

Full Length Research Paper

Consumer acceptability of modified and traditionally produced *amala* from fermented orange-fleshed sweet potato

Abbas Bazata Yusuf^{1*}, Richard Fuchs² and Linda Nicolaidis²

¹Federal University, Birnin Kebbi, P. M. B. 1157, Birnin Kebbi, Kebbi State, Nigeria.

²Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK.

Received 12 January 2017; Accepted 6 February 2017

Amala is a food made out of sweet potato, yam and/or cassava flour product that is traditionally consumed in Nigeria. The aim of the study was to evaluate the acceptability of *amala* produced from orange-fleshed sweet potato using traditional and modified methods of fermentation. Consumer acceptability studies provided information on the sensory attributes of traditional and modified *amala* samples. It was found that the pH of the *amala* was the same as the pH of the fermented sweet potato at Day 3 for both the cold and hot traditional (4.4) and modified (3.5) processes. The mean appearance, odour and familiarity scores were in a narrow range (7.2 to 7.8), while taste and overall acceptability showed a wider range of mean scores (6.9 to 8.0). The major differences ($P < 0.05$) observed were in taste and overall acceptability of the two products. The study indicated a higher significant acceptability for modified *amala* than traditional *amala*. It further demonstrated the usefulness of consumer acceptability test in quantifying the sensory attributes of the two products. This study was the first of its type and can serve as a good opening for policy makers wishing to promote the use of orange-fleshed sweet potato to fight against vitamin deficiencies in developing countries, particularly Nigeria. The study has successfully created varieties as well as alternative to *amala* from yam and the traditional method.

Key words: Orange-fleshed sweet potato, traditional, modified fermentation, *amala*, vitamin A and C, Nigeria.

INTRODUCTION

Amala is a stiff paste produced from fermented and sun-dried sweet potato, cassava or yam flour in Nigeria. It is a staple food that has become increasingly popular in

Nigeria (Adewumi and Adebayo, 2008). The cooked paste *amala* is mostly consumed when hot and is rarely stored (Omemu et al., 2011). Fetuga et al. (2013)

*Corresponding author. E-mail: aybazata91@yahoo.com. Tel: 08146273881.

reported that *amala* produced from yam and cassava is more widely used than *amala* made from sweet potato. They also found that *amala* made from yellow-fleshed sweet potato is more widely eaten than *amala* made from orange or white-fleshed varieties. Furthermore, the colour of the products produced from orange-fleshed sweet potato poses problems and challenges associated with acceptability and could put some consumers off this product (Akoroda and Egeonu, 2009). Therefore, effort should be made to improve acceptability of *amala* made from orange-fleshed sweet potato amongst consumers.

Sweet potato is one of the world's most important food crops that have the potential of bridging food gap due to diversified processing and utilization technologies that have been produced but not yet fully exploited (Woolfe, 1992). Developing countries produced more than 95% of the world's sweet potato over the period of 2004 to 2009 (Harvestplus, 2004-2009). Nigeria is the second producer of sweet potato in the world and the highest in Africa (FAOSTAT, 2005; Akoroda and Egeonu, 2009; Lebot, 2009), where production is mainly targeted at food security (Minde et al., 1999). Micronutrient deficiency is increasingly becoming a public health problem in developing countries, particularly affecting women and preschool children (UN SCN, 2004). There is potential for orange-fleshed sweet potato, which contains high levels of β -carotene and ascorbic acid, to contribute to overcoming this deficiency. Orange-fleshed sweet potato is regarded as a healthy crop that contains significant amounts of natural health promoting compounds (Bovell-Benjamin, 2007). Processing can result in the loss of these key nutrients and previous studies have shown that modifying the process can result in the retention of higher levels of vitamins (Yusuf et al., 2015).

The roots are normally processed into other food products before consumption and the traditional processing method commonly used is fermentation (Odebode et al., 2008). In Nigeria, the common fermentation methods involve cold water fermentation (soaking) and hot water fermentation (parboiling) (Fetuga et al., 2013) and are aimed at improving the shelf life, texture, taste, aroma and nutritional value of the end product (Kohajdova and Karovicova, 2007). It has been reported that the addition of fermentable sugar (glucose, fructose or sucrose) to fermentations compensate the loss of sugars as a result of the initial microbial activity and provide enough fermentable sugar during the important stage of lactic acid bacteria growth to produce sufficient lactic acid to decrease the pH level (Shao et al., 2004, 2005). It is considered that the addition of fermentable sugar will extend the growth and metabolism of lactic acid bacteria to produce lactic acid and sustained pH reduction, which will eventually result in a safe and nutritious food that would benefit the poorest rural people. A modified fermentation method for producing *amala* from orange-fleshed sweet potato that retained more

vitamins was prepared and its acceptability to consumers was determined. If *amala* produced by the modified method were accepted by the consumers it could increase the use of orange-fleshed sweet potato. The acceptance of an orange-fleshed sweet potato product (*amala*) produced from a modified method by the targeted consumers is important (Oyunga-Ogubi et al., 2011). The present study was aimed at comparing the acceptability of *amala* produced from traditional and modified fermented orange-fleshed sweet potato.

MATERIALS AND METHODS

Sample preparation

Orange-fleshed sweet potatoes (CRI-Apomuden variety (CIP440254)) were purchased from a retail super-market in Medway and washed using tap water in the Natural Resources Institute Food Processing Laboratory, University of Greenwich, United Kingdom. Sweet potato roots were peeled, cut into slices (2.0 cm long and 15 mm thick) and dried in an oven (Gallenkamp) at 60°C for 18 h.

In the traditional method, sweet potato slices (2000 g) were weighed into a 5000 ml sterile beaker and 2000 ml deionised sterile water was added. For the modified fermentation, 100 g (5% w/v) food grade fructose (Tate and Lyle Fruit Sugar, Tesco, United Kingdom) was dissolved in 2000 ml of sterile deionised water and 2000 g of sweet potato slices were added. The top of the beaker was covered with aluminium foil. The beaker was then incubated at 30°C (to represent ambient temperature in West Africa) for 3 days for the cold water fermentation. For the hot water fermentation, the beaker was placed in a water bath set at 65°C (based on the range of 63 to 67°C observed in the field survey) (Fetuga et al., 2013). Once the water in the beaker had reached 65°C, the temperature was taken down to 30°C. The samples were kept at this temperature in the water bath for 3 days.

The changes in pH of the fermenting sweet potato medium at Days 0 and 3 and *amala* for both the traditional and modified fermentation methods was measured and recorded in triplicate at each sampling time using automatic pH meter (3510, Jenway).

Preparation of cooked *amala* samples

Amala was prepared by taking slices of the fermented sweet potato (after 3 days of fermentation) and drying them in an oven at 60°C for 18 h. The dried samples were pounded into flour using a pestle and mortar. The flour was sieved using a domestic sieve and mixed with boiling water at a ratio of 1:4 and then stirred continuously to prevent lumps from forming. The paste was cooked for 10 min over a low heat. The cooked paste was wrapped in aluminium foil with the shiny side on the inside and kept at 63°C in a calibrated oven (to hot-hold *amala*) before serving.

Consumer acceptability test

Approval to conduct the study was sought from the University of Greenwich Research Ethics Committee and was given on 22nd November, 2013. The consumer acceptability test was carried out in the Food Processing Laboratory at the Natural Resources Institute, University of Greenwich, United Kingdom on 17th December 2013.

Table 1. The mean acceptability test scores of *amala* produced from traditional and modified fermented orange-fleshed sweet potato.

Fermentation method	Appearance	Odour	Taste	Overall acceptability	How much you like this product compared to the <i>amala</i> that you are familiar with
Traditional cold	7.4 ± 0.13	7.3 ± 0.13	6.9 ± 0.13	6.9 ± 0.13	7.2 ± 0.13
Modified cold	7.6 ± 0.13	7.6 ± 0.13	7.9 ± 0.13	7.9 ± 0.13	7.8 ± 0.13
Traditional hot	7.3 ± 0.13	7.3 ± 0.13	7.1 ± 0.13	7.0 ± 0.13	7.3 ± 0.13
Modified hot	7.5 ± 0.13	7.5 ± 0.13	8.0 ± 0.13	8.0 ± 0.13	7.8 ± 0.13

A group of people was recruited to assess the acceptability of *amala*. *Amala* is a traditional product commonly consumed in Nigeria. An invitation to participate in the acceptability group was e-mailed to staff and students of the University of Greenwich. Familiarity with *amala* traditional fermented food product from West Africa was one of the selection criteria for participating. Participants with any health issues or an allergy to sweet potato or fermented food products were excluded from the study. Responses were received and participants were selected based on the above mentioned criteria. Sixty two healthy adults were selected to take part in the study and were asked to sign a consent form. *Amala* was cooked on the day of tasting and cut into approximately 30 g pieces and served on a white plastic tray coded with a three-digit random numbers (care was taken to ensure that each consumer received samples in a different order). Participants were seated at a tasting booth presented with four *amala* samples (traditional cold, traditional hot, modified cold and modified hot) randomly placed on the plate. Each sample was accompanied with a score sheet and participants were asked to score the sensory attributes of *amala* using a 9-point hedonic scale which ranged from "like extremely" to "dislike extremely" (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely). The scores of the attributes were recorded and the mean test scores were calculated and tabulated (Table 1). Bottled water was provided for participants to rinse their mouth between samples. Good hygienic practice was followed throughout the process.

Statistical analysis

The consumer acceptability data recorded for the four *amala* samples were subjected to a two-way analysis of variance (ANOVA) using the R-package. The significant differences between the mean scores for the four *amala* samples (appearance, odour, taste, overall acceptability and how much you like the product as compared to the *amala* that you are familiar with) were tested. A p-value of <0.05 was considered to be statistically significant.

RESULTS

Amala was produced from traditional and modified fermented orange-fleshed sweet potato for both cold and hot processes. The pH value of the traditional and modified fermented orange-fleshed sweet potato and that of *amala* were measured and recorded (Figure 1). Figure 2 shows the changes in the mean scores of *amala* for the two fermentation methods over sensory attributes. The following interpretation of the 9-point hedonic scale was used for the discussion of the results: 7 to 9 was

considered to be positive and indicated that the participant liked the product, 4 to 6 was considered the neutral part of the scale (neither liked nor disliked the product), while 1 to 3 was considered to be negative (the participant disliked the product).

Analysis of the differences in mean test scores recorded between *amala* produced from traditional and modified fermented orange-fleshed sweet potato was shown to be statistically significant ($p \geq 0.05$).

DISCUSSION

Amala is a popular food that is eaten every day in Nigeria. By modifying the method of producing *amala* using orange-fleshed sweet potato, more vitamins could be introduced into the diet. However, promoting the new method of production and acceptability of the new product by the target consumers will determine its success. The present study was the first to assess consumer acceptability of *amala* produced from traditional and modified fermented orange-fleshed sweet potato using a 9-point hedonic scale.

The pH of the fermenting sweet potato at Days 0 and 3 and *amala* for both the traditional and modified methods was measured. It was found that the pH level dropped to 4.4 and 3.5 on Day 3 in the traditional and modified fermentation methods, respectively (Figure 1). The pH of the final *amala* was the same as the pH of the fermented sweet potato at Day 3 for all the processes. The minimum pH levels (4.4 and 3.5) recorded would classify the products as a high acid food in which growth of known foodborne pathogens would be inhibited and outgrowth of bacterial spores would not take place. The cause of the decrease in pH could be due to the production of organic acids such as lactic and acetic acids in the first three days of the fermentation as a result of microbial activity. The results suggest that in the traditional fermentation method, key nutrients needed for microbial growth and concomitant acid production are limited. It can be considered that the addition of 5% w/v fructose in the modified fermentation method enhanced acid production and resulted in a concomitant pH reduction (Shao et al., 2004, 2005).

The sensory attribute score means ($n=62$) for the four

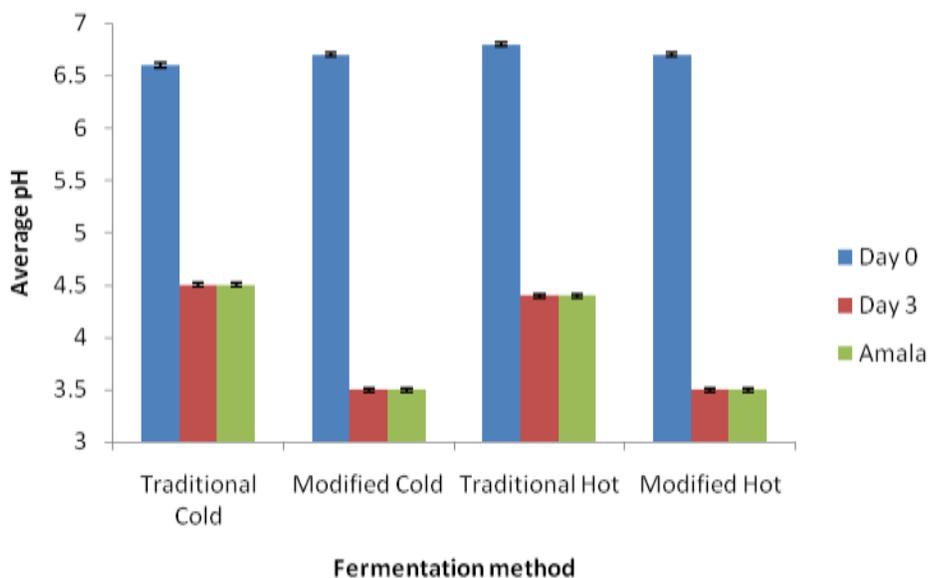


Figure 1. Comparison of changes in mean pH \pm S.E between traditional and modified fermentation methods.

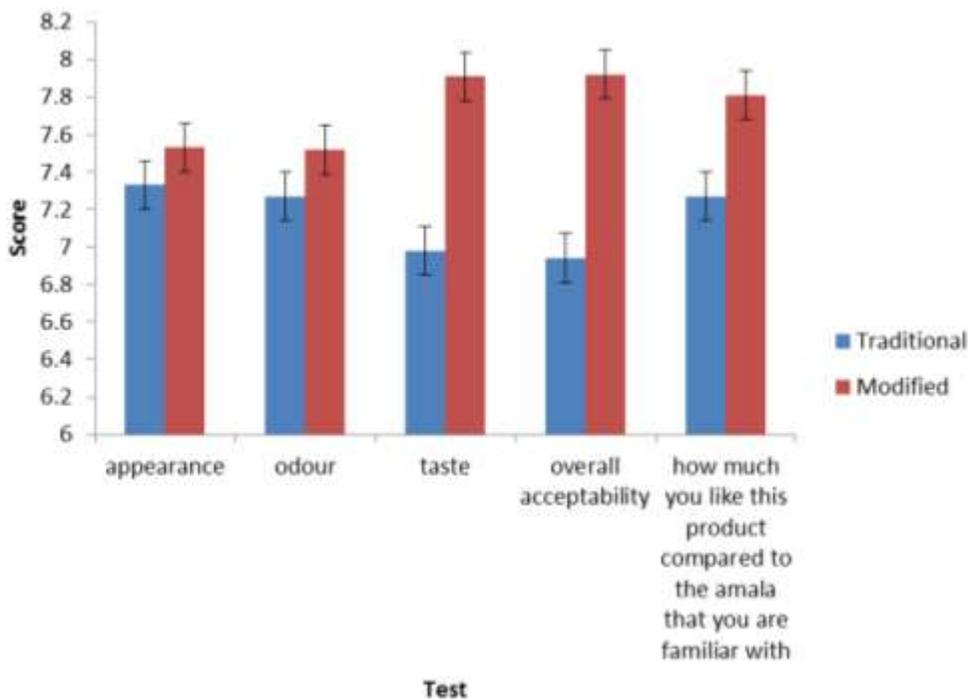


Figure 2. Comparison of changes in mean test score \pm S.E of *amala* produced from traditional and modified fermented orange-fleshed sweet potato.

different *amala* samples are shown in Table 1 and Figure 2. The mean appearance and odour scores were in a narrow range of 7.3 to 7.6, with modified *amala* having

slightly higher scores than the traditional *amala* for both cold and hot methods. This indicated little or no difference in the appearance and odour of traditional and

modified *amala* for both cold and hot processes. A wider range of mean scores from 6.9 to 8.0 was obtained for taste and overall acceptability, with modified *amala* recording the highest mean scores. This showed a clear difference in the taste and overall acceptability between traditional and modified *amala* for both the cold and hot processes. When examining consumer acceptability of the modified product as compared to the *amala* that they were more familiar with, the mean scores ranged from 7.2 to 7.8, with the mean score for modified *amala* being slightly higher than that of traditional *amala*. There was very little or no difference between *amala* that consumers are used to eating and the *amala* (traditional and modified) produced for this study. Overall participant's acceptability of *amala* produced from the modified fermentation was significantly higher ($p \geq 0.001$) than that of *amala* produced from traditional fermentation methods. This could be attributed to the addition of sugar (5% w/v fructose) to allow the fermentation to continue, as demonstrated by a lower pH in the modified process. It is possible that a sustained lower pH level produces *amala* which has a taste and flavour preferred by the participants.

The high ranking scores observed for modified *amala* indicated a higher acceptance among participants (Table 1). This suggests a readiness amongst participants to accept the modified *amala*. A survey report from Fetuga et al. (2013) has shown that if sweet potato flour were to be made readily available, then sweet potato *amala* could offer food security and improved nutritional status to the rural poor as compared to cassava and yam *amala*.

The acceptability of *amala* produced from the cold and hot fermentations for both the traditional and modified water fermentation were analysed. This study revealed a non-significant difference ($p \leq 0.05$) in the acceptability of *amala* produced from both types of fermentation. This was probably due to the fact that both types of fermentation were carried out for the same period of time.

CONCLUSION AND RECOMMENDATIONS

Evidence from the consumer acceptability test showed a greater acceptability of *amala* produced from the modified fermentation method than the traditional method. The major differences were in taste and overall acceptability of the two products. The study indicated a higher significant acceptability for modified *amala* than traditional *amala*. Hence, the modified method results in a safe and nutritious food that would benefit the poorest rural people. This is a useful conclusion for pre-school children and pregnant women at risk of becoming vitamin deficient in developing countries. Consideration would have to be given to whether the use of an additional substrate would be economically viable. Fructose is commercially available in retail super markets but the

additional cost (250 g of fructose is required to ferment 5000 g of orange-fleshed sweet potato with a total cost of ₦271 (1.65 \$ or 0.99 £) could be a constraint to this method being used by the rural poor. This is because 70.8% of the Nigerian population are living on less than ₦164.66 (less than 1 \$ or 0.60 £) a day (Human Development Report, 2006).

In summary, therefore, it has been demonstrated that the modified fermentation could improve vitamin A and C levels in *amala* (Yusuf et al., 2015) and could help to make the method more widely used.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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