

Full Length Research Paper

## Effect of pre-drying treatments on utilizability of sweet potato tubers for production of chips for confectionery flour

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Yellow variety of sweet potato tubers lots were processed with different pre-drying treatments of peeled washed chips: Unblanched without Sodium Metabisulphite (UB-SMBS), blanched without sodium metabisulphite (B-SMBS), unblanched with sodium metabisulphite (UB+SMBS) and blanched with sodium metabisulphite (B+SMBS) for production of dried chips for confectionery flours. Low moisture contents in the range of 2.48 to 5.00% were achieved for the dried chips lots in 20 h of drying at about 55 to 60°C using NSPRI's Cabinet Crop Dryer without smoking. The dried chips had no visible mould growths in the duration of drying and mould loads were low (in the order of 10<sup>2</sup> cfu/g). However, different colours and textures were observed in dried chips and flours depending on pre-drying treatment. While UB-SMBS and UB+SMBS sweet potato chips' flours were suitable and acceptable for production of chin-chin, the B-SMBS and B+SMBS were unsuitable and unacceptable at 100% composition of the flour.

**Key words:** Sweet potato, blanching, sodium metabisulphite, dried chips, flour.

### INTRODUCTION

*Ipomoea batatas* (L.) Lam, commonly called sweet potato is a tuberous root crop. Generally, sweet potato tuber is boiled, pounded or fried for eating in Nigeria, like is done for yam tubers. Kochlar (1981) reported that sweet potato has found uses in much the same way as Irish potatoes. Collins and Walter (1982) and Bouwkamp (1985) also reported that sweet potato can be processed for consumption by boiling or baking and can be preserved by canning or dehydration. CTA (2007) reported the boiling and mashing of sweet potato tubers with beans, the

milling or pounding of the dried chips to make flour which can be mixed with either millet or cassava flour to make stiff porridge in Eastern Africa. Iwe and Onuh (1992) reported that sweet potato tubers are suitable for use as sweeteners in cereal based beverages (locally referred as "Kunu").

However, the processing of sweet potato for chips and flour is not common in Nigeria, perhaps due to lack of information on the production protocol and various characteristics of products for utilizations. Traditional

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**Abbreviations:** UB-SMBS, Unblanched without sodium metabisulphite; B-SMBS, blanched without sodium metabisulphite; UB+SMBS, unblanched with sodium metabisulphite; B+SMBS, blanched with sodium metabisulphite.

drying of yam and cassava chips and cassava mash in Nigeria has been by open air sun-drying on flat surfaces, including bare ground, mats, polythene sheets and the notorious roadside drying of produce. Such dried crops have been plagued by contamination with dirt from blowing wind, animal and birds feeding action including contamination with faeces. The wetting and high moisture of crops during raining season, in continued and intermittent rains, especially in the more humid Southern Nigeria result in problems of delayed and inadequate drying of crops. Thus, compounding the problem of poor quality of traditional drying of crops, with high moisture retained in crops for too long under warm tropical ambient condition in Nigeria, the traditionally dried crops risked mouldiness, mycotoxin contamination and early insect infestation. Further, Akinola et al. (2006) reported that the drudgery, rudimentary and dirt contaminating nature of traditional food processing in Nigeria requires change for the better. Open air sun drying result in low value or outright rejection of products.

Sweet potato is an important crop in Nigeria, especially in Oyun and Offa areas of Kwara State, where the production of sweet potato is of social-cultural importance. However, the problem of soil fertility and more importantly the limited market for sweet potato tubers have been limiting production of sweet potato coupled with the increasing influence of cassava (NSPRI, 2002), even in Oyun/Offa area. Therefore, the need to give consideration to how to sustain the symbolic social-cultural heritage that sweet potato represents for the people the Oyun/Offa area is very important. Effort in this direction can be by actions such as creating a valuable market for harvested sweet potato tubers, especially through acceptable product development and protocol. Farmers would be encouraged to sustain and increase production of sweet potato tubers if the market for the harvest is guaranteed.

Production and processing of sweet potato can be a way for women and many youths in Nigeria to be gainfully employed. Also, opportunity exists for controlling post harvest deterioration of sweet potato tubers by processing into useful and acceptable products.

In Nigeria, quality drying of crops hold potential for production of primary products, preservation, and conservation, giving the relative ease of entry for women and the teaming unemployed youths than for involvement in the more complex industrial manufactures.

Concerning the poor drying problem of crops in Nigeria, Nigerian Stored Products Research Institute (NSPRI) has been intervening in promotion of its improved dryers, including Solar Tent, Solar Tray, Multipurpose dryer, Hybrid dryer (Oyebanji, 2003) and Electric Cabinet dryers for hygienic, clean and effective drying of produce. The opportunity for creating market for sweet potato tubers through the drying of the chips for confectionery flour needs to be investigated in Nigeria. In similar thinking, Adebayo (2006) reported the production of "High Quality

Cassava Flour" (HQCF) for confectionery from dried freshly harvested cassava tubers in IITA. The HQCF was found suitable for use in confectioneries, at least in part mixing with wheat flour up to 20% for baking bread. Also, fermented dried cassava chips were made into fufu and lafun flours. Also, yam tubers are made to flour for amala meal and pando-yam flour in Nigeria.

The practice of peeling yam and cassava tubers and chipping into water to limit oxidative discolouration has been in Nigeria. As well, the use of sodium metabisulphite for retention of bright colour of products against discolouration and prevention of microbial spoilage controls during drying has been reported for tomato (Okanlawon et al., 2002). Efforts to process crops have in part been for production of utilizable products. Cassava tubers have been made into confectionery flour used at up to a maximum of 20% with 80% wheat flour for making bread. Processing of sweet potato tubers into adequately dried chips suitable for confectionery flour production would create market for sweet potato farmers and encourage increase in production. These would call for establishment of useful and acceptable processing protocol for drying sweet potato chips. It was therefore considered a possibility to utilise sweet potato tubers for production of confectionery flour for chin-chin, as snack in urban centres and for school children. Blanching, a form of per-boiling is being used in the production of yam flour (Elubo) for 'amala' meal and retention of bright colour and control of mouldiness on tomato during drying has been attributed to the pre-drying treatment of cut pieces of tomato with sodium metabisulphite by dipping (Okanlawon et al., 2002). Thus, the effects of blanching or not and combination with dip treatment of sweet potato in sodium metabisulphite or not as pre-drying treatments were investigated to determine the effects on quality characteristics of sweet potato chips' flours and the suitability for production of chin-chin at 100%.

## MATERIALS AND METHODS

### Sweet potato

Sweet potato tubers, *Ipomoea batatas* (L.) Lam., of the yellow variety were procured within 24 h of harvest from Ijagbo farm gate market for use in this study. The procured sweet potato tubers were quickly brought to the Community Processing Centre in Ijagbo, where the tubers were shared into four (4) lots for immediate in pre-drying treatments and drying of the chips for use in the production of confectionery flour which may be suitable for chin-chin production.

### Sweet potato chips, pre-drying treatments and drying

Processors in Ijagbo were gathered at the Community Processing Centre with the assistance of extension officials of Kwara State Agricultural Development Project (KwADP) as link agency for the scheduled participatory research for development. The procured sweet potato tubers' lots were respectively peeled, chipped and washed in portable water manually by the participating processors

for the pre-drying treatments for eventual appreciation of comparison of results. The pre-drying treatments were:

1. Unblanched without sodium metabisulphite (UB-SMBS)
2. Blanched without sodium metabisulphite (B-SMBS)
3. Unblanched with sodium metabisulphite (UB+SMBS)
4. Blanched with sodium metabisulphite (B+SMBS)

Blanching was by dipping manually chipped (2.5 x 20 x 30 mm) peeled washed sweet potato tuber into boiling water for 5 min and unblanched was the control and these were with or without sodium metabisulphite treatment at 0.5% in boiling water or water at ambient temperature, respectively. The respectively treated sweet potato chips were drained and air dried on raised platforms in sieve trays within 10 min for surface moisture to evaporate. Subsequently, the 4 differently treated sweet potato chips lots were respectively thin layer spread on net laid trays in NSPRI Multipurpose cabinet dryers to dry within 20 h at 55 to 60°C.

#### **Analyses: Colour of chip, moisture content and mould load**

Peeled sweet potato chips drained after washing were visually examined and colour was described to characterise changes that was due to treatment or drying. That is, dried chips from the respective pre-drying treatments were respectively visually examined for colour. Also, representative samples of the dried chips were analysed for moisture contents of milled portions by oven method of AOAC (2000) and mould load by serial dilution pour plate technique (Akani and Madumere, 2008; Oyebanji et al., 2011) on malt extract agar on 3 day old culture at 28°C.

#### **Test milling into flour and chin-chin production**

The dried chips were "milled" respectively using hammer mill. The "flours" from the 4 treatments were visually examined and described for flour forms. Samples were then taken from the 4 "flours", each at 100% (without wheat flour) and were respectively mixed with other ingredients or recipe and (2 ½ Cups of Sweet Potato "flour" + 1/5 Cup of Sugar (instead of 2/3) + ½ Teaspoon of salt + ¼ Teaspoon of Baking Powder + 2 eggs + 5 Tablespoons of Butter + 2 Tablespoons of Powered Milk) mixed with water for dough and flattened to 10 mm thickness for cutting into strips and pieces and fried into chin-chin in pan on gas burner with 4 cups of groundnut oil. Mixed-pressed-rolled-cut pieces of 'dough' of respective flour lot was visually examined and described for the form of roll, dough and chin-chin. Pictures were taken to compliment descriptions of materials, methods and results. Further, a panel of 5 processors and chin-chin consumers was constituted to determine the acceptability of chin-chin made from the respective flour lots on the hedonic scale of 1 to 9 (Ihekoronye and Ngoddy, 1985; Munoz and King, 2007) for appearance, texture, flavour, taste and overall acceptability of chin-chin produced. Means of values were computed and data presented as a table to compare effects of the pre-drying treatments.

## **RESULTS AND DISCUSSION**

### **Preparation of sweet potato chips for pre-drying treatments and drying**

The manual peeling of sweet potato in this study by Ijagbo food processors at the workshop was consistent with the commonly observed practice for peeling similar root and tuber crops such as yam and cassava in Nigeria. However, the manual peeling of sweet potato observed was considered tedious, and so this operation would need

need scale up for mechanization to remove the drudgery. The drudgery was not found in literature and was not anticipated. In any case, mechanical peeling machine development is still a challenge in Nigeria. The challenge has been attributed to the irregularity of root and tuber forms for ease of design and fabrication of effective peeling machine. Also, the chipping of the sweet potato called for the use of a chipping machine in the peculiar drudgery of manual chipping of sweet potato when compared with yam and cassava. Manual peeling of sweet potato in this study was at the rate of 50 kg/h/person, which meant approximately 400 kg/day of 8 h and labour charge of N400/day in Ijagbo. However, the activity was capable of contributing to alleviation of poverty in the associated employment of rural women and youths involved in such processing activities.

### **Effect of pre-drying treatments of sweet potato chips on colour of dried chips and flour quality**

Table 1 summarizes findings which was characteristic of the sweet potato chips pre-drying treatments and drying effects. The yellow variety of sweet potato used for this study was characteristically cream white colour upon peeling. Following drying of the pre-treated sweet potato chips for 20 h in NSPRI's Multi Crop Cabinet Dryer (Plate 1), the UB-SMBS and UB+SMBS lots, had moisture contents of 3.85 and 2.48%, respectively and were brittle to touch, suggesting considerably low moisture contents as compared to the required safe moisture content of about 10% required for flour mills in Nigeria. While subsequent practice may not require this long drying duration, this result showed that the chips dried very well in terms of the extent of moisture reduction much below the safe level, and so can have extended shelf life against mouldiness in hermetic containers and against insect infestation in the relative cleanliness of the drying environment as compared to traditional open air drying. Similarly, B-SMBS and B+SMBS treated dried chip lots had low moisture contents of 4.98 and 5.00%, respectively (Table 1), but were glassed and flexed, which showed change of form from the expected.

The clean dried products with low moisture levels obtained in the respectively treated and subsequently dried sweet potato chips were indications of the effectiveness of the improved crop dryer used. The low mould load in sweet potato lot dried in NSPRI's Multipurpose dryer contrasted with the high load associated with traditional road side dried fufu made from cassava. Moulds detected in samples were still indications of contamination in the drying environment and so continued to call for improvement in sanitation and hygiene of the processing equipment and personnel. The contaminants on crops will become important in the spoilage of the dried products if holding moisture condition becomes too high in a situation of poor storage, under warm tropical condition. Dried sweet potato chips' appearance varied depending on the



**NSPRI's Multipurpose dryer**



**Sweet potato chips dried in NSPRI's Multipurpose dryer at Ijagbo**

**Plate 1.** Sweet potato chips in NSPRI's Multi Crop Cabinet Dryer at Ijagbo.

pre-drying treatment and expectedly from the fresh peeled sweet potato chips. While fresh peeled sweet potato used in this study was cream white, the dried chips with unblanched pre-drying treatments were grayish white while the blanched pre-drying treatments changed to yellow irrespective of whether with SMBS or not. Result for the blanched sweet potato chips showed additional colourising effect of blanching different from that due to the drying of the chips. Also, the blanched lots (B-SMBS and B+SMBS lots) were glassed. It was not surprising that the dried blanched lots could not be well milled; they came out as broken pieces of flakes and granules upon milling. This was because the associated starch became gelatinized in the high blanching tempera-

ture. On the other hand, the dried unblanched sweet potato chips' lots milled into flour easily.

#### **Effect of pre-drying treatments of sweet potato chips on chips' flour quality for dough rolling, cutting and frying into chin-chin**

Dough roll and cutting tests were positive for UB-SMBS, UB+SMBS and B-SMBS flour, but was negative for B+SMBS. That is, the B+SMBS flour lot did not roll and could not be cut into pieces for chin-chin. The mixture of B+SMBS in confectionery ingredients scattered as granules upon frying in vegetable oil. Thus, result showed that adverse effect of sodium metabisulphite treatment on

**Table 1.** Characterizations of sweet potato chips before and after drying for different pre-drying treatments: UB-SMBS, B-SMBS, UB+SMBS and B+SMBS and effect on milling quality and chin-chin production.

Parameter	Pre-drying treatment			
	UB-SMBS	B-SMBS	UB+SMBS	B+SMBS
Fresh peeled chips' colour	Cream White	Cream White	Cream White	Cream White
Multipurpose dryer dried sweet potato chips	Greyish White	Yellowish	Greyish White	Yellowish
Moisture content (%) of 20 hr dried chips	3.85	4.99	2.48	5.00
Mould load (cfu/g) of the dried chips	3 x 10 <sup>2</sup>	2 x 10 <sup>2</sup>	3 x 10 <sup>2</sup>	3 x 10 <sup>2</sup>
Milling quality test of dried chips to flour	Positive	Negative	Positive	Negative
Rolling of ingredient mixed 'flour' for duff	Positive	Positive	Positive	Negative
Cutting test of 'rolled' duff into pieces	Positive	Positive	Positive	Negative
Frying of pieces in vegetable oil for Chin-Chin	Positive	Negative	Positive	Negative

**Table 2.** Appearance, flavour, texture, taste and overall acceptability of chin-chin made from different treated chips' flours.

Parameter	Acceptability (Scale 1 – 9)			
	UB-SMBS	B-SMBS	UB+SMBS	B+SMBS
Appearance of the chin-chin	8.66 <sup>a</sup>	2.78 <sup>c</sup>	7.00 <sup>b</sup>	1.78 <sup>d</sup>
Flavour of chin-chin	7.11 <sup>a</sup>	4.89 <sup>c</sup>	6.22 <sup>b</sup>	3.11 <sup>d</sup>
Texture of chin-chin	7.89 <sup>a</sup>	6.89 <sup>b</sup>	7.89 <sup>a</sup>	2.00 <sup>c</sup>
Taste of chin-chin	8.33 <sup>a</sup>	6.00 <sup>c</sup>	7.22 <sup>b</sup>	2.00 <sup>d</sup>
Overall acceptability of chin-chin	8.44 <sup>a</sup>	2.76 <sup>c</sup>	6.89 <sup>b</sup>	1.11 <sup>d</sup>

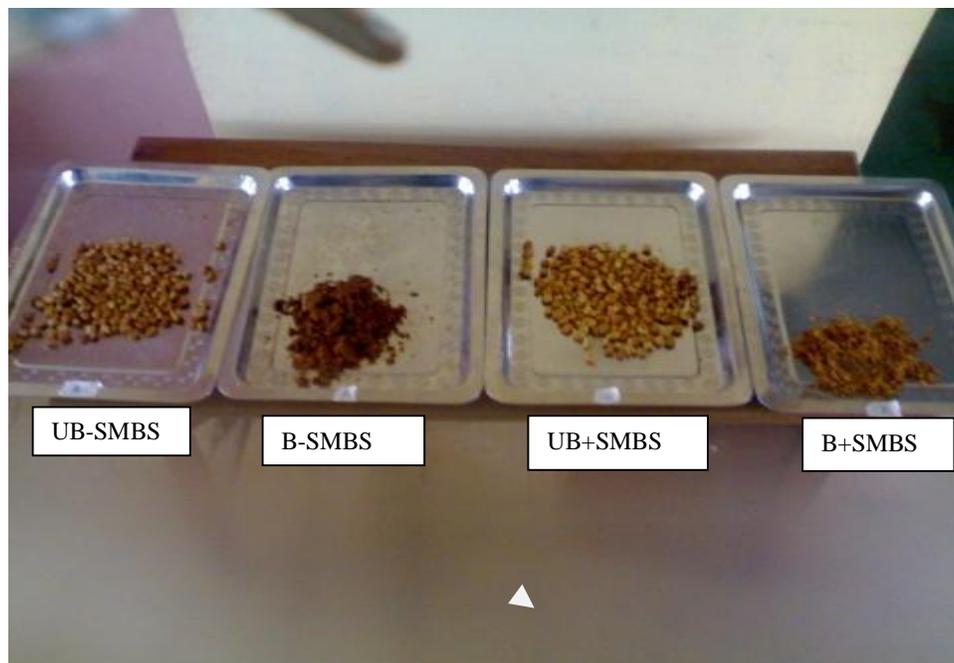
Values along rows with different letters are significantly different at p=0.05. The high overall acceptability of UB-SMBS (8.44) and UB+SMBS (6.89) samples in production of chin-chin contrasted with the low values for B-SMBS (2.76) and B+SMBS (1.11).

rolling and cutting of dough was influenced by the blanching. Table 2 shows the acceptability of chin-chin produced from the different treated chips' flours in terms of appearance, flavour, texture, taste and overall acceptability on the hedonic scale of 1-9. Further, Plate 2 showed that frying of the un-blanching lots (UB-SMBS and UB+SMBS) in vegetable oil gave acceptable chin-chin, but blanching lots without metabisulphite (B-SMBS) when rolled and cut, scattered during frying while the B+SMBS could not be rolled, cut or fried for chin-chin. That is, frying test confirmed that sweet potato chips need not be blanched or treated with sodium metabisulphite, if the flour is intended for chin-chin production at 100% sweet potato flour. However, the chin-chin made from UB-SMBS and UB+SMBS flours were considered acceptable to chin-chin consumers but attempts from B-SMBS and B+SMBS were rejected by the panel of 5 processors and chin-chin consumers. Thus, dried chips or flour should be packed in hermetic containers tightly filled and closely packaged to store in a cool atmosphere to control insect infestation during storage without using insecticides. The hygienic drying in the improved dryer should enhance storability of the dried chips against insect infestation. The sweet potato flour at 100% when needed will be ready for use in making chin-chin. Part mixture of sweet potato flour with wheat flour was not

considered in this study, but part mixture of high quality cassava flour with wheat for production of bread has been promoted in Nigeria to create market for cassava farmers and processors.

## Conclusion

There is no difference in the effect of pre-drying treatment (addition or not of sodium metabisulphite) of un-blanching sweet potato chips on colour of dried chips' flour quality for dough roll, cutting or frying for chin-chin. Thus, it becomes economical to do without the application of sodium metabisulphite in the production of sweet potato chips for 100% sweet potato flour for chin-chin production. Further, any risk of misuse or abuse of use of sodium metabisulphite would be avoided, with the indication that there was no need for sodium metabisulphite dip treatment of sweet potato chips. That is, the recommended protocol for production of sweet potato flour for 100% use in chin-chin production is: Procure freshly harvested sweet potato tubers (within 48 h of harvest), wash, peel, chip, wash, drain, air dry (in sieve under net cover on a platform for about 10 min to remove surface moisture) and then properly dry chips (in improved dryer for effective moisture reduction and against contamination



**Fried sweet potato pieces from flours of different pre-drying treatments of chips**

**Plate 2.** Showing sweet potato chin-chin fried from UB-SMBS, B-SMBS, UB+SMBS and B+SMBS, respectively. NB: A is UB-SMBS, B is B-SMBS, C is UB+SMBS and D is B+SMBS.

to safe moisture level) and allow chips to cool, then mill into flour. The sweet potato processing venture would enable employment of rural women and youths and the sweet potato flour would be marketable, creating income for investors in processing and confectioneries as well as market for sweet potato farmers.

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