

THE EFFECT OF PACKAGING ON THE CONTROL OF INTERNAL BROWNING OF PINEAPPLE

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ABSTRACT

The development of internal browning of fresh pineapple (*Ananas comosus* (L.) Mer) subsequent to cold storage imposes a severe limitation in the marketing of fresh fruit. The manifestation of this condition is a result of chilling injury of the tissue during cold storage. Fruits of cultivar 'Mauritius' at mature green stage were packed in corrugated cardboard boxes using two different packaging materials: shredded paper and dried straw. The control did not contain any packaging material. Fruits were stored at 15°C and relative humidity (RH) of 85-90% for a period of ten days. The fruits were subsequently exposed to ambient conditions of temperature of 27-28°C and RH of 65-70%. Samples were tested for the development of internal browning at 0, 2, 4 and 6 day intervals. Fruits packed with dried straw showed a significant reduction in the incidence and severity of the damage compared to control fruits and fruits packed with shredded paper. The incidence was observed to be 16% in the straw packed fruits, compared to 78 and 75% in the control and fruits packed with shredded paper respectively, at the end of cold storage followed by four days at ambient conditions. Severity of the incidence was minimal in the fruits packed with dried straw while it was much higher in the other two and resulted in unmarketable fruits. The severity of the browning increased with the increase in duration of storage under ambient conditions. At the end of the total storage period of fourteen days, the dried straw packed fruits had acceptable organoleptic qualities with total soluble solids of 11-12% and total acidity of 1% with an orange yellow shell colour.

KEY WORDS: Pineapple, Internal browning, Straw and paper packaging.

INTRODUCTION

Low temperature storage of pineapple causes chilling injury to the tissue and results in a physiological disorder causing the browning of tissue. This condition is a common problem in all pineapple growing countries and is seen both in field growing conditions and during low temperature storage after harvest. It has been reported that under Australian climatic conditions this problem occurs during fruit development. Ambient temperature of less than 25°C, during the day or less than 20°C during the night combined with low light intensity results in this injury

(Lubulwa *et al.*, 1995). As reported in Hawaii (Paull, 1993) and Malaysia (Lubulwa *et al.*, 1995) it is manifested as post harvest problem.

Studies have been conducted in all the pineapple growing countries over the past three decades (Akamine, 1963; Akamine *et al.*, 1975; Paull and Rohrbach, 1985; Abdullah, 1997) but the condition has not been eliminated totally. The techniques of modified atmospheric storage (Abdullah *et al.*, 1985) and use of wax coating on pineapples of cultivar 'Smooth Cayenne' (Rohrbach and Paull, 1982) showed only a decreasing trend

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in the incidence and did not eliminate the problem to a marketable level. Results of studies conducted (Akamine *et al.*, 1975; Abdullah and Rohaya, 1983; Paull, 1993) have confirmed that the prolonged period of cold storage results in chilling injury which leads to an increase in the content of phenols and polyphenol oxidases. Prolonged exposure to ambient conditions thereafter results in the development and manifestation of the internal browning symptoms (Paull, 1993).

Pineapple is one of the main fruit crops of Sri Lanka and the widely grown cultivar 'Mauritius' has a very high potential and demand as a table fruit due to its highly acceptable organoleptic properties. Presently it is being only air freighted in the export trade and increasing air freight charges impose a serious limitation in the expansion of the market.

The objective of the study was to investigate possible measures to overcome this problem and facilitate the export of pineapple by sea investigating an extended cold storage period.

MATERIALS AND METHODS

Packaging

Fruits of cultivar 'Mauritius' at mature green stage were used in this study. Fruits were collected from a commercial cultivation in the Gampaha District. The fruits were sorted, brushed and trimmed to a stem length of 4-5 cm. Each fruit was enclosed in a kraft paper bag and packed in either straw or shredded paper. The control consisted of fruits enclosed in a kraft paper bag and packed direct into the boxes. Four fruits were packed in each box and a total of forty boxes were assigned for each treatment. The experiment

consisted of four replicates. Five ply corrugated cardboard boxes with internal dividers similarly used in the export trade were used to pack the pineapple fruits.

Storage

The fruits were stored in a cold-room at 15°C with RH of 85-90% for a period of ten days and subsequently fruits were transferred to ambient temperature of 26-28°C and RH of 65-70%. The fruits were tested for the development of internal browning symptoms at 0, 2, 4 and 6 day intervals. The incidence of internal browning was taken as the percentage of fruits that developed the symptoms. While the severity of browning (none to complete browning), was recorded on a scale of 0-6 (Paull and Rohrbach, 1985).

Evaluation

Fruits were evaluated for the following characteristics at the end of 4 and 6 day intervals after removal from the cold storage. The characters were scored based on the scale developed by Rohrbach and Paull (1982). Shell colour development was scored on a scale of 0-5 (green to 100% yellow/yellow orange). Shell appearance on a scale of 1-4 (good to poor) and crown appearance on a scale of 1-4 (good to poor). Juice extracted from the edible portion was used to measure the total soluble solids and acidity. Total soluble solids was measured using a pocket refractometer and acidity was determined as percentage of citric acid by titrating with 0.1N NaOH, using phenolphthalein as indicator.

The experiment was laid out in randomized complete block design and the means were compared by Duncan's multiple range test.

RESULTS AND DISCUSSION

The effect of packaging on the incidence and severity of internal browning at 15°C followed by storage under ambient conditions is given in Table 1. The fruits packed in straw showed a significant reduction ($p \leq 0.05$) in both incidence and severity compared to the fruits packed with shredded paper and control fruits. This is also evident from Figs. 1, 2 and 3.

The studies of Rohrbach and Paull (1982) and Wijeratnam *et al.* (1992) to investigate the effect of waxing in controlling the chilling and thereby the internal browning of pineapple have shown a decreasing tendency but did not result in a significant reduction of the condition. The effect of modified atmospheric storage conditions (Abdullah *et al.*, 1985) and the use of controlled atmospheric storage conditions (Akamine *et al.*, 1975; Haruenkit and Thompson, 1993) have shown a reduction in the incidence only, while the overall quality of the fruit still remained beyond an economical level for marketing.

Considering the results of the reported research findings, packing with dried straw eliminates the problem to a level of economically feasible marketing. Paull and Rohrbach (1985) have reported that fruits of severity score ≤ 3 are within the limit of economic marketing. The low level of severity (1.2) and incidence (16.2%) even in the affected fruits still qualify them for marketing.

Published literature on the post harvest storage of pineapple so far, has not addressed the effect of any packing material in the cold storage of pineapple. While examining the effect that dried straw has produced in reducing both the incidence and severity of browning it could be envisaged that the packing material renders an insulatory effect by developing a microclimate within the box. The straw or intervening medium could regulate the chilling, thus reducing the damage to a level that prevents the manifestation of browning symptoms under the experimental conditions. Extending the storage beyond ten days at 15°C leads to a progressive increase in both the incidence and severity of the symptoms on exposure to ambient conditions (Suntharalingam *et al.*, Unpublished data).

Table 1. The effect of packaging on incidence and severity of internal browning at storage temperature of 15°C followed by ambient conditions.

Type of packaging	Days at ambient condition							
	0		2		4		6	
	%Incidence	Severity	%Incidence	Severity	%Incidence	Severity	%Incidence	Severity
Straw	2.1±1.0b	0.0	5.5±1.2b	0.5	16.2±0.5b	1.2	26.2±1.7b	2.5
Shredded paper	34.2±4.3a	1.0	70.2±3.3a	1.6	75.1±1.3a	2.5	75.7±2.6a	4.0
Control	37.0±2.2a	1.0	70.5±2.1a	4.0	78.3±2.3a	4.5	78.5±1.9a	5.0

Treatment means in a column followed by the same letter are not significantly different at 5% level (DMRT).

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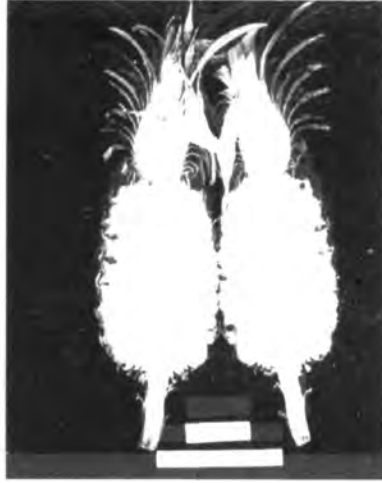


Fig. 1. Pineapple stored at 15°C and followed by 6 days under ambient conditions.

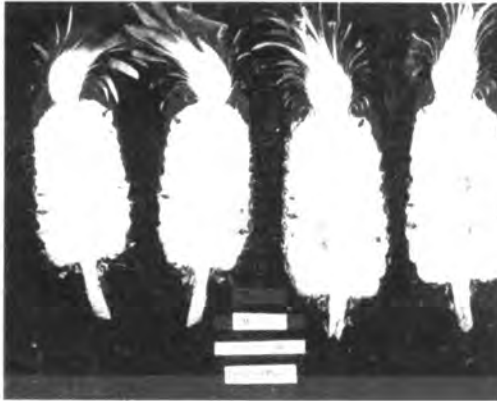


Fig. 2. Pineapple with shredded paper packaging, stored at 15°C and followed by 6 days under ambient conditions.

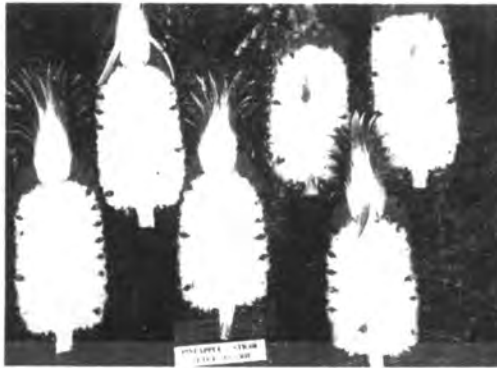


Fig. 3. Pineapple with straw packaging, stored at 15°C and followed by 6 days under ambient conditions.

Table 2. The effect of low temperature storage on fruit characters of pineapple.

Fruit character	Days at ambient condition	Type of packaging		
		Straw	Shredded paper	Control
Shell colour	4	4.3±0.4a	4.5±0.7a	4.9±0.8a
	6	4.8±0.5a	4.8±0.8a	4.9±0.6a
Shell appearance	4	2.8±0.2a	2.9±0.5a	3.9±0.2a
	6	2.9±0.4a	3.0±0.8a	3.2±0.4a
Crown appearance	4	3.5±0.2a	3.5±0.3a	3.7±0.3a
	6	3.2±0.2a	3.4±0.4a	3.4±0.4a

Treatment means in a row followed by the same letter are not significantly different at 5% level (DMRT).

Table 3. The effect of low temperature storage on TSS and acidity of pineapple.

Parameter	Days at ambient condition	Type of packaging		
		Straw	Shredded paper	Control
TSS	4	11.2±0.8a	11.0±0.6a	11.3±0.2a
	6	11.5±0.7a	11.5±0.5a	11.5±0.3a
Acidity (%)	4	1.1±0.2a	1.0±0.2a	1.0±0.2a
	6	1.1±0.2a	1.1±0.2a	1.2±0.2a

Treatment means in a row followed by the same letter are not significantly different at 5% level (DMRT).

The effects of storage on shell colour development, shell appearance and crown appearance under ambient conditions following cold storage condition is given in Table 2. The fruit characters remain satisfactory on removal from cold storage and during subsequent exposure to ambient conditions. The fruits developed a shell colour of yellow/orange compared to the coppery red colour development that was observed in fruits that were stored at 10°C or less (Suntharalingam *et al.*, unpublished data). The low temperature injury results in the development of a coppery red shell colour (Haruenkit and Thompson, 1993) and the

results of the present study indicate the advantage of the selected treatment (straw packaging) in developing a more natural colour enhancing the consumer acceptability as fresh fruit. The scoring of shell and crown appearance also indicate the acceptability of the commodity for a fresh fruit market with minimal shriveling.

The effect of storage on total soluble solids (TSS) or °brix value, and acidity is given in Table 3. The TSS of 11-12% and acidity of 1% results in acceptable organoleptic attributes. Even though the sweetness is low compared to the freshly

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harvested ripe fruits, it still possesses the acceptable sweetness compared to the other cultivars that are available on the international market.

The drawback of the selected treatment is that it requires disposal of straw at the retail market and the quarantine restrictions imposed by certain countries regarding the use of straw. This could be overcome by developing an appropriate packaging material with the thermal properties comparable to straw.

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