Storage of Sweet Potato Toasted Granules and Shelf Life Under Ambient Condition

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ABSTRACT

The highly perishable nature of sweet potato tubers has caused severe limitations to the commercial exploitation of the crop. Processing involves peeling, grating, fermentation, dewatering and toasting, resulting in a granular product. It is a shelf stable food consumed as processed or cooked. When kept, it is subject to post-process contamination. Investigations were carried out to establish the storability of processed sweet potato toasted granules under ambient condition over a period of 1 month, 1 year, 6years and 7 years. The processed sweet potato toasted granules were packed in sealed cellophanes and kept under ambient condition. Only the toasted granules that are one month showed low load of bacterial count which could be of public health importance in toxin production. However, those processed and stored up to a year and above did not show any bacterial count which could be as a result of less moisture content. Location and storage at ambient temperature did not mar the qualities of the toasted samples, because the sensory evaluation showed high acceptability (78%) of the product. Estimated shelf-lives of sweet potato toasted granules were determined for nothing less than seven years. Recommendations for its packaging and storage conditions were given. This will lead to more market for sweet potato farmers and for establishment of cottage industry.

Keywords: Sweet potato, toasted, granules, microorganism, ambient temperature, shelf life,

INTRODUCTION

The sweet potato (*Ipomoea batatas*) is a dicotyledonous plant which belongs to the family Convolvulaceae. Amongst the approximately 50 genera and more than 1,000 species of this family, only *I. batatas* is a crop whose large, starchy, sweet tasting tuberous roots are an important root vegetable (Alvarez, 1987; Woolfe, 1992). Sweet potato plays a major role as a famine reserve for many rural and urban households. This is because of its tolerance to drought, short growth period and high yield with limited inputs on relatively marginal soils (Bashaasha *et al*., 1995). Sweet potato tubers are consumed by both human and livestock (Silva, 1990; Onwueme and Sinha, 1991; Otoo *et al*., 2001, Oyeniyi *et al.,2004).* Sweet potatoes (*Ipomoea batatas*) are about 7th most produced food crop in the world, when compared with wheat, rice, corn, potato, barley, and cassava (FAO, 1990; Meludu, *et al.,* 2003, Meludu and Ayobami, 2005). The reasons that sweet potato is a great crop include that it is relatively easy to grow, relatively free of pests and diseases, has relatively high productivity, and is food with principally starch, some protein and vitamin C, an excellent source of Vitamin A (especially in orange varieties) and small amount of other Vitamins such as Vitamins B (Ndolo *et al,* 2001) the young leaves are rich in protein.

Its ability to produce in poor soils makes the sweet potato an especially good crop for poor tropical soils where fertilizer is not available (Bashaasha *et al*., 1995). If the leaves are also used as food, sweet potato will probably produce more nutrients per acre than almost any other crop under those conditions (Meludu and Ayobami, 2005). Depending upon variety, sweet potatoes may be ready for harvest after 10 weeks or may require up to 9 months in the field. Majority of the varieties can be harvested after 4½ months in the field. Cool conditions such as found in tropical highlands can often extend the needed growth period of normal varieties to 8-9 months. Meludu and Ayobami, (2005) emphasized that sweet potatoes produce best in a well-aerated soil with

medium texture. In such soils they need not be planted on ridges. Also, they can be produced in heavy soils formed into ridges for drainage and increased aeration. Sweet potatoes are often grown in sandy soils. The requirements for soil fertility are fairly low, moderate nitrogen, low phosphorous and high potassium. Too much nitrogen often results in abundant foliage and low and /or late yields. However, the rate in copious yield could also depend on the variety. It would be difficult to try to describe all the sweet potato varieties that exist or even the best varieties in the world. There are too many even on country bases and they are not freely moved from one place to another. The specific needs of each area, including human preferences, mean that local variety trials and preference tests are always desirable. Some of the varieties found in Nigeria include Kayode, Shaba, Alphonso, GR-3-25, TIS 80/004, department wall, butter and others based on local names (Meludu *et al.*, 2003). The focus of this research is on the storability of the processed sweet potato, which might not depend on the variety.

Harvest and storage

There is no perfect time for the harvest of sweet potato. Early harvest often results in fewer yields, smaller roots, less insect damage, less cracking, milder flavors, and poor storability. Late harvest results in the reverse. Cut away the vines before harvest. These can be fed to animals, composted, or buried (Oyeniyi, *et al.,* 2004). The storage roots can be dug by hand with spades or forks, or by plow, especially a "middle buster". As soon as possible after digging, remove the sweet potatoes from the sun, in boxes, bags, or baskets. Sweet potatoes may have to be cleaned, depending on the soil where produced. A minimum task to perform on the farm is to brush off the soil. After washing, the roots should be drained and dried, but not in the sun. The roots should be sorted for storage. Damaged roots can be used immediately or processed (Meludu *et al*, 2003). Quality roots without blemish can be stored at cool temperatures (minimum 55F, 13C) for 2-8 weeks. Rot of roots in storage is reduced by curing at high (80-90%) humidity and high (90-95 degrees F) temperature for 4-5 days Otoo *et al*., 2001. Cured roots can be stored at the recommended temperature for up to one year. This does not reduce high rate of damages/waste in sweet potato production. It is on this platform that Meludu *et al.*, (2003), Meludu, (2009), Meludu, (2010), processed and recommended for the processing of sweet potato into toasted granules for different uses.

Principle uses of sweet potatoes

The sweet potato plant can be harvested for leaves during the 2nd and 3rd months of production. Only the tender stem and young not fully developed leaves, which constitute the distal 2-4 inches of the growing stem, should be taken. The sweet potato can then be served as is, mashed, or combined in many dishes (casseroles). The mashed pulp can be used as a partial substitute for wheat flour in baked products such as pancakes, cakes, flat breads, cookies, fritters, or even bread. The entire sweet potato could be wrapped in foil and then baked in an oven one hour at 350 degrees Centigrade. Sweet potato can also be processed into flour for confectionary and home uses in baking (Meludu 2009). Peeled sweet potato can be shredded, and the shreds immersed in water for two hours. This process works better if the water is changed 2-3 times. The shreds are drained and then dried, first in the shade (with air movement or wind) and later in the sun (in some cases, drying over the stove or in an oven will be necessary). The brittle shreds are easily crushed to flour, or this can be done rapidly in a household blender. The flour can be stored for six months or more in sealed containers. Starch can be recovered from sweet potato; the peeled sweet potato is ground in a mill or blender as finely as possible, and mixed with 5-10 times its weight in water. The starch settles out, and the water is carefully poured away. The starch is then mixed with water 1-3 times more and the process is repeated. After the last settling the water is carefully drained and the starch is dried on a metal surface in the sun. It can be used, as is any starch, such as corn starch, and can be stored in sealed containers for a year or more. A breakfast food similar to "cereal" can be made from any sweet potato. The sweet potato is grated (not as finely ground as for starch), suspended in water, and filtered through a cloth. The liquid is saved for starch, the residue is suspended 1-3 times more in water, and filtering is repeated. The portion of the sweet potato that does not pass through the filter is then dried and lightly toasted on a hot plate (over the fire) with carefulness. The toasted product can be stored in sealed containers and eaten with milk without further cooking, or can be used much like starch or flour, imparting its characteristic flavor. Meludu, (2010) described how sweet potato can be toasted into granules and its potential as famine food and dietary supplement for the Diabetics.

Problem focused in the study

Almost 800 million people in the developing countries do not have enough to eat, while another 34 million people in the industrialized countries also suffer from chronic food insecurity (Arcan, 2000). In Nigeria, the food situation had led to a tremendous increase in the prices of food over the years and deterioration in the living conditions of many families. In order to enable consumers have another food to supplement with, as the price of cassava product is getting high, sweet potato diversification and value addition emerged. This technology/technique was developed by some researchers from the Faculty of Agriculture and Forestry, University of Ibadan since 2001 and with an in-depth assessment to other uses of sweet potato through 2006. In this study, the technology was transferred to only two regions in Nigeria-Aguleri in Anambra State and Ogbomosho in Oyo State (Two major sweet potato producing areas in Nigeria). The result determined that 99 percent of the women were not aware that sweet potato could be toasted into granules. Less than half (40%) of the respondents had an idea of the protein and carotene content of sweet potato. Majority (98 percent and 60 percent) of the respondents were aware of the sugar and carbohydrate content of sweet potato. The women were educated on the economic and nutrition importance of sweet potato. The women were recommended and encouraged to process and sensitize other communities not included in the project to cultivate and process sweet potato into toasted granules not only for the fact that the sugar content was reduced but that it was a way of diversification for income generation and sustainable livelihoods. However, the women were skeptical about the storability and shelf life of sweet potato toasted granules especially in the tropics.

MAIN OBJECTIVE OF THE STUDY

The research determined storability and shelf life of sweet potato toasted granules under ambient condition. These will open market for sweet potato and less importation of some other related products.

MATERIALS AND METHODS

Experimental Site for the production of the tubers and processing into toasted granules.

1. The experiment was conducted in an experimental field located at Parry Road, University of Ibadan, Ibadan from April to August 2002. The location is on longitude 3^0 54"E and latitude 7^0 27" N; altitude 250mm above sea level. The total land area was $453m^2$. The bush was cleared manually and land ploughed before ridges made with hoes. Soil Status showed that the land used for the experiment was a level terrain. Soil samples were collected from the farm and analyzed for the physiochemical characteristics. The soil samples were air dried for a week, crushed and sieved with a 2mm sieve and 0.5 mm sieve before taking to the laboratory for analysis. Vines planted were obtained from existing field close to the experimental field. Vines of some other cultivars were obtained from the Department of Agronomy, University of Ibadan. Clones of 12 varieties were planted in all and 30cm long vine was planted per hill, Meludu and Ayobami, (2005).

2. **Processing of the roots**: Processing of sweet potato into toasted granules.

The harvested roots were from the project experiment site in the University of Ibadan

I. On the same day that the sweet potato was harvested, it was washed and peeled.
II. It was Grated/ground after peeling roots and put in an empty rice bag to ferment for about 2-3 days (Optional).
III. Water was pressed out from the bagged pulp. This must be done on the day the pulp will be toasted.
IV. The chaff was sifted out and then toasted little quantity at a time and quickly using a dry toasting pan with a special spatula, until the moisture is completely dried out.
V. After toasting the granules could be sifted again to have a fine texture (Meludu *et al*., 2003, Meludu 2010).

3. **Packing and Storage:** Locally available packaging methods for long-term storage of processed cassava products roots was adopted for storing sweet potato toasted granules. Storage is very important to keep the produce for a long time. Ensure that the product to be packaged is dried to safe moisture content. The amount of moisture in an agricultural crop or product is the most important factor determining its storability. The moisture content was determined by hand touch and the texture showed significantly dried particles. Allow the product to cool sufficiently before packing it. Latent heat that is not released will later condense inside the sealed container, resulting in bacteria growth and insect development. The toasted granules was packed

into smaller packages (in quantities of 250g), in thick polythene bags and was sealed for different duration (6 month to 7 years). It is important to note that no preservative or fumigant was used in keeping the product.

DATA ANALYSIS

The samples were taken to the department of microbiology, University of Ibadan for analysis. The samples include the sealed toasted granule processed in 2002, 2003, 2008 and 2009. They were of the same sweet potato variety. The samples were submitted for analysis in June and were analyzed in July 2009.

An informal sensory evaluation was conducted to determine sweet potato toasted granule acceptability after storage under ambient condition for period of seven years. The sensory evaluation was done on the purposively 60 randomly selected sweet potato marketing rural women in Otuocha market Aguleri local government in Anambra State. The reason being that Otuocha market is the main major whole market where sweet potato roots are sold.

Limitation of the study: The amount of moisture in a sample of produce which does not decompose when the produce is heated can be determined by weighing some of the ground produce and then drying it in a forced draft air oven at a given temperature for a predetermined length of time. The drop in the weight of the produce is measured according to its initial weight (wet basis). However, this product did not follow this procedure because of lack of this special weighing equipment at the point of storage but that did not affect the storability and shelf life. Also the temperature of the storage compartment was not determined.

RESULTS AND DISCUSSION

TABLE 1
Microbial count analysis of the sweet potato toasted granules

Sample code	Sample title	Date of processing	Total bacteria count cfu/g	Total fungal count	Remark
A	Local variety	October 2003	Non-growth	Non-growth	
B		July 2008	Non-growth	Non-growth	
C		June 2009	35	Non-growth	*B. cereus, B subtolis*
D		October 2002	Non-growth	Non-growth	

Table 1 shows the total viable counts and average total viable counts of the bacteria in samples of sweet potato toasted granules over the periods of one month, one year, six years and seven years. The result in table 1 also shows that older samples did not show growth of any microorganism, which demonstrates good processing, packaging and storage. This also, excludes any moisture content of the toasted granules and the product was well dried before packaging. It is also important that moisture content could lead to growth of microorganisms. This is probably the reason why the fresh sample just under one month could contain 35cfu/g of bacteria, specifically the *B. cereus* and *B subtolis*. Even though, the count is still tolerable by human, however, the presence of *B. cereus* could be of public health concern in toxin production. Therefore, samples A, B and C are very suitable for human consumption. Which means that sweet potato toasted granule could be stable in packing and storage under ambient condition. Storage of sweet potato at ambient temperature did not mar the qualities of the toasted samples therefore, estimated shelf-lives of sweet potato toasted granules is nothing less than seven years.

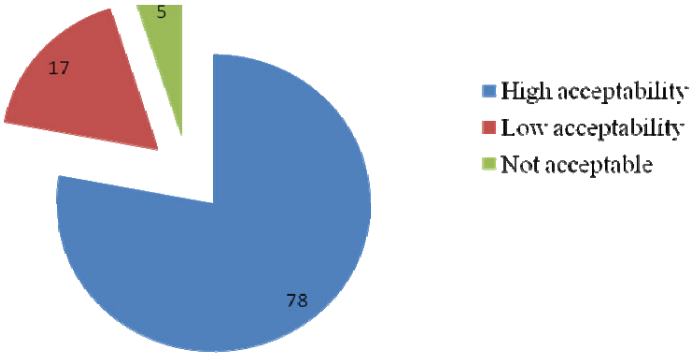

Figure 1: Sensory evalution of sweet potato toasted granules stored under ambient condition for seven years

However, an informal sensory evaluation was conducted to determine sweet potato toasted granules acceptability after storage under ambient condition for period of seven years. The result in figure 1 shows that majority (78 %) of the respondents accepted the taste of the sweet potato toasted granules, while few (17%) of the respondents showed low acceptability and only minority (7 %) did not accept the taste. This means that storage of sweet potato at ambient temperature did not tarnish the taste qualities of the toasted samples, an evidence of high economic value. At this point it has become evident that sweet potato toasted granules has high competitive characteristic as food. This agrees with the initial percentage of the rate of acceptability when it was original processed (Meludu *et. al.,* 2003). It was also observed that the colour, texture and odor of the stored toasted granules did not change

CONCLUSION

Storage of sweet potato at ambient temperature did not mar the qualities of the toasted samples, because the sensory evaluation showed high acceptability of the product. It is important to note that no preservative or fumigant was used in keeping the product. Estimated shelf-lives of sweet potato toasted granules are nothing less than seven years. This will lead to more market for sweet potato farmers and for establishment of cottage industry. It is recommended that if the moisture content of toasted granule is not sufficiently low it cannot store for a long time. So if the product is intended for long-term storage, it must be well toasted to exclude moisture and then sealed in polythene to provide better conditions. These will open market for sweet potato roots and less importation of some other related products and the establishment of sweet potato toasted granules cottage industry in Nigeria.

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