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Biodeterioration of the African star apple (*Chrysophylum albidum*) in storage and the effect on its food value

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The biodeterioration of the African star apple fruits in storage was investigated at Ibadan, southwestern Nigeria. Eight fungal isolates were found associated with the deteriorating fruits. The fungi are *Botryodiplodia theobromae*, *Rhizopus stolonifer*, *Aspergillus niger*, *A. tamarii*, *A. flavus*, *Fusarium spp*, *Penicilium* spp and *Trichoderma* spp. All the fungal isolates were pathogenic on the star apple fruits with the exception of *Trichoderma* spp. The African star apple fruits stored for up to 5 days were associated with severe fungal infections and had significantly reduced crude protein, crude fat and moisture content while dry matter, potassium, calcium and sodium increased compared to the freshly harvested fruits.

Key words: *Chrysophilum albidum,* biodeterioration, fungal pathogens, storage.

INTRODUCTION

Chrysophyllum albidum (Linn.) belongs to the family Sapotaceae. It is primarily a forest tree species and its natural occurrences have been reported in diverse ecozones in Nigeria, Uganda, Niger Republic, Cameroon and Cote d'Ivoire (Bada, 1997). The plant often grows to a height of 36.5m though it may be smaller (Bada, 1997). The african star apple fruit is a large berry containing 4 to 5 flattened seeds or some times fewer due to seed abortion (Keay, 1989). The plant has in recent times become a crop of commercial value in Nigeria. The fleshy pulp of the fruits is eaten especially as snack and relished by both young and old (Cenrad, 1999). The African star apple fruit has been found to have highest content of ascorbic acid with 1000 to 3,330 mg of ascorbic acid per 100gm of edible fruit or about 100 times that of oranges and 10 times of that of guava or cashew (Asenjo, 1946). It is reported as an excellent source of vitamins, irons, flavours to diets and raw materials to some manufacturing industries (Adisa, 2000; Bada, 1997; Okafor and Fernandes, 1987; Umelo, 1997). In addition, its seeds are a source of oil, which is used for diverse purposes. The seeds are also used for local games (Bada, 1997). The fruits also contain 90% anacardic acid, which is used industrially in protecting wood and as source of resin, while several other components of the tree including the roots and leaves are used for medicinal purposes (Adewusi, 1997; Bada, 1997).

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C. albidum fruit is common in both urban and rural center especially during the months of December to April. The fruits are not usually harvested from the trees, but left drop naturally to the forest floor where they are picked. Allowing the fruits to drop before picking promotes fungal infections. Recent market survey revealed that the fruits often deteriorate within a very short period. According to Adebisi (1997), *C. albidium* actually becomes bad in a period of 5 days, with the deterioration starting with change of colour from uniform orange to one with patches, and followed by shrinking of the fruit. This study was undertaken to investigate the etiology of post-harvest biodeterioration of african star apple fruits in Ibadan, South Western Nigeria and the effects on its nutrient (food) value

MATERIALS AND METHODS

Twenty five african star apple trees from Moniya and Apata areas of Ibadan in south western Nigeria were used for the studies in 2000 and 2001. Ibadan (7^0 20′N, 3^0 50′E: 200 mm above sea level) is in a transition zone between the humid forest and derived savannah agro- ecologies of Nigeria. It has a mean annual rainfall of 1200 mm and mean daily temperature of between 24^0C (min) and 34^0C (max). Infected fruits were collected from above mentioned locations and brought to the laboratory for further studies.

The infected portions of the fruits were sliced into 2 mm^2 pieces, surface sterilized for 3 min with 1% NaOCl and rinsed in 4 successive changes of sterile distilled water. The surface-sterilized infected portions were then plated on sterile potato dextrose agar (PDA) in petri dishes and incubated for six days under alternating

12-hour light and dark periods at 26^{0}C. The fungal isolates were examined under a stereo binocular microscope, and their identities determined using cultural, morphological, and descriptions in existing publications (Barnett. and Hunter, 1972; Booth, 1971; Webster, 1980).

Pathogenicity Test

Freshly harvested ripe african star apple fruits obtained from a tree at Moniya, Ibadan were surface sterilized by swabbing with 70% alcohol. A sterile cork-borer (4mm in diameter) was used to remove a tissue core from each of the surface-sterilized fruit. A second sterile cork-borer was used to cut discs of agar containing 3-day-old cultures of fungal mycelia of the isolates and used to inoculate the hole created by scooping out fruit tissue. The scooped out tissues were replaced to cover the inoculated portion of the fruit. The inoculated fruits were then enclosed in polythene bags containing moist cotton wool to maintain high relative humidity and incubated at 25^{0}C in Gallenkamp incubators for 7 days. Four fruits were inoculated per isolate, while the control fruits were inoculated with sterile PDA agar discs. The extent of rot was determined by measuring the size of infection (mm). Wet mounts of hyphal/asexual structures obtained from these infected materials were stained with lactophenol in cotton blue and viewed under the compound microscope for the presence of the pathogen that was used in the inoculation.

Storage of the African star apple fruit

African star apple fruits collected as soon as they dropped naturally from the tree were kept in an oven-sterilized container lined with sterile filter paper and kept in the laboratory at a temperature of 26$\pm$2^{0}C. Samples were observed for spoilage (deterioration) and nutrient composition for10 days at an interval of every other day.

Nutrient Composition

Ten of the stored african star apple fruits were processed for nutrient analysis at 3 days interval for 9 days along with 10 freshly picked fruits. The fruits were kept in clean containers, de-seeded and weighed. The fleshy pulp was cut into pieces and dried in a hot air oven at 60^{0}C for 3 days. The dried fruits pulp was ground into powder, and analyzed (in triplicates) for moisture, carbohydrate, ash, crude fibre, crude proteins, and crude fat according to AOAC (1984) procedure. Mineral analysis was also carried out according to standard AACC (1983) method.

RESULTS AND DISCUSSION

Eight fungi were isolated from the deteriorating african star apple fruits in Ibadan, South Western Nigeria. The fungi include *Botryodiplodia theobromae*, *Rhizopus stolonifer*, *Aspergillus niger*, *A. tamarii*, *A. flavus*, *Fusarium spp*, *Penicilium* spp and *Trichoderma* spp. However, *A. niger* was the most prevalent of all the isolates, followed by *Penicilium* spp, *A. flavus* while *B. theobromae* was the least encountered (Table 1). The stored fruits were found associated with fungal infections begining from the 3rd day in storage. After about nine days in storage, deterioration in the fruit is manifested by shrinking and obvious fungal mycelia growth. The predominant fungi on the3rd day was *A. niger* and *R. stolonifer*, but on the 9th day all of the other eight fungi associated with the field infection with the exception of *Trichoderma* spp had colonised the deteriorating pulp (Table 2). *B. theobromae* which occurred least in stored african star apple fruit has been reported to be one of the most important fruit rot pathogen in southwestern Nigeria (Adisa, and Fajola, 1982), and has been observed to cause significant reduction in cashew yield (Olunloyo, 1979). All the isolates except *Trichoderma* spp were observed to be pathogenic to African star apple fruit (Table 2). *R. stolonifer* and *A. niger* which are usually present in the air (Webster, 1980), are probably secondary invaders.

Table 1. Incidence of occurrence and pathogenicity of fungi found associated with the African star apple fruits in Ibadan in 2000 and 2001.

Fungal isolates	Rate (%) of occurrence	Diameter of infection (mm)
A. niger	22	14
A. flavus	50	28
Penicillium sp.	65	14
Fusarium sp.	40	25
R. stolonifer	75	19
A. tamari	28	25
Trichoderma sp.	16	6
B. theobromae	21	42

This study showed that 35% of the fruits picked were infected. These infected fruits when packed with non-infected caused increased deterioration of African star apple in transit and storage (Adebisi, 1997). The natural dropping of star apple fruits probably causes entry point for the fungi that were associated with fruit deterioration. It is also possible that insect vectors are involved in dissemination as reported by Adelaja (1997) indicating that fruit fly stings enhance the entry of *Colletotrichum* spp into African star apple fruits by their oviposition on the fruits.

Results of the nutrient analysis revealed that the freshly harvested African star apple fruits had crude protein contents (CP) of 8.75 %, carbohydrate content (CHO) of 29.6%, crude fat (CF) of 16.2% and moisture content (MC) of 42.1%. However, 9 days after harvesting, the CP, CHO and CF contents decreased to about 5.01%, 20.2% and 13.2%, respectively. The MC also decreased to 32.6 % within the same period of study (Table 3). The nutrient analysis of the freshly harvested fruits revealed that Potassium (K), Calcium (Ca) and Sodium (Na) contents were 1.63%, 0.70% and 0.63 % respectively (Table 2). Nine days after harvesting, the K, Ca and Na contents of the fruits had

Table 2. The incidence of occurrence of fungal isolates on the African star apple fruits stored for nine days.

	Days in storage/incidence of occurrence								
Fungi isolates	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A. niger			+	+	+	+	+	+	+
A. flavus				+	+	+	+	+	+
Penicillium sp.				+	+	+	+	+	+
Fusarium sp.					+	+	+	+	+
R. stolonifer			+	+	+	+	+	+	+
A. tamari					+	+	+	+	+
Trichoderma sp.									
B. theobromae						+	+	+	+

+ = present on the pulp

Table 3. Nutrient[α] content of African star apple fruits in Ibadan, Southwestern Nigeria.

Days in storage	Moisture contents	% Crude protein	% Ether extract (fat)	% CHO	% K	% Na	% Ca
1st Day	42.10	8.75	16.2	29.6	1.63	0.63	0.70
3rd Day	39.6	8.39	16.0	29.2	1.88	0.63	0.70
6th Day	34.4	6.27	14.6	23.4	2.50	1.13	0.70
9th Day	32.6	5.01	13.2	20.2	2.75	1.25	0.72

[α]Proximate composition (% dry matter)

increased to 2.75%, 1.25% and 0.75% respectively. However, fruit from the market had 28.2% carbohydrates, 8.02% protein, 15.8% fat and 39.1% moisture. Adelaja (1997) reported that the crude protein, carbohydrates, crude fat content of the African star apple fruits were 8.8%, 29.9% and 17.1% respectively.

It could be deduced from this study that, deterioration of the fruit by the pathogen might have led to an increase in the mineral contents and decrease in metabolic synthetates of the African star apple fruits. The industrial use of African star apple fruits in jam making has been experimentally demonstrated (Umelo, 1997). Changes in nutrient composition caused by infection of the fruit will adversely affect the uses for jam and other food products. Because the fruit may become contaminated when picked from the forest floor, disinfecting before storage and use within three days of dropping/picking will prevent excessive infection of the pulp by fungal pathogens.

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