoft, France) [26,27]. Each panelist was given one slice of a half-moon (4x7 cm) of each variety, simultaneously. Consumers were required to rate the acceptability of the yam samples on a 7-point Hedonic scale from 1-dislike extremely to 7-like extremely [25]. Drinking water was provided to panelists to thoroughly rinse their mouths before tasting subsequent samples. As a tool for gathering data the consumer completed a questionnaire consisting mainly of closed ended questions on consumer demography, yam consumption patterns and access the convenience of the package used for packaging the precooked vacuum-packaged yam slices.

2.6 Statistical Analysis

The data captured for the sensory evaluation and consumer preference was subjected to a one-way analysis of variance (ANOVA) using the two different varieties as the main factor. A 0.05% level of significance was adopted to establish differences between sensory attributes and acceptability of the two yam varieties. Data from the questionnaire was coded and entered into SPSS and analyzed using descriptive statistics [28]. Differences between consumer preferences for the slices from the two varieties were assessed using the t-test. Regression analysis was conducted to determine the contribution of each attribute to overall acceptability of precooked vacuum-packaged yam from the two varieties.

3. RESULTS AND DISCUSSION

3.1 Sensory Evaluation

Sensory evaluation of precooked vacuum-packaged slices from the two white yam varieties showed significant differences ($p < 0.05$) in taste and colour but not texture and aroma. However, *pona* had the highest score in all attributes (Fig. 1.) but did not differ significantly ($p > 0.05$) from *dente* in overall acceptability. *Pona* obtained an overall acceptability rating of 4.5 representing “like slightly” on the 7-point hedonic scale, while *dente*, obtained a score of 3.6 representing “neither like nor dislike”. In studies reported by Brunnschweiler [29], the author described taste, texture and appearance as the primary quality criteria for determining the choice of yams while odour and colour are the secondary quality criteria. Subsequently, other authors have shown that *pona* is preferred to other white yams and have attributed this preference to its sweet taste [9,30]. The difference in taste between the two varieties is probably due to the difference in total sugar content of the varieties. Even though the two varieties belong to the same cultivar (*D. rotundata*), inherent properties that control the breakdown of starches into sugars during storage and other associated mechanisms relating to sugar content vary. Although, sweetness is not the only determinant of yam quality, total sugar content greatly influences its acceptability [31,32]. Generally, *D. rotundata* is noted for its excellent taste and is preferred to *D. alata* and *D. cayensis* [1,9-11].

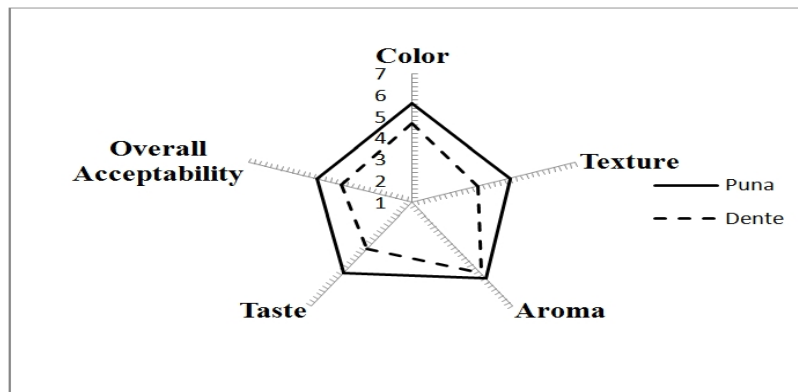


Fig. 1. Sensory profile of precooked vacuum-packaged yam from two white yam varieties

The colour of *pona* was perceived as better and therefore rated significantly higher (5.6) than *dente* (4.7). The difference in rating reflects the difference in appearance of boiled yam slices from the two varieties. Yams contain anthocyanin and carotenoid pigments, which are known to characterize the flesh colour of the tuber. Differences in the levels of these phenolic compounds results in colour differences among tubers. The perceptible difference in colour probably arose as a result of browning effect. Although this was controlled during processing, the fact that some extent of this phenomenon may have occurred cannot be overemphasized as observed in studies by Oduro, et al. [33].

The texture of boiled yams is described in terms of mealiness, hardness, sogginess, waxiness and stickiness [34]. However, mealiness and softness are the most preferred [26,36]. Differences in texture between the two varieties suggests different histological properties among the two varieties and further reveals the likelihood of dissimilar breakdown

or loss of cellular integrity and other chemical properties during cooking [29]. This observation is similar to that reported by Otegbayo, et al. [34], in which some *D. rotundata* varieties also showed different textural behavior after cooking.

In this study, taste and texture attributes contributed significantly ($p < 0.05$) and correlated positively with overall preference of the slices from the different varieties (Table 1). Both taste and texture attributes together accounted for 84.3% of the variation of the overall acceptability of the boiled yam. This is similar to studies reported by Egesi, et al. [26] and Eze, et al. [35], who observed that taste and texture attributes influences the general preference of boiled yam. Colour and aroma attributes did not significantly influence panelists' preference for the boiled yam, even though they are essential attributes and may affect preference for other food products. This buttress the report by Brunnschweiler [29] that colour and aroma are secondary attributes for quality of boiled yams.

Table 1. Regression of attributes on overall acceptability of boiled yam slices from two white yam varieties

Attribute	Estimate	Standard error of estimate	Partial r^2
(Constant)	0.050	0.657	
Taste	0.537	0.121	0.473*
Texture	0.401	0.112	0.370*
Total			0.843

*significant at $p < 0.05$

3.2 Consumer demography and yam consumption pattern for yam food forms

The demographic data of one hundred and ninety one consumers' completed questionnaire is presented in Table 2. The gender status of respondents was skewed towards males as more took part in the survey than female an indication of high male patronage of restaurants in Ghana. Generally, the sample population was youthful and well educated, with most (79.6%) of them within the age range of 18 - 35 years and approximately 80% having obtained at least a bachelor's degree. About 58% of respondents came from households of more than 4 people. In a household of 3 to 4 people, 33.6% was surveyed, whilst 8.9% was surveyed for a household of 2 people.

Yam consumption in Ghana cuts across geographical and socio-economic bounds and serves as a valuable source of calories, even though it is relatively more expensive than other root and tuber crops such as cassava, sweet potato, cocoyam and taro [4,36,37]. Its consumption among the consumers surveyed varied from "once a day" to "rarely" with a majority (44.2%) of respondents eating boiled yams more than once in a week. Nearly 11% and 34%, correspondingly eat boiled yams at least once a day and at least once in a month. Although the crop is quite popular and is deemed to be widely consumed, the remaining 11% of respondents either rarely eat or had never eaten boiled yams before.

Table 2. Demographic profile of consumers

Variable	Frequency	Percentage (%)	Mean acceptability Score	p-value
<i>Gender</i>				
Male	132	69.1	6.0	0.194
Female	59	30.9	6.1	
<i>Age</i>				
18-35	152	79.6	6.0	0.258
36-45	26	13.6	6.0	
46-55	7	3.7	6.2	
>55	6	3.1	5.5	
<i>Educational level (n=190)</i>				
Primary	2	1.1	5.3	0.130
Secondary	37	19.5	5.8	
Tertiary	149	78.4	6.0	
Professional	2	1.1	5.8	
<i>Household size</i>				
2 or less	17	8.9	6.1	0.074
3	32	16.8	6.0	
4	32	16.8	6.2	
>4	110	57.6	5.9	
<i>Frequency of consumption</i>				
once a day or more	20	10.5	6.1	0.098
>once a week	84	44.2	6.0	
Once a week	49	25.8	6.0	
Once a month	16	8.4	5.6	
Rarely	20	10.5	6.0	
Never	1	0.5	5.0	

Earlier studies reported indicated that boiled yam is a very popular food form of fresh yam processing [9,37,38]. Similarly, surveyed consumers' response indicated their choice for boiled yam as the yam cuisine usually consumed compared to fried yam and mashed yam. The survey indicated 66% consumers' preferred boiled yam, while 30% preferred fried yam and 4% preferred the least popular mashed yam (Fig. 2.). Boiled yam, locally called *ampesi* in Ghana is usually eaten with soups and sauces as accompaniments. Boiled yam as a food form demands that the cultivar used should have excellent culinary properties such as good taste and mealiness [24,39]. As a result, yams from *D. rotundata* are fancied for use as *ampesi* compared to *D. alata* and *D. cayensis*.

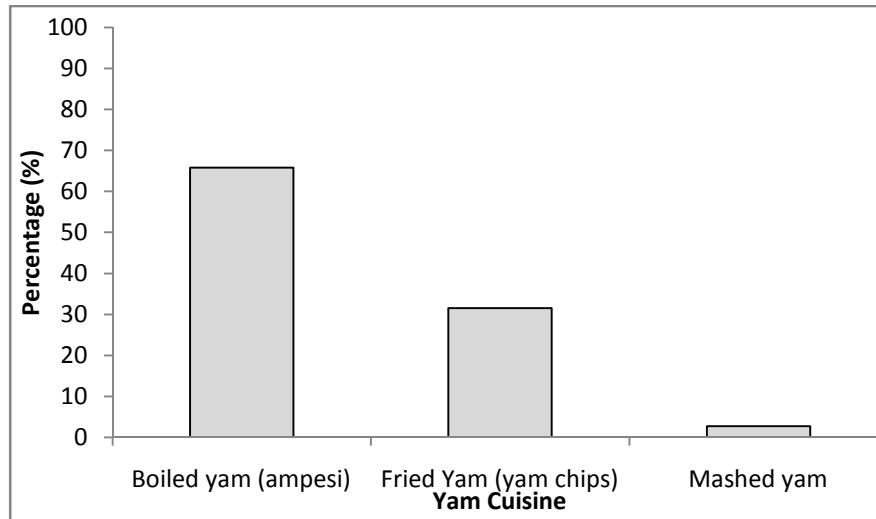


Fig. 2. Yam cuisine usually consumed

3.3 Consumer Preference for *Pona* and *Dente* Varieties

Pona was the most preferred cultivar by 68.3% of consumers in this assessment. It had a mean score of 6.3, significantly different from the mean score for *dente* (5.7) as shown in Table 3. The results affirm the high overall acceptability score for *pona* compared to *dente* by the laboratory sensory panel. The reasons why consumers choose *pona* over *dente* was based on either taste or texture and a combination of these two attributes.

Table 3. Mean score for boiled yam preference

Cultivar	Percent	Mean score	t-stat	p-value
<i>Pona</i>	68.3	6.3±1.0	5.15	<0.0001
<i>Dente</i>	31.7	5.7±1.3		

Respondents who said taste of the boiled yam influenced their preference for *pona* were nearly five times more than those whose choice was based on texture of the boiled yam (Fig. 3.). The overwhelming effect of taste on preference compared well with results reported by Aidoo [9] in which more than 80% consumers' indicated that their choice of a particular yam variety is based on taste. This observation is similar to that reported by other authors that consumers desire boiled yam that is sweet, mealy and soft [34,35,39] and these qualities are characteristics of *pona*. The observations from the consumer preference test buttress studies by Aidoo [9], who also identified *pona* as the mostly preferred white yam in most parts of Ghana. Even though *pona* is more perishable compared to other varieties, consumer demand is always high [1]. High consumer preference for *pona* and other *D. rotundata* varieties explains why they form the bulk of yams cultivated in Ghana.

Consumer preference scoring of boiled yam slices did not significantly differ ($p>0.05$) among respondents with different demographic profiles as shown in Table 2. Also, how often consumers eat yams did not significantly ($p>0.05$) affect preference scoring, even though a cursory look at preference scores (Table 2) show that those who eat yams "once in a day or more" had a higher score for the samples. In other studies, the authors reported that

demographic characteristics have an influence on consumer preference for certain foods such as meat and meat products and common foods and beverages [40,41]. Interestingly, the study observed that demography did not affect acceptability score of the boiled yam similar to earlier studies by Aidoo [9], who reported that utilization of yam varieties for food in Ghana is unlimited by socio-economic bounds.

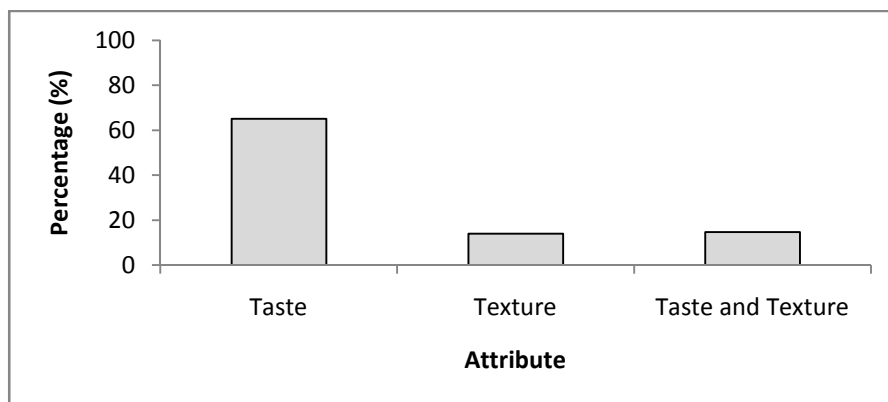


Fig. 3. Attributes influencing preference of boiled slices from different yam varieties

4. CONCLUSION

Sensory evaluation rated taste, colour, texture, aroma and overall acceptability of *pona* variety as higher than *dente* variety even though texture, aroma and overall acceptability were not significantly different ($p>0.05$) among the two varieties of white yam. Regression analysis on the sensory evaluation indicated that 84.3% of the variation in overall acceptability was contributed by taste and texture attributes. Although the consumers' acceptability scores for *pona* variety was higher than *dente* variety it was not influenced by consumers' demographic status. Boiled yam precooked vacuum-packaged of *pona* variety was most preferred to *dente* variety due to its good taste and superior texture.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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