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Full Length Research Paper

Mycoflora of sun-dried sweet potato (*Ipomoea batatas* L.) slices in Benin City, Nigeria

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A study was carried out to isolate and quantify the fungi present in sun-dried sweet potato slices in Benin City, Nigeria. Potato tubers were peeled, washed, sliced and sun-dried for 30 days. Oven-dried slices served as control. Meteorological data were obtained for the period of study. Fungal colonies on slices were counted with the aid of a hand lens and the average number of colonies calculated. The relative density of each fungus was determined by plating on potato dextrose agar and incubating for 7 days at ±28°C. Fungi were isolated and identified and colony forming unit (cfu) determined. Results revealed 12 fungal species, whereas the control had no fungal growth. Isolated fungi were *Botryodiplodia theobromae, Rhizopus stolonifer, Mucor mucedo, Aspergillus niger, A. fumigatus, A. flavus* and *Penicillium digitatum* in May (relative density = 5.5-29.4%). *A. ochraceus, Curvularia* sp. and *Neurospora sitophila* were isolated in June in addition to the above fungi (relative density = 2.1 - 23.2%). Eight fungi were isolated in July (relative density = 2.6 - 26.8%). The cfu ranged from 2.8 x 10^6 - 11.6 x 10^6 in May, 1.9 x 10^6 - 9.1 x 10^6 in June to 4.1 x 10^6 - 11.3 x 10^6 in July. Other means of drying such as tunnel dryers (operated at 60 - 70°C) and drum-drying are recommended.

Key words: Fungi, sun-drying, sweet potato.

INTRODUCTION

Sweet potato, (*Ipomoea batatas* L.) Lam. is a major source of carbohydrates (Tewe et al., 2003). Its leaves and vines are also used for feeding rabbits, sheep, goats and cattle. Sundried tuber pellets are used as starter diet for broilers. Sweet potato is traditionally boiled and eaten with various accompaniments (such as vegetable stew, cowpea, rice, millet, and benniseed). The flour is popular for sweetening foods when used in combination with other foods (for example, garri and flour from cassava, plantain, maize) as well as for biscuit making.

Prolonged storage is achieved by drying (usually sun-drying) slices. During the period of drying, micro-organisms settle on the exposed surfaces of the slices. The high moisture content of the sweet potato slices permits the growth of contaminant fungi during sun-drying. According to Bankole and Adebanjo (2003) these fungi will reduce the nutrients and may produce toxins that are harmful to man. Ekundayo (1986) also reported that the mycoflora of yam slices during sun-drying almost completely depleted the starch, sucrose and maltose fraction within 15 days.

The composition of the fungal species which will be established on exposed surfaces is a reflection of the abundance and distribution of the fungal particles suspended in the atmosphere (Okungbowa, 2004, 2005; Bankole et al., 2006) and the establishment of these fungi is determined by nutrient availability and the prevailing environmental conditions (Njokuocha and Agwu, 2007). Although Bankole et al. (2006), Ekundayo (1986), Adisa (1983), Bankole and Adebanjo (2003) and Valero et al. (2007) have reported on fungal contamination of sun-dried foods of various kinds, there is however, no documented report on fungi which contaminate and colonize sweet potato despite its profound use as food and its potential for other uses such as fuel and animal feed. This study was undertaken to isolate and document the fungi associated with sun-dried sweet potato slices with a view to highlighting their possible effect on food quality and to generate data for improvement of the processing of sweet potato slices.

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MATERIALS AND METHODS

Potato tubers

These were purchased from three local markets (New Benin, Uselu and Oliha) in Benin City. The tubers from each market were separated into three batches, one batch for each of the months of May, June and July. The tubers were peeled and washed thoroughly in several changes of distilled water. A weight of 200 g was taken from each batch of potatoes for the experiment. The peeled potatoes were cut into about 2.5-4 x 5-7 cm flat sheets (slices) with a clean, sharp kitchen knife. The moisture content of the slices was determined by oven-drying some slices to constant weight according to standard procedures (AOAC, 1990). This was done three times for each batch. The moisture content of the potato slices was also determined at the end of 30 days of sun-drying for each month.

Sun-drying of potato slices

The slices for sun-drying were spread (wearing sterile hand gloves) on sterilized plastic trays. The control was set up by oven-drying potato slices for 5 h. The trays of potato slices were placed on 60 cm high stools in an open field for 9 h daily (9am - 6pm) for 30 days. Fresh samples of the potato batches were sun-dried each month (May, June and July), following the same procedures. Care was taken to ensure that rain or dew did not wet the slices during the period of exposure by transferring the trays to a shade during rainfall.

Determination of fungal relative density

At the end of sun-drying, fungi present were detected by examining 4 randomly selected slices with a hand lens. Colonies on each slice were counted and average number of colonies on 4 slices determined. This average value for each fungus was used in the determination of relative density of each fungus on potato slices using a previously used method (Verma and Dubey 2001) as follows: Relative density (%) of each fungus on sample (potato slices) = (Number of colony of fungus / Total number of colonies of all fungal species) x 100

Determination of fungal total viable count

From the advancing edge of colonies three 2 X 2 mm discs were cut and plated on Potato Dextrose Agar, PDA (Oxoid, England) containing chloramphenicol (500 mg/ml) and incubated at room temperature (28 ± 2°C) under light for 7 days. The control was set up by oven-drying fresh potato slices for 5 h and aseptically plating 2 X 2 mm discs on PDA as above. Pure cultures of fungi were obtained by inoculation onto fresh PDA plates and incubating at 28 ± 2°C. Fungi were identified by their colony and microscopic morphology following the descriptions and illustrations of Barnett and Hunter (1998) and Klich (2000). Total viable count of isolated fungi (expressed as colony forming units (cfu/g) was determined by using the method of Harrigan and McCance (1976). 25 g of potato slices were ground with a clean kitchen grinder and mixed with 250 ml sterile distilled water. Ten-fold serial dilution was made by transferring 1 ml of mixture into 9 ml sterile distilled water. Further serial dilutions were prepared. Then 1 ml of the appropriate serially diluted mixture was aseptically spread with an L-shaped glass spreader on PDA containing chloramphenicol and incubated at ambient temperature (28 ± 2°C) for 7 days. Fungal colonies were then counted.

Statistical analysis of data was done using Student t-Test with level of significance fixed at 0.05.

Meteorological data

The rainfall, maximum and minimum temperatures, relative humidity and sunshine for each day of the three months of study were obtained from the Nigerian Institute for Oil Palm Research (NIFOR), Benin City. The mean data for each month were calculated.

RESULTS

A total of 12 fungal species were isolated from all the sweet potato samples tested (Figures 1-3). *Botryodiplodia* had the highest relative density (29.4, 23.2 and 27%) for the months of May, June, and July, respectively. *Aspergillus* was the single genus that recorded 4 different species in the month of May, 3 species in June and 4 species in July. While the relative density of some fungi decreased from May-July (*Rhizopus*, *A. fumigatus, Penicillium*), that of others had no definite pattern (*A.flavus, Mucor, Botryodiplodia, A.niger*). *Aspergillus ochraceous*, *Curvularia* and *Neurospora* made appearance in the second month, while *A. tamarii* was observed only in the third month.

Seven fungal species were isolated in the month of May, 10 in June, and 8 in July. There were significant differences between relative densities of fungi in May and July and between June and July ($p=0.05$). There was no detectable fungal growth in the control. The cfu values were high for most of the fungi in the three months (Table 1). The cfu values for *B. theobromae*, *R. stolonifer, M. mucedo, A. niger* and *P. digitatum* were not significantly different for the three months ($p = 0.05$). *Aspergillus fumigatus* which was not detectable with the hand lens (nil relative density) in June had a cfu value of 2.6×10^6 in June, which was significantly different from values recorded for May and July. The cfu of *A. flavus* in May was significantly different from its cfu in June and July. The moisture content of the potato slices before drying was (71.8-72.6%) and 9.0-9.1% after drying. The meteorological data showed that there was significantly more rainfall and less sunshine in July than in the other months (Table 2).

DISCUSSION

Several fungi were isolated in each month, most having high relative density and cfu values. Some or all of the fungi isolated were previously reported to cause spoilage of food and have been isolated from various food items such as cotton seeds (Okungbowa, 2005; Okungbowa and Dede, 2005), cassava (Jimoh and Kolapo, 2008), grapes (Valero et al., 2007), garri (Ogiehor et al., 2004), yam chips (Ekundayo, 1986), plantain pudding (Ohenhen et al., 2006) and cocoyam chips (Uguanyi, 2007). They are fungi that occur in the air and easily contaminate exposed foods. The high moisture content of sweet potato (71.8-72.6% before sun-drying; 71.8-72.6% after drying) as well as the humidity and high temperatures of the

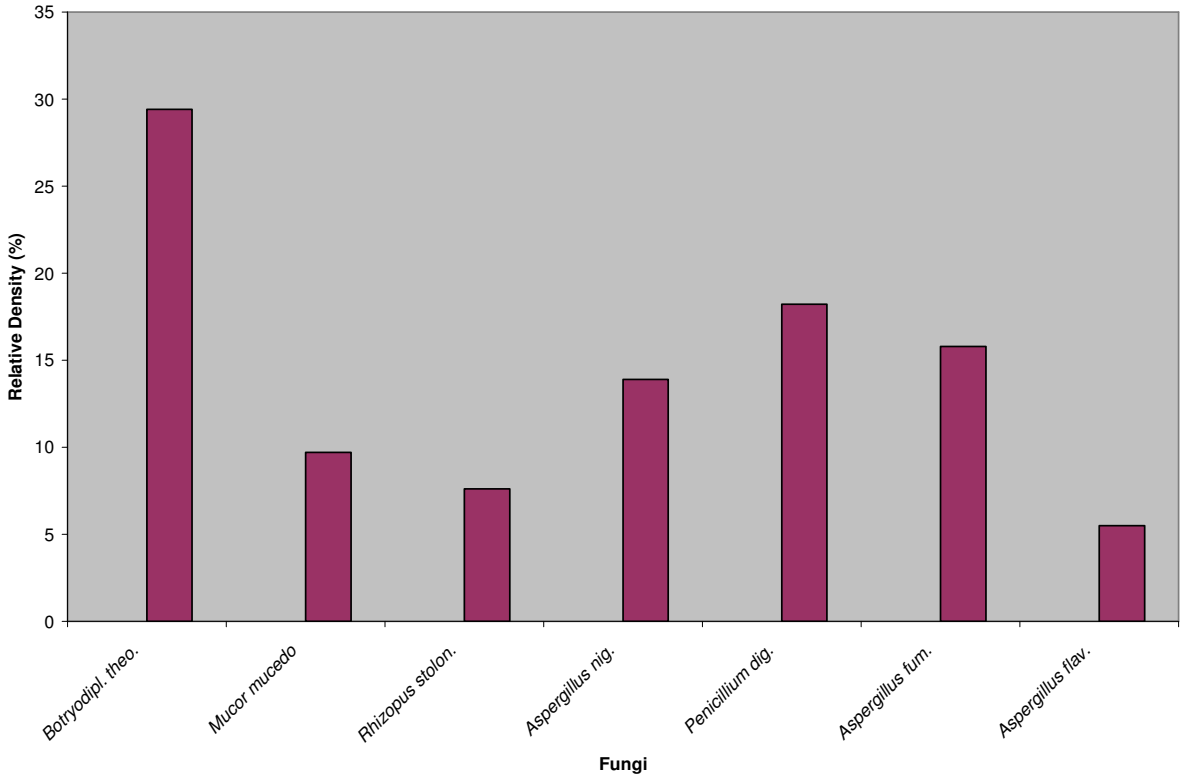

Figure 1. Fungi isolated from sun-dried sweet potato slices and their relative density in May.

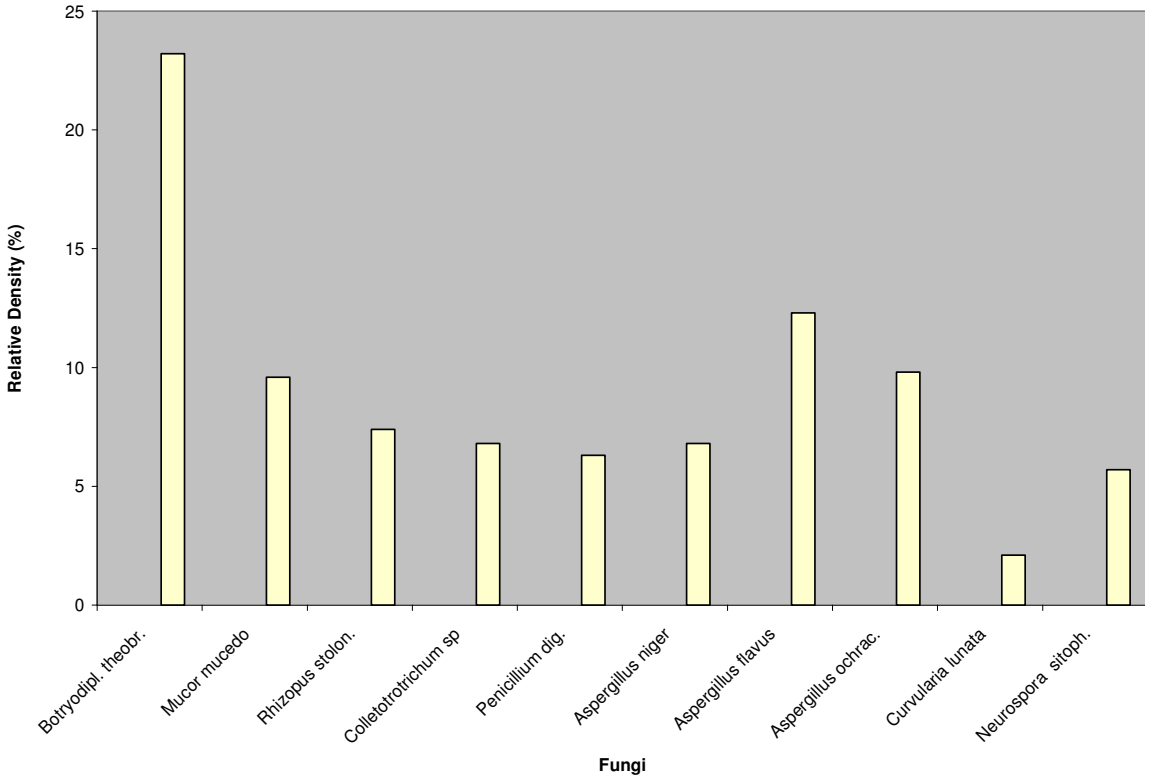

Figure 2. Fungi isolated from sun-dried sweet potato slices and their relative density in June.

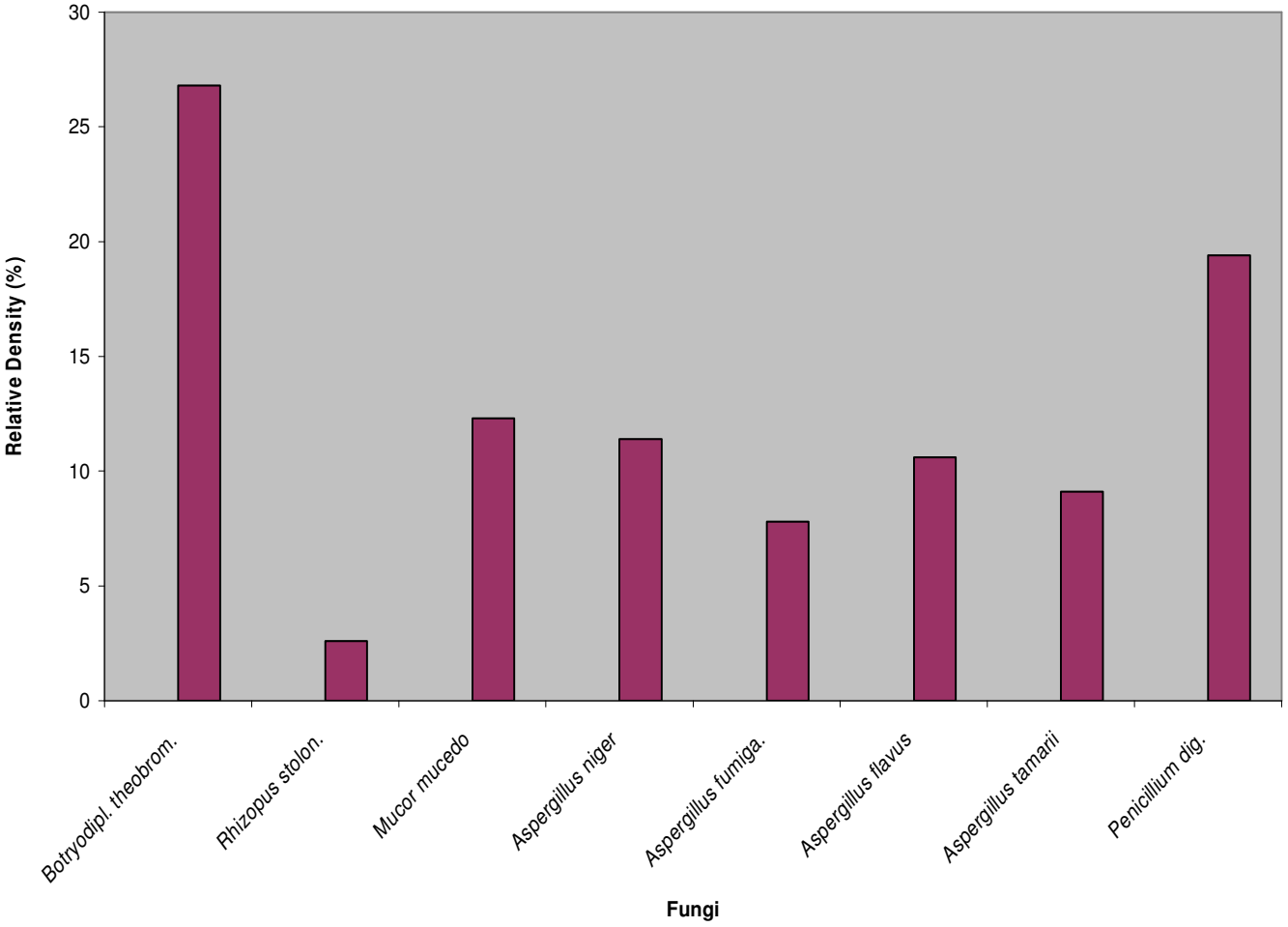

Figure 3. Fungi isolated from sun-dried sweet potato slices and their relative density in July.

Table 1. Total viable count (cfu/g) of fungi isolated from sweet potato slices sun-dried for 30 days for the months of May, June and July.

Fungi isolated	*Total viable count (cfu/g) x10^6		
	May	**June**	**July**
Botryodiplodia theobromae	11.6	8.7	9.3
Rhizopus stolonifer	6.4	6.5	4.1
Mucor mucedo	8.8	9.1	11.3
Aspergillus niger	10.7	7.5	10.6
A. fumigatus	11.4^a	2.6^b	7.6^a
A. flavus	2.8^c	6.1^d	5.8^d
Penicillium digitatum	8.7	8.2	8.5
Colletotrichum sp.	-	3.8	-
A. ochraceus	-	6.9	-
Curvularia sp.	-	1.9	-
Neurospora sitophila	-	6.7	-
A. tamarii	-	-	4.8

*Values with different letters in superscript in the same row are significantly different.

Table 2. Meteorological data* of Benin City for the months of May, June and July, 2007.

Month	RF (mm)	MaT (°C)	MiT (°C)	RH (%)	SS (hr)
May	3.3 [a]	30.2	21.5	53.4	2.5[a]
June	4.9	29.6	19.2	50.3	1.2
July	11.2[b]	26.0	21.8	46.9	0.4[b]

RF=Rainfall, MaT= Maximim temperature, MiT = Minimum temperature, RH = Relative humidity, SS = sunshine. Values are means of data for 30 days.
Values with different letters in superscript in the same column are significantly different.

months of May, June and July (as shown in the meteorological data) encouraged the germination of and colonization by these fungi.

Aspergillus and *Penicillium* are ubiquitous (Alexopoulos and Mims, 1979). According to Bankole et al. (2006), Adisa (1983), Mounjouenpou et al. (2008), and Jimoh and Kolapo (2008), some species of *Aspergillus* and *Mucor* produce toxins which can harm man and other animals when foods containing them are consumed. *Apergillus flavus* was the fungus with highest relative density in cassava and yam chips (food substances closely related to sweet potato as sources of carbohydrate) in the report of Gnonlonfin et al. (2008).

Four *Aspergillus* species were isolated in this study all having high relative density as well as high cfu values (close to the results of Mounjouenpou et al., 2008). Also, Gnonlonfin et al. (2008) reported almost similar cfu values for fungi isolated from cassava and yam chips in Benin Republic, a neighbouring country of Nigeria, many of which have the potential for toxin production. Detection of mycotoxins was however, not included in this study. *Neurospora sitophila* which made appearance in June is a fungus that is usually found growing on maize cobs in Nigeria. This period (May - July) is the period of cultivation of maize in Southern Nigeria. *Colletotrichum* is a fungus which commonly causes spoilage of fruits and seeds (Ikhatua and Anyanru, 2006). *Curvularia* is an ascomycete which has been reported to cause deterioration of food and plant parts (Singh et al., 2008).

This is the first documented report of fungi which colonize sun-dried sweet potato slices. The results of this study have shown that several fungal species are associated with sun-dried sweet potato slices, some of them potential mycotoxin producers.

Conclusion

Just as Raheem and Chukwuma (2001) pointed out that there are a lot of traditionally processed staple foods in Nigeria and other African countries which need improvement, sweet potato can be said to be one of such foods. In order to improve the quality of sweet potato slices made into flour for use with other foods or for biscuit-making, tunnel dryers (operated at 60-70°C) and drum-drying should be used, as these will reduce exposure to and colonization by fungi usually encountered during sun-drying. Further investigation aimed at determining toxin levels and nutrient depletion in sun-dried sweet potato slices is recommended.

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