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FUNGI ASSOCIATED WITH DETERIORATION OF ACKEE (*Blighia sapida* L.) IN JAMAICA

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INTRODUCTION

The ackee, (*Blighia sapida*), besides being the national fruit of Jamaica, is a major component of one of Jamaica's favourite dishes. Because of seasonality of production and a high demand both locally and by Jamaicans abroad, the food processing industry has developed methods for canning the ackee.

The edible portion of the ackee fruit is botanically known as the aril - a cream-coloured mass of succulent tissue that is attached to the seed.

For marketing as a fresh vegetable, the ackee pods are allowed to open on the tree and the opened pods are harvested individually. For the processing industry, however, because of the large quantity required at any one time and the extreme susceptibility of the aril to deterioration the harvesting procedure has been modified. Fruits for processing are harvested by vigorously shaking the branches of laden trees to dislodge the fruits. The fallen fruits are then collected and delivered to the processing plant some 24 to 48 hours after harvest. By this method, fruits in various stages of maturity are harvested and, in addition the pods generally are badly bruised.

In the processing plant, unopened fruits are placed on racks to allow the maturation process to continue and from these, fruits are collected for processing when they open.

With this procedure, it is estimated that losses of about 40-60% occur. These losses are due either to the failure of the pods to open owing to immaturity or excessive dehydration, and to rots caused by pathogenic micro-organisms.

The primary objectives of this study were to identify the micro-organisms associated with deterioration of the ackee fruits and to extend the shelf-life of the fruits by suppressing the development of micro-organisms and reducing the rate of dehydration of the pods.

MATERIALS AND METHODS

Most of the ackee fruits used in this study were obtained from the processing plant, Frozen Foods (Jamaica) Ltd. However, the fruits used in pathogenicity tests were carefully harvested individually from trees on the University Campus.

Fruits obtained from the processing plant on different occasions were examined individually and classified into the following groups on the basis of symptoms - healthy, soft white rots, soft brown rots and other lesions.

Several specimens were selected from each of these groups and repeated isolations were made both from the pods and decaying arils. Isolations were made both from pods and decaying arils. Isolations were made on potato dextrose agar (PDA) mainly, with or without lactic acid, in an effort to selectively isolate fungi and bacteria. Some isolations for bacteria also were made on nutrient agar. Pathogenicity tests were carried out with all the isolated micro-organisms on individual pods and arils that were either wounded with a sterile needle or undamaged. Inoculated pods were enclosed in polyethylene bags for 48 hours after which they were left on the laboratory bench for a further period of 1-4 days before being assessed.

Rate of maceration of arils by fungi: Mature, unopened ackees were carefully harvested from a single tree, surface disinfested with sodium hypochlorite or 70% ethanol and the arils plus seeds removed under asceptic conditions. Arils were dipped either in sterile distilled water or a standardised spore suspension obtained from a particular fungus and then placed in sterile wide-mouthed flasks. Each treatment contained three arils and there were two replicates. Data on the extent of maceration were obtained at 24, 48, 72 and 96 hr. after inoculation. After removing the seeds, the arils were weighed, washed to remove macerated tissue, blot-dried and again weighed.

Fungicide treatments: The fungicides used were benomyl (methyl 1-butyl carbamoyl)-2-benzimidazole carbamate, thiabendazole (2-(4-thiazolyl) benzimidazole), dicloran (2,6 dichloro nitrol aniline) and sodium hypochlorite. Pods (10 or 25 per treatment) were dipped in each fungicide suspension or hot water for a particular period. Observations were made on the incidence of pod rot and opening of pods at various times.

RESULTS

Frequency of occurrence of various symptoms: From one sample of 365 fruits randomly selected from a batch of fruits obtained from the processing plant, 51% showed brown, soft rot symptoms attributable to Botryodiplodia theobromae, 4% showed other brown lesions and 41% apparently were healthy.

Isolations from diseased pods and arils: Repeated isolations from the soft, decaying arils revealed the presence of two unidentified bacteria. One isolate produced whitish colonies whereas the other produced yellow colonies on potato dextrose agar.

A number of fungi were isolated from decaying arils and pods from miscellaneous brown lesions on the pods. R. nigricans was repeatedly isolated from pods which showed symptoms of white soft rot, and B. theobromae similarly was

obtained from pods which showed symptoms of brown soft rot. Other fungi, which were associated with miscellaneous brown lesions included Gloeosporium sp., Pestallotia sp., Phomopsis sp. and Fusarium spp. B. theobromae and R. nigricans also were isolated from decaying arils.

Pathogenicity tests and symptom development: Pathogenicity tests on healthy wounded arils indicated that neither bacterial isolate was pathogenic. However, all the fungi isolated were able to infect both wounded pods and arils but the rate of infection varied appreciably. The Fusarium species, Phomopsis, Gloeosporium, and Pestallotia all caused firm dark brown lesions which developed slowly on the pods. The lesions produced by these fungi were indistinguishable except in the case of Pestallotia which produced lesions that were noticeably sunken. In contrast, B. theobromae produced a rapidly spreading brown lesion which was fairly soft and R. nigricans produced a soft white rot which spread with extreme rapidity.

When unwounded pods were inoculated with spore suspension of the different fungi, only B. theobromae caused infection. Within five days all of 10 inoculated pods were infected and had an average of 55% of the pod surface rotten. All arils were partially macerated. Some 59% of the lesions originated from the attached end of the pod, 29% from the stylar end and 12% from other areas of the pods.

Aril maceration by fungi: All seven isolated fungi were shown to macerate the ackee arils converting them into soft, mushy masses of tissue. R. nigricans was the most prolific. Within 24 hr. after inoculation it had macerated 19% of the aril tissue compared to 0-4% by the other fungi, and by 48 hr. maceration had increased to 92% compared to 5 - 15% by the other fungi. B. theobromae was nearly as prolific except for a slower start and between 48 and 72 hr. after inoculation maceration by this fungus had accelerated from 15 to 82%. The other fungi were somewhat slower and after 96 hr. 81, 79, 72, 61 and 52% of the tissues were macerated by Fusarium (salmon), Gloeosporium, Phomopsis, Pestallotia and Fusarium (red), respectively. The controls remained virtually unaltered during the test.

Effect of fungicides and other treatments on pod rot and pod opening: The results of these treatments are summarised in Tables 1, 2 and 3. In Table 1, all treatments except thiabendazole and cold water were better in suppressing pod rots within four days but by seven days only the hot water treatment was markedly different. Although effective in suppressing pod rot the hot water treatment caused a brown scorch of the pods.

In Table 2, dicloran, benomyl and sodium hypochlorite significantly reduced pod rot at both 4 and 7 days in one lot of pods but in a second lot, neither sodium hypochlorite nor a benomyl plus dicloran mixture was effective. In addition, the ability of the fungicides to suppress pod rot was greatly reduced when treated pods were kept in sealed polyethylene bags. Pods that were enclosed in polyethylene bags were quite fresh after 7 days whereas those kept on open trays were fairly dehydrated and shrivelled. But enclosure in polyethylene bad greatly suppressed pod opening.

This feature again is evident in Table 3 in which 30% of the pods opened after 7 days when kept in sealed polyethylene bags as compared to 80, 80 and 95% when they were kept in open trays with or without periodic spraying with water, or in perforated polyethylene bags, respectively.

In one trial in which carefully harvested undamaged pods were kept in the laboratory for 10 days, rots developed on only 4% of the pods and all pods were either fully or partially opened within this period. The pods, however, were fairly well dehydrated and it is likely that this prevented them from opening fully.

TABLE 1. Influence of various fungicides on percentage pod rot (A) and percentage of open ackee pods (B) after 4 or 7 days when kept on open trays in the laboratory (Av. of two reps.)

TREATMENT	% POD ROT AND OPEN PODS			
	4 days		7 days	
	A	B	A	B
1. Hot water (56°C/10 min.)	0	18	18	52
2. Benomyl (500 ppm/3 min.)	2	32	56	46
3. Thiabenazole (500 ppm/3 min.)	8	46	56	74
4. Dicloran (1000 ppm/1 min.)	0	24	50	58
5. 2 plus 4 (3 min.)	4	26	50	56
6. 3 plus 4 (3 min.)	2	28	40	68
7. Sodium hypochlorite (0.26% 10 min.)	4	52	36	70
8. Tap water (5 min.)	16	28	56	32
9. Control (no treatment)	8	12	64	12

TABLE 2. Influence of various fungicides on percentage pod rot (A) and percentage of open ackee pods (b) after 4 or 7 days when kept either on open trays or enclosed in polyethelene bags in the laboratory (Av. of two reps.)

TREATMENTS	% POD ROT AND OPEN PODS							
	OPEN TRAY				SEALED BAGS			
	4 days		7 days		4 days		7 days	
	A	B	A	B	A	B	A	B
(i) Dicloran	8	96	8	98	8	30	78	42
Benomyl	8	92	10	98	8	18	92	30
Sodium hypochlorite	4	98	4	100	2	4	80	8
Control	20	92	22	98	20	44	64	60
(ii)Sodium hypochlorite	35	55	75	100	30	30	85	30
Benomyl + Dicloran	15	25	70	100	10	10	75	10
Control	25	45	65	100	0	0	50	0

(i) and (ii) represent lots of fruits received on two different days. Rate and duration of treatments as shown in Table I.

TABLE 3. Influence of benomyl and various subsequent treatments on percentage of open ackee pods (B).

TREATMENTS (i)	% POD ROT AND OPEN PODS				
	4 days		7 days		
	A	B	A	B	B
Open tray	10	60	20	80	
Open tray + water spray (ii)	10	70	10	80	
Enclosed in perforated plastic bags	15	80	15	95	
Enclosed in sealed plastic bags	10	20	50	30	

(i) All treatments previously dipped in benomyl at rate and duration as in Table I; (ii) water was sprayed twice daily.

DISCUSSION

It is clear that fungi are the main micro-organisms responsible for the deterioration of ackees. Isolated bacteria were non-pathogenic whereas all fungi isolated were able to infect wounded ackee pods and macerate the arils. R. theobromae was the fungus of most importance owing to the frequency of its occurrence, its ability to infect unwounded pods and the rapidity with which infection progressed. Another fungus of major importance was R. nigricans again because of its rapid infection rate and its ability to sporulate quickly and profusely. This fungus apparently is unable to infect undamaged pods but because of the method of harvesting, numerous wounds generally are produced on the fruits and these provide ready avenues of ingress for the pathogenic micro-organisms.

The inconsistency in the performance of the fungicide treatments may be largely attributable to variability in the stages of infection at time of treatment. It appears, therefore, that for effective control of pod rots a harvesting method which would greatly reduce pod damage would have to be developed. This, either alone or in association with a fungicide dip (sodium hypochlorite or benomyl) applied immediately after harvest, should result in effective control. In addition, it seems that measures to reduce the rate of dehydration of the pods, possibly by periodic misting, also would be beneficial but since high humidity would favour the development of micro-organisms a carefully balanced system would have to be worked out.

The suppression of pod opening by complete enclosure in polyethylene bags is noteworthy. This may be due to a build-up of carbon dioxide or some other volatile chemical in the immediate environment of the pods and suggests that complete enclosure should be avoided.

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