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PROLONGATION OF THE STORAGE LIFE OF BREADFRUITS

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INTRODUCTION

Breadfruit (Atrocarpus communis, also A. altilis) is widely grown in the tropics as a source of carbohydrate. It has an extremely short storage life and is considered unpalatable as soon as it begins to get soft and sweet. This creates problems in marketing locally and makes exportation even by air unprofitable.

Reported methods of preservation of the fruit are by fermentation (Barrau 1957) and drying (Peters and Wills 1956, and Barrau 1956) but information on the storage of the fresh whole fruit is non-existent. The fruit has a high respiratory rate reaching a climacteric peak of above 3ml CO_2 per kg/h at 20°C 5 days after harvest (Biale and Barcus 1970). The problem therefore is to prolong the post-harvest pre-climacteric stage and delay the onset of the cliacteric stage and its associated accumulation of soluble solids and softening, yet maintain the fruit in its fresh, firm and green state.

This paper describes experiments which were carried out in order to determine the length of the storage life of the fruit and the effects of treatments which have been shown to extend the pre-climacteric of other climacteric fruits.

MATERIALS AND METHODS

Fruits used in these experiments were, except in one case, harvested by a climber who used a forked stick to break their stalks causing them to fall. They were not allowed to fall to the ground but were caught and placed in cartons which had 9 cubicles formed by cardboard separators. The fruits were next packed around with newspaper to prevent bruising during transportation.

Except where stated all the fruits used were mature. A mature breadfruit (cooked by roasting) as compared with a younger one (cooked by boiling) is darker green in skin colour, with a light browning and a lack of lustre. It is generally larger in size. The two most common varieties, Yellowheart and Whiteheart fruits, were used.

Experiment 1.

Ten mature and ten younger fruits were stored under one of the following conditions:-

1) 27.7°C and 85 - 94% RH.
2) 12.0°C and 61 - 75% RH.
3) 7.0°C and 61 - 75% RH.

The weight-loss of 5 fruits from each stage was also determined.

Experiment 2.

One of 6 groups each consisting of 10 Yellowheart fruits was allocated to one of the following treatments and then stored at 12.0°C and 91 - 98% RH:-

1) Unwrapped.
2) Wrapped individually in newspaper.
3) Stored individually in 75x46 cm x 150 gauge polyethylene bags which were then tied.
4) Stored individually in polyethylene bags perforated with 16x6mm diameter holes.
5) Stored in moist coir dust.
6) Stored in a 200 L capacity plastic bin of tap water. The fruits were only partially submerged as they floated.

Experiment 3.

Twenty Yellowheart fruits were left unwrapped and another 20 were placed individually in polyethylene bags. Ten from each treatment were stored at 24.5°C and 56 - 80% RH. and the others at 12.5°C and 92 - 98% RH.

Experiment 4.

Twenty Yellowheart fruits were harvested by the method mentioned earlier and then packed in cartons. Another 20 were allowed to fall to the ground and then packed in hessian bags for transportation.

While in storage the general condition of the fruits was observed daily and their firmness assessed by feeling. Frequent recordings of their fresh weight were also made. At the earliest perception of softening the fruits were regarded as being unmarketable and were therefore removed from storage, On removal they were weighed, ph level measured, their firmness and soluble solids content determined by the use of a Magness Taylor penetrometer and a pocket refractometer respectively. In certain cases the CO_2 content of the polyethylene bags was measured with a Daeger Multigas Detector. The experimental designs were factorial or randomized blocks and the data obtained were calculated mainly by the statistical analysis of variance method.

Results.

The results showed that temperature, unperforated polyethylene bags and a combination of both were most significant in prolonging the storage life of the breadfruit.

Temperature

Storage at 24 - 28°C resulted in the complete softening of fruits within 2 - 4 days while at 12.5°C they softened in 8.3 days. At 7°C softening was greatly delayed and when, either because of prolonged storage or transfer to ambient, ripening eventually began it was irregular and abnormal. The skin colour changed from green to dull brown after 2 or 3 days' storage, softening occurred in patches and the pulp was discoloured.

Fruits stored at low temperatures lost less weight than storage at ambient.

At 28.5°C no soluble solids were found during the first 2 - 3 days but after 3 - 4 days when softening started levels up to 15% accumulated. At 12.5°C soluble solids were rapidly accumulated on return to ambient but at 7°C very little soluble solids accumulated even on transfer to ambient conditions.

Packing

Breadfruit wrapped in newspaper as compared to unwrapped fruits showed no significant differences in weightloss or the number of days to softening. Moist coir dust and polyethylene bags whether perforated or whole resulted in very little weight-loss. Whole polyethylene bags significantly extended the storage life at both high and low temperature. At 24.5°C the extension was from 2.8 to 14.1 days and at 12.5°C from 8.3 to a maximum of 21.5 days (Tables 3 & 4). During storage these fruits retained their fresh green appearance and when they eventually ripened they did so normally. Storage in water prolonged the storage life significantly (Table 3) but after approximately a week in storage the fruits had absorbed so much water (0.9% weight gain per day) that they started to split exposing the mesocarp. After splitting that area got very soft and started to disintegrate.

Maturity

The number of days to softening of the two maturities used did not vary significantly even at different temperatures (Table 1). However, the dry matter contents were significantly different (Table 2).

Fruits which were caught did not prove to have a longer storage life than those which were allowed to fall to the ground.

Microbial Infections

Fungal and bacterial infection were very rare and when seen were limited to very ripe fruits where the tissue structure had broken down.

DISCUSSION

Softening of the breadfruit appears to be associated with the accumulation of soluble solids, a process which normally accompanies the ripening of climacteric fruits eg. bananas (Barnell 1941). Unlike all other fruits breadfruits are utilized as a starchy food and are therefore only marketable during the short period between maturity and the onset of the starch to sugar conversion and softening.

Although the data showed that there are no significant differences in the number of days to softening between the two maturities, other unpublished data showed that there is a difference in the soluble solids content of both (mature 15 - 23% and young 9 - 12.5%) and that an intermediate stage was capable of storage for 12 - 13 days at 20 - 22°C. This data also confirmed the fact that the 2 stages above had approximately the same shelf-life.

Reduced temperatures slowed respiration and the ripening processes as in other fruits and like many other tropical fruits (Biale and Young 1962) breadfruits stored below 12.5°C showed physiological and anatomical abnormalities which are associated with chilling injuries.

Polyethylene bags caused a delay in the onset of softening and a reduction in weight-loss which are understandable. These bags are semi-permeable to O_2 and CO_2. During storage the proportion of each gas changes because of respiration and diffusion resulting in a CO_2 rich environment which slows down respiration and leads to a longer storage life. Thompson et al, 1973, noted that plantains ripened much slower at high humidities than low humidities. The humidities in polyethylene bags containing breadfruits quickly rose to 100%.

The prolongation obtained by storage in water may also be due to inhibition of gas exchange and of water loss.

Harvesting by the traditional method of allowing fruits to drop to the ground had no detectable effect on the length of storage life. This seems surprising as the height of fall was in excess of 6m but is encouraging as other methods would prove to be practically difficult as trees are commonly 15 to 20m tall.

It was surprising that no significant differences was observed in the storage life of young and mature breadfruits (Table 1). Unpublished observation indicate that fruits intermediate in development between these 2 grades have a longer storage life than either. If, therefore, this stage of development can be identified it is possible that the storage life of breadfruit can be further extended.

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TABLE 1. **Effects of temperature and stage of maturity on the number of days for breadfruit to soften after harvest.**

Temperature	Mature	Young	Mean	C.V.%
28	3.3	3.4	3.4C	
12	5.2	5.6	5.4B	
7	8.4	9.2	8.8A	
Mean	5.6A	6.1A		5.9

Figures followed by the same letter were not significantly different (P=0.05) and are read separately for each mean.

TABLE 2. Effects of storage conditions and stage of maturity on the mean of dry matter content of breadfruits.

Days in storage	Temperature °C	Mature	Young	Mean	C.V.%
0		32.6A	31.7A	-	3.7
4	28	34.1	32.1	33.1B	
8	12	33.0	31.5	32.3B	
10	7	36.0	32.0	34.0A	
Mean		34.4A	31.9B		2.2

Figures followed by the same letter were not significantly different (P=0.05) and are read separately for each mean.

TABLE 3. Effects of packing treatment on the length of storage life and other parameters.

Treatment	Soluble solids %	Firmness (kg./cm^2) skin	flesh	Dry matter %	Days to softening (mean)
Unwrapped	18.8A	61AB	5.6AB	31.4A	10.4BC
Newspaper	17.4A	62AB	4.3AB	27.5A	8.5C
*Polyethylene	17.1A	78A	8.6A	28.2A	17.7A
Perforated polyethylene	16.1A	64AB	2.8C	28.5A	9.1C
Coir dust	19.0A	77A	4.2BC	27.3A	11.8B
*Water	7.0B	48B	8.9A	23.1B	16.7A
C.V.%	12.0	8.6	30.8	2.9	18.8

*Polyethylene and water treatments were analysed after 19 days storage. Other treatments after 15 days.

Figures followed by the same letter were not significantly different (P=0.05) and are read vertically.

TABLE 4. Effects of packing treatment and temperature on the no. of days to softening.

Storage temperature	Packing treatment	Mean no. of days to softening
24.5°C	Unwrapped	2.8
	Polyethylene	14.1
Mean		8.5*
13.0°C	Unwrapped	8.3
	Polyethylene	21.5
Mean		14.9

*Effect of temperature significant at P=0.001 level

Effect of polyethylene significant at P=0.05 level.

TABLE 5. Effects of packing and temperature on the mean % weight-loss during storage.

Days from harvest	Storage temp. °C	Unwrapped	Polyethylene bags	Mean
3	24.5	3.9	0.2	2.0
	13.0	1.1	0.1	0.6
	Mean	2.5	0.2	
7	24.5	12.6	1.9	7.3
	13.0	3.9	0.3	2.1
	Mean	8.2	1.1	
12	24.5	-	3.2	-
	13.0	7.9	0.8	4.3
	Mean	-	2.0	
16	24.5	-	4.7	-
	13.0	-	1.3	-
		-	3.0	-

TABLE 6. Effects of harvesting and transportation methods on weight-loss and softening.

Treatment	% weight-loss (day 13)	% of soft fruits (day 9)
caught	10.9	86
dropped	10.6	93