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Full Length Research Paper

Evaluation of the sensory characteristics and consumer acceptability of deep-fried crisps of two varieties of Ghanaian yam (*Dioscorea rotundata*) in the Accra Metropolitan Area

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ABSTRACT

Deep-fried crisps snack developed from yam (*Dioscorea rotundata*) was evaluated on its sensory characteristics and consumer acceptability. The crisps were developed from two Ghanaian common varieties of white yam (*pona* and *dente*) using eight different seasonings. These were subjected to a sensory evaluation using 25 trained panelists to assess color, crispiness, aroma, taste and overall acceptability. Subsequently, the two most preferred yam seasoned chips were selected for a consumer acceptability survey using 158 respondents.In the sensory evaluation, significant difference ($p<0.05$) was established for crispiness, taste and overall acceptability of the crisps. Ginger and shrimp seasoned chips from *pona* variety was the most preferred.Regression analysis showed that taste and crispiness significantly influenced the selection of the most preferred products. In the consumer acceptability campaign, the two differently seasoned chips were rated similarly($p>0.05$), although more respondents preferred the ginger seasoned chips. Preference for the two seasoned crisps was markedly different among males and females but quite akin, considering other demographic parameters.

Keywords: *Dioscorea rotundata*, crisps, deep-frying, ginger, shrimp,sensory analysis, consumer acceptability

INTRODUCTION

Snack foods are popular and very well exploited throughout the world. They are handy and light, usually seasoned with salt and other flavorings and eaten between regular meals (Lusas, 2001).Snacks vary widely in their form and range from raw to cooked foods. A significant lot of these snacks, however, are processed by deep-frying, with potato chips being one of the most popular (Salvador *et al.,* 2009). The aim of deep-frying is to enclose the food in a crispy crust that will retain the flavours and juices of the fried food (Mallikarjunan *et al.,* 2010). The process involves immersing a food product in edible oil or fat, heated above the boiling point of water to achieve cooking (Mariscal and Bouchon, 2008). In the process, heat and mass transfer occur concurrently between the food product and the heating medium. Water within the food is converted into steam, which effects cooking and escapes, leaving spaces which are filled with the oil. This method of processingis quite rapid and convenient and imparts peculiar sensory attributes such as colour, texture and flavour and is commonly used in the snack food industry (Chen and Moreira, 1997).

Development of snacks from yam has become attractive in the light of a search for alternative uses of root and tuber crops. Yam (*Dioscorea spp*) is an important staple cultivated widely in Ghana and is ranked second most important root and tuber crop after cassava. Production of yam in Ghana has doubled over the past decade. Yam production estimates for 2009, 2010 and 2011 were 5.7, 5.96 and 5.85 million tonnes, respectively (MoFA, 2013). In 2011, Ghana exported approximately 27,000 MT of yam (MoFA, 2013). In Ghana, the white yam (*Dioscorea rotundata*) due to its excellent taste is mostly preferred to water yam (*Dioscorea alata*) and yellow yam (*Dioscorea cayensis*) and therefore

constitutes about 80% of total yam produced in Ghana (Aidoo, 2009; IITA, 2001; Bancroft, 2000; Tetteh and Saakwa, 1994). Typical of root and tuber crops, yam is an excellent source of energy but contains rather low amounts of fat, vitamins, proteins, and minerals (Afoakwa and Sefa-Dedeh, 2001; Shanthakumari *et al*., 2008). Yam is also believed to possess medicinal properties because it contains diosgenin, a steroid saponin known to have anti-obesity effect (Kwon *et al*., 2003).

Culinary applications of yam in Ghana has customarily been its use as a main meal when the tuber is boiled, roasted, fried, pounded or made into flour and cooked and eaten with accompaniments. The potential use of yam in producing deep-fried snacks largely remains untapped. Therefore, developing snack products from yam will further diversify its culinary uses and increase its premium as a root and tuber crop.Further, crisp from yam present the consumer with a wide array of snacks to satisfy the demands of urbanization. This is important as urbanization creates new food markets opportunities and consumers' preferred food changes from basic commodities to value-added foods(Gehlhar and Regmi, 2002). According to Gehlhar and Regmi (2002) the increased growth in global food markets will be realized by increased value-added food products and not through increased production volumes of basic food staples. Hence the objective of this study is laudable as it develops deep-fried yam crisps fromtwo local varieties of *Dioscorea rotundata* (*pona* and *dente*), evaluate its sensory characteristics and test its acceptability in a consumer preference survey in the Accra Metropolitan Area.

MATERIALS AND METHODS

Materials

Two common Ghanaian *Dioscorea rotundata* varieties(*pona* and *dente*)were procured from the HaatsoYam Market in Accra and stored in a cool and dry place before processing.Matured yams from these varieties were used to develop the fried crisps. Spices/seasoning (turmeric, ginger, garlic, Adobo®, cayenne, shrimp, ginger+garlic (G+G) and *kelewele* mix) and vegetable oil (Frytol®) were obtained from a local shopping mall.

Processing of yam crisps

Matured yam tubers were carefully selected and washed by hand in potable water before peeling with sharp stainless steel blades knives. The peeled yams were secondly washed in potable water before slicingusing a kitchen slicer with adjustable stainless steel blades. Frying was done in a deep fryer fitted with a temperature regulator (MCSDF15ST2, Magi c Chef Inc., USA). Yam slices (2.0 mm thick) were spicedbefore frying for 5 min at 140 ℃. One set of yam slices from each variety, however, was not spiced before frying. Eighteen samples were obtained in all (16 seasoned and 2 unseasoned) for the sensory evaluation.In order to avoid bitterness the middle portions of 10 cm from head and tail of yams were used in the study. Fried slices were drained, transferred to a colander lined with tissue paper and allowed to cool. Yam crisps were then packaged in polypropylene bags and sealed with a 12" impulse bag sealerwith adjustable timer (PFS-300B, Doug Care Equipment Inc., USA).

Sensory evaluation

Twenty five trained panelists assessed the yam crisps.Each judge evaluated a total of eighteen yam crisps at two sessions (9 samples per session), following a randomized design matrix (XLSTAT 2012, Statsoft, France). The panelists were served with 100 g of each sample of yam crisps and instructed to taste and evaluate the sample using an evaluation sheet. Sensory attributes assessed included colour and colour uniformity, crispiness, aroma, taste and overall acceptability. A 7-point Hedonic scale with 1 representing 'dislike extremely' and 7 representing 'like extremely' was used for the evaluation (Stone and Sidel, 2004; Lawless and Heymann, 2010; Rampersad *et al*., 2003; Hooda and Jood, 2005).Panelists were also given the option to make general comments about the samples. The evaluation was conducted in individual sensory booths consistent with ISO 8589. Unsalted cracker and water were supplied to panelists for refreshing their palates before tasting subsequent samples.Individual scores from the panelists were averaged and data analyzed (SPSS 17.0.1, 2008). Statistical significance was set at a level of 95% confidence interval.Stepwise regression was used to determine the influence of sensory attributes on overall acceptability of yam crisps.

Consumer acceptability survey

Based on the outcome of the sensory evaluation, two different crisps were selected for the consumer preference test. One hundred and fifty eight consumers evaluated the yam crisps for acceptability.Participants were consumers of fried foods and were selected after reading and signing a consent form. Three pieces of each of the two yam crisps samples were presented to panelist on a white Styrofoam platter, labeled with a unique 3-digit code.Unsalted cracker and water were provided to clean and refresh the palate before evaluating different samples. A 7-point Hedonic scale ranging from 1 'dislike very much' to 7 'like very much' was used to rate product acceptability as described by (Stone and Sidel, 2004; Lawless and Heymann, 2010; Rampersad *et al*., 2003; Hooda and Jood, 2005).Consumers were also given the

Table 1. Mean of Hedonic ratings for sensory attributes and overall acceptability of yam crisps

Sample code	Seasoning	Mean score for attributes				
		Colour	Crispiness	Aroma	Taste	Acceptability
Dente	Ginger	4.7	4.8^{ab}	5.2	4.7^{ab}	4.1^{ab}
Dente	Cayenne	5.3	5.3^{ab}	5.5	4.7^{ab}	4.7^{ab}
Dente	G+G	5.9	4.6^{ab}	4.4	4.0^{ab}	4.0^{ab}
Dente	Shrimp	3.7	4.2^{ab}	4.2	3.6^{a}	3.3^{a}
Dente	Turmeric	4.3	5.9^{b}	4.9	4.5^{ab}	4.5^{ab}
Dente	Adobo®	5.0	5.1^{ab}	5.1	4.5^{ab}	4.3^{ab}
Dente	"No seasoning"	4.5	5.3^{ab}	4.6	4.0^{ab}	4.2^{ab}
Dente	*Kelewele*	4.5	5.1^{ab}	4.8	4.1^{ab}	4.2^{ab}
Dente	Garlic	4.9	4.9^{ab}	4.3	4.2^{ab}	3.8^{ab}
Pona	***Ginger***	***5.1***	***4.6^{ab}***	***5.2***	***4.8^{ab}***	***5.1^{b}***
Pona	Cayenne	4.6	3.5^{a}	4.2	4.4^{ab}	3.9^{ab}
Pona	G+G	5.4	4.5^{ab}	4.4	4.5^{ab}	4.1^{ab}
Pona	***Shrimp***	***5.1***	***4.2^{ab}***	***5.0***	***5.7^{b}***	***5.2^{b}***
Pona	Turmeric	4.5	5.2^{ab}	4.8	4.3^{ab}	4.9^{ab}
Pona	Adobo®	5.2	4.2^{ab}	4.5	4.9^{ab}	4.5^{ab}
Pona	"No seasoning"	4.9	4.6^{ab}	4.7	4.4^{ab}	4.1^{ab}
Pona	*Kelewele*	5.1	4.5^{ab}	4.0	3.9^{ab}	3.9^{ab}
Pona	Garlic	5.5	4.2^{ab}	4.3	4.4^{ab}	4.5^{ab}

Means with different superscripts are significantly different at $p<0.05$. Italicized samples were selected for the consumer acceptability survey.

option of writing their comments about the two products. Following the acceptability test, each consumer was also made to complete a questionnaire of closed ended questions. The questionnaire was used to collect information on consumer demography and product acceptability.

RESULTS AND DISCUSSION

Sensory evaluation

Sensory evaluation of yam crisps based on the selected attributes is presented in Table 1. Generally, the colour of the crisps was liked by the panelists. The mean scores for the 18 variants of the product ranged between 3.7 and 5.9. Shrimp spiced crisps of *dente* variety received the lowest score rating among the yam crisps variants, followed by turmeric of *pona* variety."No seasoning" of *dente* variety and *kelewele* of *dente* variety had a mean score of 4.5. The G+G of *dente* variety and garlic of *pona* variety were the most highly rated in terms of their colour and were rated as "like moderately" of 5.9 and 5.5, respectively. Colour is one of the most important physical attribute that greatly influences consumer perception and can summarily lead to rejection of a project. According to Pedreschi *et al.* 2007, consumers tend to associate colour with sensory and physicochemical attributes of products because they correlate.Additionally,Miranda and Aguilera (2006) observed that during frying, the colour of the product is developed as a result of Maillard and is influenced by factors such as reducing sugar and amino acid content.

Development of a crispy, crunchy and crackly texture is one of the distinct properties of fried food products and considerably affects acceptability. Generally, crispiness was rated quite highly by participants, with the highest rated sample obtaining a mean score of 5.9. This score can be described as 'like moderately' on the 7-point Hedonic scale. Conversely, cayenne of *pona* variety had the lowest score of 3.5 and panelists were indifferent (neither like nor dislike) about its crispiness. These two samples were judged as markedly different ($p<0.05$) from one another.Differences in crispness could arise from air spaces that may develop within the crisp structure (Vincent, 1998), sogginess, moisture uptake after frying (Miranda and Aguilera, 2006) as well as differences in starch and other chemical components of the food product (Kita, 2002).

Aroma of the crisps was not significantly different ($p>0.05$) from each other and was generally rated as 'like slightly' by the 25-man panel. This outcome was regardless of the fact that different seasoning were used for each of the variants, apart from the control. Regarding the taste, only shrimp *dente* variety was perceived significantly different ($p<0.05$) from the rest of the samples. Incidentally, this particular sample also had the least score for taste (3.6).

The lowest mean score of 3.3 was obtained for overall acceptability by shrimp *dente* variety. It was considerably different from ginger *pona* variety and shrimp *pona* variety for overall acceptability. The shrimp seasoned *dente* variety also had low scores for colour and taste, an indication that this sample was generally undesirable by the panel. All other crisps variants were acceptable to the panel since they scored more than 3.5 (neither like nor dislike) on the 7-point Hedonic scale. Based on the mean overall acceptability ginger-flavoured *pona* variety crisps and shrimp-flavoured *pona* crisps were selected for the

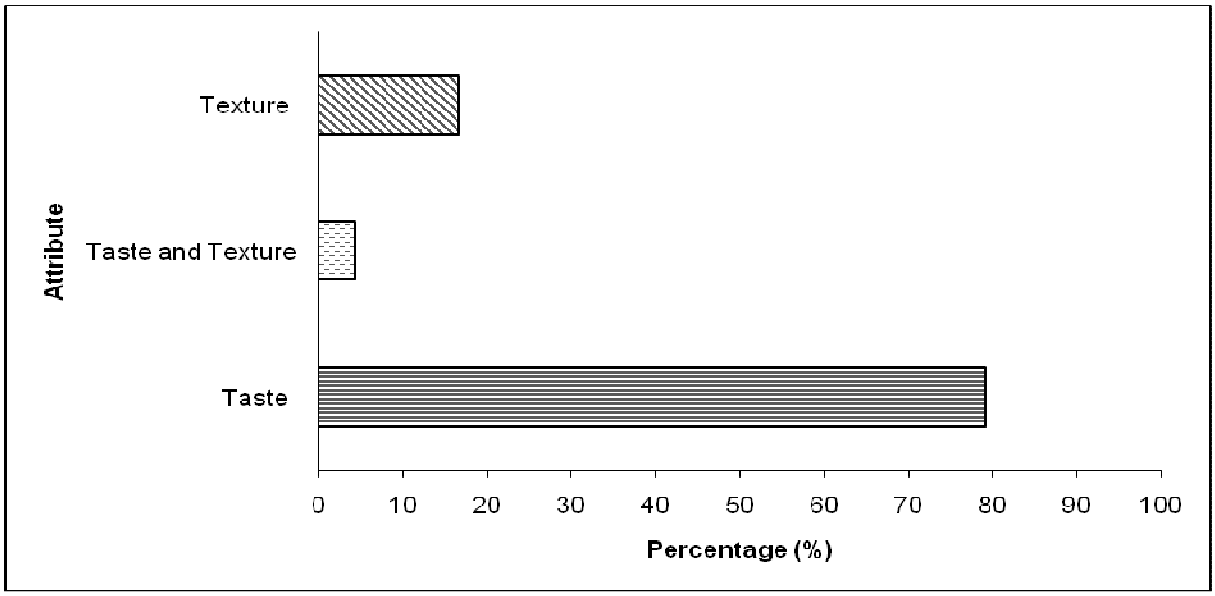

Figure 1. Attributes of fried yam chips that influence acceptability

consumer acceptability survey.This reiterates the point that *pona* has always been the mostly preferred white yam variety in Ghana (Aidoo, 2009).

There was a strong correlation (R^2 = 0.619) between the overall acceptability and the sensory attributes of the yam crisps. A stepwise multiple regression between overall preference and sensory attributes showed that taste and crispiness significantly ($p < 0.05$) affected acceptability and were therefore the best predictors of crisps acceptability. Taste and crispiness accounted for 62% of the variability in the relationship between the sensory attributes and overall preference.This finding underscores the focal role of taste as an essential attribute of food products and affirms the observation by Krokida *et al.* (2001) and Kita (2002) that crispness is an important texture property of fried chips.

Consumer demography

The panelist who participated in the survey, consisted of 57% male and 43% female majority (66.4%) were aged between 18 and 35 years (Table 3). The participants were largely literate, with 35.5% as tertiary level graduates and the remaining 64.5% as secondary or basic school level graduates.Nearly,81% of participants came from households with four or more members, as is typical of most families in Ghana (GSS, 2012) while the remaining had households'less than four members.

Consumer acceptability

Ginger seasoned chip was the most preferred among the selected crisps variants and was the choice of 52.2 % of 152 consumers surveyed. However, the mean acceptability score assigned was not significantly different among the two samples, although the ginger flavoured chips had a higher mean ratingof 6.5 (Table 4). This observation verifies the results of the sensory evaluation conducted prior to the consumer preference survey, which also had acceptability scores not being significantly different between these two samples.

Chi square test (Table 3) indicated that preference for the two yam crisps was significantly different ($p<0.05$) between males and females with a majority of females liking shrimp seasoned crisp most and males preferring ginger seasoned crisps most. Apart from gender, no clear trend in preference was established for the fried yam crisps with respect to the other demographic indices. Consumers with different social status rated the crisps similarly, an observation which indicates that the developed yam crisps would be widely acceptable, regardless of demographic status.

Reasons for consumers' choice of the fried yam crisps were based on taste, texture and a combination of taste and texture as indicated in figure 1. This trend was similar among the two variants of yam crisps.A remarkable observation of this result is the fact that none of the participants' choice was influenced by colour or aroma. This lends credence to the findings from the regression analysis conducted on the responses from the sensory assessment (Table 2). Even though these attributes may greatly influence the acceptability of certain food products, they may be described as secondary attributes for consumer acceptability of deep-fried yam crisps.

CONCLUSION

Sensory evaluation of the yam crisp showed preference for samples from *pona* variety as opposed to samples

Table 3. Demographic characteristics of participants

Variable	Frequency	Percentage (%)	Preferred sample	χ^2	p-value
Gender					
Male	90	57.0	788	5.104	0.024
Female	68	43.0	416		
Age (n=152)					
18-35	101	66.4	416		
36-45	18	11.8	416	5.017	0.286
46-55	20	13.2	788		
>55	13	8.5	788		
Educational level (n=155)					
Primary	17	11.0	788	5.468	0.065
Secondary	83	53.5	416		
Tertiary	55	35.5	788		
Household size					
2 or less	10	6.3	788	2.797	0.731
3	20	12.7	416		
4	26	16.5	788		
>4	102	64.6	416		

Table 4. Mean score for yam chips preference

Seasoning/Flavour	Percent	Mean score	Inference	p-value
Ginger	52.2	6.5±0.6	Like very much	<0.514
Shrimp	47.8	6.4±0.6	Like moderately	

from *dente* variety with taste and texture (crispiness) playing a significant role in selection of preferred choice.Two other attributes, color and aroma did not contribute significantly to the preferred option of sensory panelists. Yam crisps seasoned with ginger or shrimp were liked most compared to crisps seasoned with the other 6 spices. Consumer acceptability survey revealed that more consumers (>52%) liked the ginger-seasoned crisps than shrimp seasoned crisps (<48%). Although, gender influenced the choice of deep fried yam crisps, other demographic indices such as age, educational status and household size of consumer did not.Generally, the developed yam crisps was acceptable since it had an acceptability score of 6.4 – 6.5 as 'like moderately' to 'like very much' on a 7-point Hedonic scale.

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