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ASSESSING THE ACCEPTABILITY OF PACKAGED YAM STRIPS AS CONVENIENT FOOD

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ABSTRACT

Purpose: The aim of the study was to process, package and store yam strips as frozen food for use as convenient food. Two cultivars of white yam (*Discorea rotundata)*, were used for the study.
Design/Methodology/Approach: The cultivars were processed into strips and packaged in a 1.5kg polyethylene bag which was designed and labelled for the purpose. The packaged product was frozen using an Ocean freezer at a temperature of -18^{o}C for storage studies over a period of four weeks at the chemistry laboratory of the CSIR- Food Research Institute Accra. The frozen yam strips were fried and presented to 50 evaluators on a weekly basis for four weeks for assessment in order of preference with respect to their sensory attributes (size, colour, aroma, taste, moistness, hardness, crispiness, sogginess and overall acceptability). Purposive and random sampling technique were employed in selecting the respondents.
Findings: The result of the sensory evaluation showed that fried yam strips were found to be acceptable as most of the evaluators indicated that they were satisfied.
Research Limitation: Due to time factor and finance the laboratory analysis was carried out for only four weeks. However, it is ideal to conduct the storage studies over a year to determine the shelf life of the yam samples for at least one year.
Practical implication: Hotels, restaurants, takeaway food operators including domestic users can benefit a lot since the yam is minimally processed and require no preparation before frying. It saves time and labour.
Social implication: Development of yam into convenient food product and high quality packaging can contribute immensely by adding value to the crop thereby increasing yam availability in all seasons. This can boost yam production and improve the livelihood of the people in rural and urban centres.
Originality/Value: This study is the creative work of the authors and it has not been conducted and published by any Technical university in Ghana. We are in an era where consumer demand for minimally processed food is high and the need for reduced preparation and cooking time of food, it is becoming unattractive to sell whole yam tubers to the working class since the yam could be processed and used as a convenient food.

Keywords: *Dente. frozen. fry. laribakor. yam.*

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INTRODUCTION

Yam is one of the most important starchy crops grown in the form of large tubers produced by annual and perennial vines and it is the common name given to a plant species in the genus *Discorea* which belong to the family known as *Discoreacea* (IITA, 2012; Lopez-Montes *et al.*, 2012). There are over 600 species of yam in existence but only about six are grown for consumption namely: white yam (*D. rotundata*), water yam (*D. alata*), yellow yam (*D. cayenensis)*, aerial yam (*D. bulbifera*), trifoliate yam (*D. dumetorum*), and chinese yam (*D. esculenta*) (Asadu & Dixon 2013). According to Hahn (1995) cited in Asadu and Dixon (2013), the six species represent over 90% of yam cultivated throughout the tropics. A study by IITA (2012) revealed that among the many species of yam available, about 10 of them are widely cultivated around the world. However, only *D. rotundata, D. alata* and *D. cayenensis* are predominantly cultivated species in West Africa.

The origin of yam, according to Global Crop Diversity Trust (2013), can be traced to each of the three tropical continents: Africa, Asia and America. In Africa, yam cultivation is said to have begun some 11000 years ago (IITA, 2012). Almost all worldwide yam production takes place in developing countries with Africa being the largest producer. Based on the report of the International Institute of Tropical Agriculture (IITA) worldwide yam production in 2007 was to the tune of 52 million tons, of which Africa produced 96%. The report further indicated that most of the world's yam production comes from West Africa depicting 94%, with Nigeria alone producing 71%, reaching more than 37 million tons.

About 48.1 million tons of yam are produced annually in West Africa's "Yam Belt" which extends from Ivory Coast to Nigeria, representing over 90% of global production (IITA, 2012; Lopez-Montes *et al.,* 2015). Yam is a primary agricultural commodity and a major staple crop in Africa. In West Africa yam is a major source of income and has high cultural value: Yam is used in fertility and marriage ceremonies, and a festival is held annually to celebrate its harvest. Consumer demand for yam is generally very high in this sub-region and cultivation is very profitable despite high production costs. Ghana is the second largest producer of yams after Nigeria with nearly 6.3 million tons of yams produced in 2011(MoFA, 2013; Lopez-Montes *et al*., 2015). According to MoFA statistics, yam production reached 6,639 million tons in 2012.

Processing and packaging of agricultural produce in Africa are among the greatest basic challenges facing the continent. Although developing countries in Africa are blessed with abundant raw materials such as fertile lands, diverse staple commodities, cheap labour and so on, it is noteworthy that all of these things in themselves alone cannot support the continent to become competitive in today's world.

In Ghana, the capability of the local people to process pretty good quality food products is still lacking and the country still imports processed foods in large quantities. This phenomenon shows that there is an enormous internal market that can be exploited by local food business owners. The

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food processing sector remains to a large extent unexploited and virgin which is an opportunity in itself for the local people.

Yam is one of the commonest staple commodities cultivated in Ghana. Unfortunately, the majority of those yams go waste due to interrelated factors such as post-harvest losses, deterioration, sprouting, respiration and weight loss in stored yams. Nevertheless, almost every household in Ghana includes yam dishes on their daily menu which are eaten boiled or fried, baked or pounded. Even though Ghana is said to have been the largest exporter of yam in the world, it only does so without any or little value addition to the commodity. As a result, yam is often sold or traded unprocessed.

However, in an era where consumer demand for minimally processed food is high and the need for reduced preparation and cooking time of food, it is becoming unattractive to sell whole yam tubers to the working class since the yam could be minimally processed and used as convenient food. Fried yam, which is a delicacy for both the elite and the uneducated people in Ghana, is mostly sold by street vending which is quite patronized. But this cannot be compared to the patronage of potato fries which have been attractively packaged and sold on the market. This research work sort to process yam into strips for use as a convenient food item to make maximum use of the crop to increase production throughout the country. The aim of this study is to investigate the marketability of processed and packaged yam strips as convenient food. The objectives are: to determine consumer acceptability of the sensory characteristics of processed yam strips and to determine a suitable package for the processed yam strips.

The study is centered on only two varieties of yam namely: “Laribakor” and “Dente” which are varieties of white yam (*D. rotundata*) and did not include other types of yams. The study focuses on the processing and packaging of yam into strips for use as convenient food.

Literature Review

Yam Processing

Opara (1999) identified industrial uses of yam to include starch, poultry and livestock feed, and the production of yam flour. Residues from sifting and peels are used as animal feed in many rural areas. One of the major disadvantages of the industrial processing of yam for food is that nutrient losses in these products can be high, particularly in minerals and vitamins. In products obtained from secondary processing such as biscuits and fufu, the amount of loss depends principally on the amount of edible surface exposed during processing operations.

Opera (1999) further observed that primary unit operations such as milling affect the thiamine and riboflavin contents of *D. rotundata*, with average losses of 22% and 37%, respectively. Sun drying results in high losses of B vitamins with little change in mineral content. Pounding yam flour in a traditional wooden mortar or grinding in an electric mixer had similar effects.

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Transportation and Packaging of Yam

After harvest, yam tubers are traditionally placed into woven baskets made from parts of the palm tree or coconut fronds. These are ideal for transporting a small quantity of tubers over short walking distances. The basket is carried on the head, or shoulder, or tied to a bicycle and transported to the market or storage facility. Compression damage is reduced since the basket can bend and thereby reduce the amount of force acting on individual tubers. However, when large quantities of tuber are harvested, these baskets are not suitable because of their limited size. Packaging tubers in full telescopic fibreboard cartons with paper wrapping or excelsior reduces bruising and enables a large quantity of tuber to be transported over long distances. Tubers can be contained in loose packs, or units of 11 kg and 23 kg (McGregor, 1987). The cartons are hand-loaded or unitised on pallets.

Thompson *et al*. (1977) identified that storing yams in modified atmosphere packaging (MAP) has beneficial effects, particularly using appropriate packaging material with a suitable size and number of holes for gas permeation. Sealing yam tubers in polyethylene film bags reduced storage losses due to weight loss and the development of necrotic tissue. Coating tubers with Epolene E10 (a commercial vegetable wax improved the appearance quality but there was no effect on levels of fungal infection. The effect of this treatment on weight loss of tuber was inconsistent.

MATERIALS AND METHODS

Equipment

The following equipment was used for the preparation of yam samples: Stainless-Steel Knife, Chopping board, Colander, Perforated spoon, Tablespoon, Teaspoon, Scale, Strainer, Plastic bowl, Plate, Kettle, Tabletop burner, Cooking pot, Plastic Film sealer, Ruler, and a Deep fat fryer (Delonghi Rotofry F28311).

Sources of Raw Materials

Two cultivars of white yam (*Discorea rotundata*) viz., “Laribakor” and “Dente” were selected for this study due to their relatively higher preference by consumers. Samples were obtained from the Aboabo yam market in Tamale, the Northern Region of Ghana as shown in plate 1.

Plate 1. Yam samples

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Preparation of yam samples

Yam tubers were washed and cut into 7cm lengths using a stainless-steel knife. The cuts were peeled, rewashed and sliced into 1cm slashes. The slashes were cut into 1cm strips and placed into a bowl of water to prevent enzymatic browning.

Packaging and Freezing of Yam Strips

Yam strips were washed, drained and weighed. Two (2) liters of water were poured into *Moulinex* kettle and 1tablespoon cooking oil was added and boiled to 100^{o}c. The boiled water was poured onto 1.5kg yam strips in a sauce pan which was covered with a tight lid (flash-blanched) for 1 minute and drained using a colander. The yam strips were allowed to cool for 25 minutes and packaged into polyethylene bag which was designed and labeled for the purpose. The bagged yam strips were sealed with Plastic Film sealer (TYPE: FR 400A, Impulse) and frozen at a temperature of -18^{o}C.

Storage Studies of Frozen Yam Strips

Storage studies of the flash-blanched yam strips were carried out over 4 weeks through a random selection of samples for assessment over the storage period. The frozen yam strips were fried and assessed through sensory evaluation by participants.

Frying of Yam Strips for Sensory Evaluation

In conducting the sensory evaluation test for the product, the yam strips, both "Laribakor" and "Dente" were thawed separately. Half ($^{1}/_{2}$) teaspoon of salt was dissolved in 5 tablespoons of water and 400g of yam strips were added and tossed for 2 minutes and drained before frying using an electric fat fryer (Delonghi Rotofry F28311). Two (2) litres of frytol cooking oil were used and 400g of yam strips were fried at a temperature of 190^{o}C for 6-8 minutes and 8-10 minutes for "Laribakor" and "Dente" respectively. The frying times differed because of the higher water content in "Dente". In addition, time intervals were given for frying both yams as consumers have different preferences in terms of colour and crispiness.

Sensory Evaluation of Fried Yam Strips

Fried yam strips were assessed using a 5 – point hedonic scale to ascertain the level of consumer acceptability. Five evaluations were carried out on the two varieties of yam, Laribakor and Dente separately. During the first week, the freshly flash-blanched yam strips were fried and assessed by participants followed by an evaluation of the frozen fried yam strips on weekly basis for four (4) weeks. Fifty (50) participants consisting of staff and students from Tamale Technical University were used at each stage of the sensory evaluation. Purposive sampling technique was used in selecting staff whiles random sampling technique was used in selecting students. 'Shitor' and 'Hayat Tomato Ketchup' were served with the fried yam strips as an accompaniment to enhance the taste. The two varieties of yam were fried at different times and evaluators were required to rinse their mouth thoroughly after tasting the first sample before assessing the second variety. The assessors ranked each attribute of the yam strips as extremely not satisfied, not satisfied, not sure, satisfied and extremely satisfied. The attributes were coded from 1 to 5 where 1 = extremely not satisfied; 2 = not satisfied; 3 = not sure; 4 = satisfied and 5 = extremely satisfied.

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Data Analysis
Respondents' scores were computed for average mean analysis and descriptive statistics were done using IBM Statistical Package for Social Sciences (SPSS) version 23.

RESULTS AND DISCUSSION
Table 1 and 2 shows the sensory average mean response of taste panelists who assessed the attributes of fresh and frozen fried Laribakor and Dente strips.

Table 1: Mean sensory scores for fresh and frozen fried Laribakor Strips

	Mean scores for attributes								
Duration of freeze preservation (weeks)	**Size**	**Colour**	**Aroma**	**Taste**	**Moistness**	**Hardness**	**Crispiness**	**Sogginess**	**Overall Acceptability**
0	4.00	4.62	4.48	4.58	4.16	4.36	4.50	4.22	4.62
1	4.44	4.46	4.34	4.40	4.28	4.36	4.56	4.38	4.70
2	4.56	4.56	4.54	4.52	4.40	4.50	4.46	4.40	4.72
3	4.64	4.70	4.70	4.74	4.46	4.50	4.62	4.56	4.84
4	4.70	4.78	4.74	4.64	4.62	4.64	4.88	4.56	4.88
Aggregate Mean	**4.52**	**4.62**	**4.56**	**4.58**	**4.38**	**4.47**	**4.60**	**4.42**	**4.75**

Interpretation of scores: Extremely not satisfied =1; Not satisfied =2; Not sure =3; Satisfied =4; Extremely satisfied =5.

The evaluation process began with the assessment of fresh flash-blanched yam samples (without freezing) which is represented as 0 under the duration of freeze preservation on the table and followed by the assessment of 1 week, 2 weeks, 3 weeks and 4 weeks frozen fried yam samples respectively. The result for all the attributes has shown a sturdy improvement in respondents' level of satisfaction derived from the fried yam samples over the storage period. The average mean score according to size revealed that the taste panelists were satisfied with the size (4.00) at the freshly fried state. However, their level of gratification increased with the storage time. For instance, the mean score for size in week 1 is 4.44 and increased to 4.70 in week 4. This shows that the longer the yam samples were frozen or stored, the more consumers appreciated their size. Among all the sensory variables of the fried freshly-blanched Laribakor strips, colour was ranked highest with a mean score of 4.62. This value is equal to the overall acceptability rating of the freshly fried yam samples which means that the respondents were satisfied.

Concerning the 1 week of frozen fried yam samples, the average mean score for the majority of the attributes was lower than the other weeks though the overall acceptability rating was higher

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(4.70) than the score for the freshly fried samples which is 4.62. Some evaluators indicated that the product was good but the colour of the one-week frozen fried yam sample was poor as compared to the freshly-blanched sample. Others also observed that some of the yam strips were crispy whereas others were moist. The observations made by this group of participants were due to the procedure used in frying the yam strips at this stage. The frozen yam strips were removed from the freezer and fried immediately. The result of this approach was that some of the yam strips appeared white even though cooked and some others seemed brown. The white-coloured ones were moist whiles the brown ones were crispy. For these reasons, the procedure for frying was changed at the week two-stage.

During the evaluation process in week 2, the yam strips were removed from the freezer and thawed before frying. The result of this method used was shown in the mean score for all variables. The size, colour, aroma and taste scored 4.56, 4.56, 4.54 and 4.52 respectively, all approximately extremely satisfied. With an overall acceptability rating of 4.72 which is higher than that of week 1. Assessors gave comments such as: good size, great colour with good scented aroma; very good in all aspects; the product looks attractive and tastes palatable; the Laribakor strips taste sweet and the size looks uniform; it is generally good for a snack; the colour looks appetizing; the taste is exciting and colour appealing and so on. Those panelists who were neither satisfied nor dissatisfied with the aroma stated that the product was generally good. To improve the aroma, they suggested some spices be added to the yam strips before frying.

In week 3, the individual attributes of the fried yam samples gained more appreciation from the respondents. For size, the mean score is 4.64, colour and aroma scored 4.70 respectively, taste was ranked highest with a mean score of 4.74, moistness scores the lowest with a 4.46 average score, hardness was 4.50, crispiness scored 4.62, sogginess was 4.56 and the overall acceptability was 4.84. This shows that a large number of evaluators were almost extremely satisfied. They expressed themselves in the following ways: the product is very nice and will be a good product for the market; the taste is distinct; extremely satisfied with all aspects of the fried Laribakor strips; it tastes bitter at the initial stage but the taste is better now; the product is excellent; I like the pleasant smell and it is very crispy; the product is very appealing and exciting in taste with good texture.

The result of week 4 shows the final assessment conducted on the Laribakor strips. The sensory parameters were rated as follows: crispiness = 4.88, clour = 4.78, aroma = 4.74, size = 4.70, taste = 4.64, hardness = 4.64, moistness = 4.62, sogginess = 4.56 and overall acceptability is 4.88. The mean response at this level revealed that all participants were almost extremely satisfied. They gave similar comments as: the product is nice and should be produced on large scale; the product is very crispy; it has a nice and pleasant smell and it is enjoyable; the overall product tastes good; extremely satisfied because of the taste and aroma; the product is very appetizing and the flavour is good; I generally accept this product.

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Table 2: Mean sensory scores for fresh and frozen fried Dente Strips.

Mean scores for attributes									
Duration of freeze preservation (weeks)	**Size**	**Colour**	**Aroma**	**Taste**	**Moistness**	**Hardness**	**Crispiness**	**Sogginess**	**Overall Acceptability**
0	4.36	4.54	4.28	3.84	4.42	4.40	4.24	4.30	4.50
1	4.44	4.46	4.18	3.90	4.26	4.40	4.52	4.28	4.54
2	4.40	4.46	4.46	3.82	4.36	4.46	4.54	4.38	4.46
3	4.58	4.68	4.28	3.86	4.32	4.52	4.64	4.34	4.48
4	4.64	4.54	4.26	3.92	4.42	4.66	4.60	4.42	4.44
Aggregate Mean	**4.48**	**4.54**	**4.29**	**3.87**	**4.36**	**4.49**	**4.51**	**4.34**	**4.48**

Interpretation of scores: Extremely not satisfied =1; Not satisfied =2; Not sure =3; Satisfied =4; Extremely satisfied =5.

As indicated in Table 2, size recorded a mean score of 4.36 at the freshly fried state, 4.44, 4.40, 4.58, and 4.64 for the first, second, third and fourth weeks of frozen fried samples respectively with an aggregate score of 4.48. Consumer preference for the size of Dente improved as storage time increases just as for Laribakor strips. The rating for colour is unique as the average score for the freshly fried yam sample was the same as the average score for 4 weeks of frozen fried which is 4.54. The first and second weeks of frozen fried yam samples also had the same rating of 4.46 average. However, in week 3, participants' level of contentment rises high at 4.68 representing the highest mean score among all the sensory attributes within the Dente strips analysis. The aroma was graded 4.28 average from the fresh fried stage and 4.26 at the end of the fourth week. The scores at this level were not stable but consumers were a little more than satisfied. The rating for taste across the various stages of preservation has shown that consumers were not too sure about the taste of Dente. This was reflected in the individual comments made by the taste panelists: good size and colour with pleasant smell but has last-minute bitterness; excellent product only that it is a little bit bitter; a little bitter; it will do well when introduced to the market. Respondents' poor rating of taste might be due to the bitter taste that is characteristic of Dente. However, few participants observed that though the fried Dente Strips tastes bitter as compared to Laribakor strips, they enjoyed the bitterness because it makes this variety of yam unique in taste and different from Laribakor.

The mean scores for moistness have seen a little variation in evaluators' level of preference from the freshly fried stage to the frozen fried stage even though the values have shown that they were more than satisfied. The mean value for fresh fried is the same as the value for 4 weeks of frozen fried 4.42. The 1 week frozen fried recorded 4.26 whereas the second and third weeks frozen fried recorded 4.36 and 4.32 in that order. The average grading of hardness shows an upward likeness of the product within the various stages of preservation as can be seen in Table 2. The freshly fried state scored 4.40 and then increased to 4.66 in the fourth week. With regards to crispiness and sogginess, participants were over-satisfied since the mean scores for each attribute were more than

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4. Respondents' overall acceptability level for all the stages of preservation has also shown that they were contented with the Dente yam strips despite the challenges they had with the taste.

CONCLUSION AND RECOMMENDATIONS

The two varieties of yam, "Laribakor" and "Dente", were successfully processed into strips and packaged using polyethylene bags. In terms of the acceptability to the sensory attributes (size, colour, aroma, taste, moistness, hardness, crispiness, sogginess and overall acceptability) the fried yam strips presented were found to be acceptable as most of the participants indicated that they were satisfied with the yam samples. However, consumers' preference level for Laribakor yam strips was higher as compared to Dente. Therefore, when given the choice they preferred Laribakor yam strips.

Recommendations

The following recommendations are made:

1. The yam strips should be thawed before frying, for this gives a uniform texture as compared to direct frying from the frozen state.
2. It should be dipped into a salt solution for some time prior to frying to ensure even distribution of salt and also to eliminate the need for additional salting just before serving. Fried yam strips hardly hold salt and so adding salt after frying may not be ideal.
3. The 'frozen yam strips' is recommended for use as snack meals and occasions such as cocktail parties.
4. The recommended frying time for Laribakor is between 6-8 minutes and that of Dente is between 8-10 minutes when using an Electric Deep Fat Fryer. However, this time frame may change due to individual preferences for colour and crispiness.
5. Other varieties of yam should be tried.

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