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Minimal processing of yam to increase consumers' acceptance

Oduro I.[1], Ellis W.O.[1], Asamoah-Okyere D.K.[2], Adu-Amankwa P.[3], Alemawor F.[1] and Amagloh F.K.[1]
[1]Department of Biochemistry, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[2]Foods and Drugs Board, Accra, Ghana
[3]Food Research Institute of Ghana, Accra, Kumasi, Ghana

Abstract. Studies were carried out on the minimal processing of yam, a value staple crop among the Ghanaian populace. Yam, reduced to different sizes was minimally processed using two methods (steaming and parboiling). These samples were stored at –20°C over a period of 12 weeks. Sensory evaluation involving 2 sets of panel to assess Product-based and Consumer-based influences was conducted on the stored samples every fortnight to evaluate the colour, texture, taste and size of the yam sample after frying and boiling. Product-based testing for parboiled *pona* shows that taste and colour for the large size yam was the most preferred and it was stable throughout the analysis. The large type also shows that preference increased with storage especially for size and texture. For the steamed pretreated, preference decreased with storage for small type samples while for chips all the four sensory parameters were acceptable to the consumers. There were varying preferences in some of the sensory parameters for small and medium types. The result of the parboil samples for the consumer-based analysis indicated that with exception of taste all the other sensory parameters were acceptable for both small and large sizes while for medium size and chips preference was for size, and texture. For the steamed samples panelists showed preference for all the sensory parameters for chips while for small size preference decreased with storage. There was a general acceptance for steamed treated chips in both product and consumer based testing. With exception of taste in the consumer-based testing all the other sensory parameters in both testing were well accepted.

Introduction

Yam (*Dioscorea* spp.), one of the most important staple crops in Ghana, is used in various forms in food preparations such as *ampesi* (boiled yam), *fufu* (pounded boiled yam), *oto* (mashed boiled yam), fried and *mpotompoto* (yam porridge). However, it is predominantly eaten as *ampesi* and fried chips.

Pona (Dioscorea rotundata) is one of the yam species commonly cultivated and consumed by Ghanaians as a staple food. However, lack of effective post-harvest storage methods affect its shelf-life, thus leading to huge economic losses whenever there is a bumper harvest. One of the innovations whose impact on post-harvest technology is increasing, is "minimal processing" of fruits and vegetables. "Minimal processing" generates products that are cut and lightly processed in order to make them easily used by consumers. Considerable data concerning the use of "minimal processing" technologies can be found in literature (Ohlsson and Bengtsson 2002). However, there is a paucity of data in the use of these techniques for yam. Also, with the changing lifestyle in our society, there is an increase in the demand for semi-processed and processed foods, thus the need for an increase in the number of minimally processed

food types to meet these demands. This study sought to determine the product stability with respect to its sensory characteristics during storage and its consumer acceptability by adapting the technology of minimal processing.

Materials and Methods

Source of yam tubers. The *pona* yam tubers were obtained from a local yam seller at Patasi a suburb of Kumasi, Ghana.

Processing and storage of samples. The yam tubers were peeled, washed and processed in two groups: the first group was cut into chips using a potato chipper and in the second batch; the peeled yam tubers were cut into pieces of three different sizes (Small – 1.5 cm; Medium – 2.0 cm; Large – 3.0 cm and Chips). These were washed and further subdivided into two groups. Samples in one subgroup were parboiled while the other subgroup samples were steamed according to the time periods shown in Table 1. After the heat treatment, the samples were cooled in cold water, packaged in low-density polyethylene bags and stored in a freezer over a 12-week period at –20ºC.

Preparation for sensory analysis. Both fresh and freeze-stored preheated yam samples were cooked. The yam chips were fried in 'Leisure' vegetable oil, using the Kenwood Di-460 deep fryer. The oil was heated to a temperature of 190ºC prior to frying and the temperature maintained during the period of frying. The chips were fried until golden brown. The other types were cooked in boiling water. The stored samples were cooked in their frozen state to reduce the effect of freeze injury. The periods for boiling and frying are also indicated in Table 1.

Sensory evaluation. The sensory analysis was conducted using a hedonic scale of 1–7 with responses ranging from dislike very much through neither like nor dislike to like very much respectively. Sensory analysis was done to determine the effect of the type of pretreatment as well as the effect of the storage method (freezing) on four parameters: taste, colour, texture and size of yam samples. Evaluations were carried out fortnightly. Fresh yam samples prior to storage served as controls.

Two types of data were collected: data on product-based analysis (in which the same sensory panelists were used throughout the period of the analysis) and data on consumer-based analysis (where panelists were varied over the period of the analysis). An untrained panel of 40 individuals was used for the consumer-based testing and 20 individuals for the product-based testing. The mean response was determined for each sensory parameter analyzed. The sample was considered acceptable by the panel if the mean value obtained falls within the range of 4 - 7.

Data analysis. The complete randomized design (CRD) was employed in this study and the analysis of variance (ANOVA) of the data was computed at $P<0.05$.

Table 1: Time for parboiling, steaming and cooking.

Type	Pre-treatment		Cooking (min)
	Parboiling (min)	Steaming (min)	
Small type	3	6	8
Medium type	4	7	10
Large type	5	9	15
Chips	2	4	6

Results and Discussion

Product-based analysis - Parboiled *Pona.* Panel response to taste over the 12-week analysis was generally in the acceptable range for all samples except for the large type, which at some point fell below the acceptable range. The small and large types were acceptable while the medium type and chips were at certain periods below the acceptable range in terms of colour. The poor response to colour for the chips and the medium type may be attributed to discoloration due to enzymatic browning (Akorada, 1995; Fennema, 1996). The results also showed no significant variations in colour. Texture of the large type and chips were the most accepted over the period of analysis. The large type gave the best texture response with a mean value of 5.88. The chips showed a high response at 5.36 and a low of 4.00. Both small and medium types however had responses at certain periods below the acceptable range during the course of the evaluation. ANOVA results indicated no significant differences ($P < 0.05$). For size, all the types were within the acceptable range though the medium type showed the highest mean-value response of 5.82 (Table 2).

Product-based analysis - Steamed *Pona.* The mean-values of response to taste showed that the chips were highly accepted, with the highest mean-value response of 5.67 and the least at 5.06 (Table 3). The responses for the small (the least accepted sample), medium and large types showed a fluctuating trend in the response range of 3.08 to 5.18. ANOVA results for taste of the samples indicated significant differences in taste ($P<0.05$). The colour of the chips was acceptable and that for the small type the least accepted. Chips showed a generally high and stable response with a high mean-value of 5.83 and a low mean-value of 4.60. The remaining samples (small, medium and large types) at some point during the evaluation were out of the acceptable range. The poor response to colour shown by the small type may be attributed to browning reactions (Fennema, 1996). For the response

Table 2: Mean range of sensory evaluation for product-based study (Parboiled).

Type	Parboiled *Pona*			
	Taste	Colour	Texture	Size
Small	3.47-4.55	4.00-5.59	3.50-5.00	4.85-5.18
Medium	3.22-4.36	3.43-5.05	3.89-4.86	4.61-5.82
Large	4.35-5.41	4.33-6.28	4.57-5.88	4.25-5.53
Chips	3.89-5.21	3.00-4.83	4.00-5.36	4.38-5.55

Table 3: Mean range of sensory evaluation for product-based study (Steamed).

Type	Steamed *Pona*			
	Taste	Colour	Texture	Size
Small	3.08-4.50	2.88-5.31	3.56-5.50	3.90-5.30
Medium	3.77-5.18	3.15-5.56	3.38-4.84	4.76-6.30
Large	3.29-5.06	3.55-5.08	3.94-5.20	3.50-5.66
Chips	5.06-5.67	4.60-5.83	5.15-5.83	5.00-6.00

on texture of the samples, chips gave the best results over the period of the analysis, showing a high mean-value of 5.83 and a least value of 5.15. Large type showed a fluctuating trend for texture response, which was between 3.94 and 5.20 over the period of the analysis. All the other types also showed fluctuation in response. Results on texture showed significant differences ($P<0.05$), which may be due to freeze storage effect. In the case of size, the chips were the most accepted and the large type, least accepted. The highest mean-value for the chips was 6.00 and its lowest mean-value was 5.00. The large type indicated a high mean-value for taste of 5.06 and the least value of 3.29. Both chips and medium types gave a relatively stable acceptable trend for response to size during the analysis. With regards to the small type, there was some fluctuation in response. ANOVA at $P<0.05$ indicated significant differences in the size of the samples. The observation made during the evaluation showed that there was a fluctuating trend in terms of product stability. This could be due to differences in perception and freeze-storage effects resulting in sogginess and, or, discolouration.

Consumer-based analysis - Parboiled *Pona.* The response to taste for all types was at certain periods below the acceptable range (Table 4). However, for the large type, the most accepted showed a high mean-value at 5.15 and a least value of 3.97. ANOVA results showed no significant differences ($P<0.05$) in the taste responses between the samples. For colour, the large type was the most preferred. The highest mean-value for the large type was 5.89 and the least 4.57. The small type was also stable throughout the period but there was fluctuation in preference for the chips and medium type. The poor response to colour could be due to discoloration brought about by freeze-storage effect. The response to the texture of the chips was the most acceptable with its highest value of 5.52 and the least at 4.19. The responses to the texture of the small type were relatively stable except for the 12th week. Medium and large types were also in

Table 4: Mean Range of sensory evaluation for consumer-based study (Parboiled).

Type	Parboild *Pona*			
	Taste	Colour	Texture	Size
Small	3.77-4.71	4.26-5.28	3.93-4.94	4.74-5.20
Medium	3.18-4.86	3.55-5.02	4.21-5.18	4.62-5.72
Large	3.97-5.15	4.57-5.89	4.69-5.43	4.20-5.08
Chips	3.85-5.34	3.17-5.59	4.19-5.52	4.31-5.35

Table 5: Mean range of sensory evaluation for consumer-based study (Steamed).

Type	Steamed Pona			
	Taste	Colour	Texture	Size
Small	3.32-4.70	3.57-5.27	3.57-5.27	4.34-5.25
Medium	3.23-5.00	3.25-5.29	3.18-5.14	4.54-5.47
Large	3.65-4.97	3.94-5.42	3.91-5.45	3.71-4.62
Chips	5.06-5.78	4.28-5.90	4.88-6.00	4.88-5.55

the acceptable range throughout the evaluation period. ANOVA results showed no significant differences ($P<0.05$) in responses to texture of the samples. For the medium type, the most preferred had a high mean-value of 5.72 and least of 4.62. All the other types were also within the acceptable range. ANOVA calculations indicated significant differences ($P<0.05$) in perception of size.

Consumer-based analysis - Steamed *Pona.* Chips had the highest mean-value of 5.78 and the least value of 5.06 (Table 5). A fluctuating trend for response to taste for all of the other types was observed over the period of the analysis. ANOVA results for taste indicated significant differences ($P<0.05$). Colour of the chips was highly accepted with the small type being the least accepted. The highest mean-value for colour for the chips was 5.90 and the least value was 4.28. For the medium types, there was a declining trend during the period of analysis showing a high mean-value at 5.29 and a low value of 3.25. The large type also showed a fluctuating trend. The poor response to colour observed might be attributed to discoloration or browning of the samples during storage. There was a significant difference ($P<0.05$) in colour. Response to texture also showed chips having the most preferred response with least mean value of 4.88 and highest mean value of 6.00. The large type showed a high mean-value of 5.45 and a low value of 3.91. The response for the small and medium types was also fluctuating as storage time increased. The size of the chips was the most accepted with its highest value at 5.53 and a least value of 4.88. For the medium type, the highest mean-value was at 5.47 and the lowest at 4.54. The small type showed a high mean-value of 5.37 and low value of 4.34. The least accepted sample, the large type showed a high value of 4.62 and low value of 3.71. There was a significant difference in responses.

Conclusion

The results from this studies show that significant changes in sensory parameters were influenced by perceptional differences of the panelists as well as effect of freeze-storage. However, chips were judged most acceptable throughout the 12 weeks of sensory evaluation of the steamed *Pona*. The large type, in terms of parboiled treatment, was more accepted. The product- and consumer-based studies showed that steamed chips and parboiled large types were the most preferred. This study has shown that minimal processing of yam using steaming for chips and parboiling for large types has a great potential especially since yam is predominantly eaten as *Ampesi* and fried chips. It is hoped that this study will provide a fundamental basis for future studies using minimal processing technology on yam.

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References

Akoroda, M.O. (compiler). 1995. Yam Research at IITA: 1971 – 1993, pp. 34 - 35.

Cantwell Marita, Postharvest Handling Systems: Minimal Processed fruits and Vegetables. (2000) University of California – Vegetable Research and Information Center http://vric.ucdavis.edu/selectnewtopic.minproc.htm.

Fennema, O.R. Food Chemistry (3rd Edition) 1996. Marcel Dekkar Inc., New York. pp. 493-494.

Minimal Processing Technologies in Food Industry. 2002. Thomas Ohlsson and Nils Bengtsson (Ed.). Woodhead Publishing.

Robert, G.L., Food Packaging: Principles and practice 1996. Marcel Dekker, Inc., New York.