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Effect of an Edible Coating on Some Quality and Physico-Chemical Parameters of Pineapple During Cold Storage

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ABSTRACT. *Mauritius is the main pineapple variety presently grown in Sri Lanka for the local market as well as for export. Internal browning [IB] disorder in pineapple is a common problem encountered by exporters as a result of cold storage during sea shipment.*

In this study, mucilaginous press-sap of Neolitsea cassia (L) Kostermans leaves was applied as a surface coating on Mauritius fruits. In the first experiment, treated and untreated fruits were stored at 8°C for three weeks. In the second experiment, they were stored in the incubator at 32°C for 24 hours and then transferred to 8°C for further storage for three weeks.

Evaluations on quality changes of the fruit were conducted at a weekly interval immediately after fruit removal from cold storage. Observations were made on weight loss, skin colour, crown condition, pulp colour, internal browning disorder, ascorbic acid, total soluble solids, pH, titratable acidity and non enzymatic browning.

Fruit quality was maintained throughout the storage at 8°C in treated fruits. The incidence of symptoms associated with IB was less when a heat pre-treatment was combined with edible coating. The fruit affected by IB had low ascorbic acid content and total soluble solids and higher titratable acidity than the unaffected fruit. Role of pH on IB was not clear. Coated fruits showed a significant difference over the control in percentage of weight loss, ascorbic acid content, and IB under cold storage.

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INTRODUCTION

Pineapple (*Ananas comosus* L.) is one of the most important economic fruit crops of Sri Lanka. Mauritius is the main variety presently grown in Sri Lanka and it is used in the local market as well as for export. Fresh fruit is usually exported more economically by sea freight under refrigerated conditions.

Pineapple is very sensitive to storage temperature. Internal browning (IB) is an important physiological disorder (also known as Endogenous brown spot or black heart) caused by storage at chilling temperatures (Dull, 1971). IB is accompanied by loss of ascorbic acid and the appearance of polyphenoloxydase activity (Teisson *et al.*, 1979). The recommended storage temperature for South African pineapples is 8.5°C (Salunkhe and Desai, 1984). Storage at 7 to 8°C and 10°C has been recommended for ripe and unripe fruit, respectively (Anon, 1989).

Waxing pineapples reduced the severity and incidence of chilling injury, affording extra storage time (Rohrbach and Paull, 1982). Exposing fruit to high temperatures (>32°C) for a short period (24 h) before or after chilling stress can control storage induced IB (Paull and Rohrbach, 1985). A series of studies on IB were reported by Abdullah and his associates (Abdullah and Rohaya, 1983; Abdullah *et al.*, 1985 and 1986).

Nanayakkara *et al.* (1990) reported that IB was not caused by the use of flowering hormones and also not due to deficiencies of calcium in the soil. The incidence of symptoms associated with the IB disorder of pineapples was reduced by controlled storage particularly when combined with wax treatment (Wijeratnam *et al.*, 1995). A heat treatment at 40°C for 24 hours before storage could reduce the incidence and delay the occurrence of IB. Waxing with SF-wax significantly reduced the severity of IB in fruits stored at 12°C (Youlin *et al.*, 1995).

As pineapple is one of the most important fruit crops in Sri Lanka, further studies on the above disorder is essential. The present investigation was therefore carried out to study the effects of an edible coating on IB of Mauritius pineapples during cold storage.

MATERIALS AND METHODS

Materials and sample preparation

Pineapple *cv.* Mauritius was obtained from farms in Gampaha District (Western Province). The fruits which were less than a quarter ripe, were harvested early in the morning and transported immediately to the laboratory in the Department of Agricultural Biology, University of Peradeniya. On arrival, the fruits were sorted according to size and maturity. The base of the fruit was then dipped in 500 μg/ml benomyl suspension for five minutes to control rot caused by *Thielaviopsis paradoxa.* Ten fruits were used for each treatment and all replicates comprised of fruits of almost similar physical characteristics.

Treatment and storage condition

The edible coating was prepared from the leaves of *Neolitsea cassia* ('Dawul Kurundu') collected from Kandy district. One kilogram of fresh material was chopped, crushed and the extract prepared in one litre of water and was diluted upto 12.5% v/v.

In the first experiment, a batch of 30 fruits was treated completely by dipping in this coating and storing at 8°C for 1, 2 and 3 weeks. Another batch of 30 untreated fruits was stored at 8°C for 1, 2 and 3 weeks as a control.

In the second experiment, the treated and untreated fruits were kept in the incubator at 32°C for 24 hours and then stored at 8°C for 1, 2 and 3 weeks. For comparison, a batch of 30 treated and untreated fruits was stored at room temperature without any refrigeration for three weeks.

Weight loss

The weight of each fruit was measured before storage (initial weight) and before the final observations were carried out (final weight). The weight loss was determined by using the following formula.

$$Percentage\ of\ weight\ loss = \frac{Initial\ weight - Final\ weight}{Final\ weight} \times 100$$

Ascorbic acid

The peel and core of the fruit was removed and whole flesh was blended using a blender. Determination of ascorbic acid was carried out by titrating with 2, 6 dichloro-phenol indophenol, according to Askar and Treptow (1993).

Total soluble solids (TSS) and pH

The TSS of fruit juice was determined by hand refractometer and pH was determined by a pH meter.

Titratable acidity

Titratable acidity was determined using the standard method of the AOAC. Acidity as percentage of citric acid was determined by titrating with 0.1 N NaOH using phenolphthalein as the indicator. Percentage of acid was determined by using the following formula.

$$Percentage\ of\ acid = \frac{Titre \times Normality\ of\ alkali \times meq.\ wt.\ of\ acid}{Volume\ of\ the\ sample} \times 100$$

IB intensity and non-enzymatic browning

Fruits were cut longitudinally into two halves and the intensity of the IB was determined visually using the scale from 0 - 5 [0 = free from IB; 5 = 100% of the scale flesh is affected] (Teisson, 1979). For the determination of non-enzymatic browning, pulp and particles were removed from juice by centrifugation. Then equal volume of 95% ethanol was diluted with the juice and again centrifuged, and filtered through Whatman No 1 filter paper. Increase in absorbance of a sample extract at 440 nm was measured using spectrophotometer. [60% aqueous alcohol used as blank].

RESULTS

Pineapple fruits coated with *Neolitsea cassia* extract showed a significant difference over the control in percentage of weight loss (Figure 1), ascorbic acid content (Table 1), and internal browning (Figure 5) under storage at 8°C.

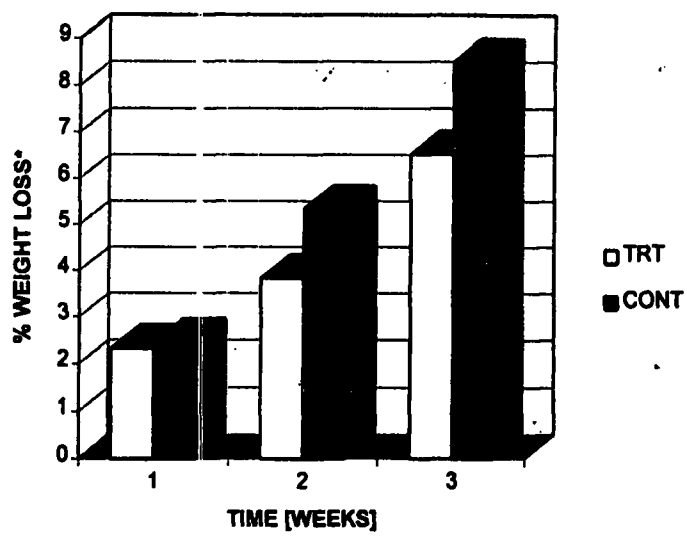

Figure 1. **Effect of edible coating on weight loss of treated (TRT) and control (CONT) Mauritius pineapples during storage at 8°C.**
[Note: * Each value is the mean of 10 replicates]

Percentage of weight loss

Figures 1 and 2 show the percentage weight loss of fruits during the storage from 1 to 3 weeks. Maximum weight loss occurred after second week. Percentage weight loss was less in the treated fruits. Percentage weight loss in the first experiment was lower than in the second experiment.

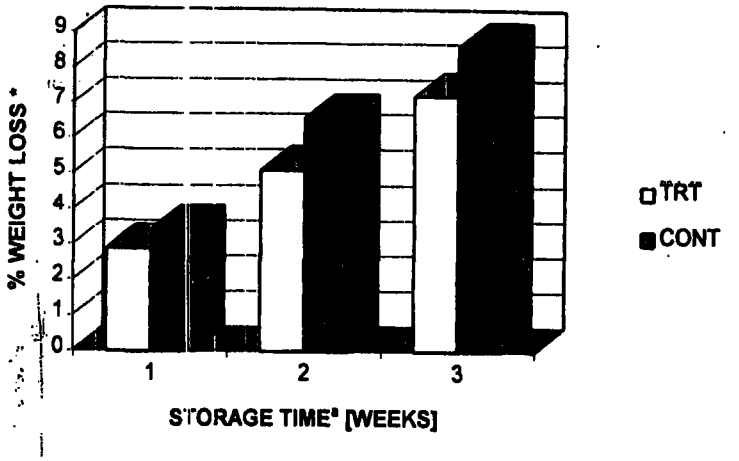

Figure 2. **Effect of edible coating on weight loss of treated (TRT) and control (CONT) Mauritius pineapples during storage at 8°C.**
[Note: a - Initially fruits kept in the incubator at 32°C for 24 hours and after stored at 8°C * Each value is the mean of 10 replicates.]

Ascorbic acid content

Table 1 shows the changes in the ascorbic acid contents in Mauritius pineapples after being stored for 1, 2 and 3 weeks at 8°C with and without edible coatings. In both, ascorbic acid content decreased progressively as the storage period was prolonged. The reduction in ascorbic acid content was greater in the control fruits than treated fruits.

Total soluble sugar [TSS]

Higher TSS (brix) values were obtained in treated fruits than control fruits. Fruits affected by IB were significantly lower in total soluble solids. TSS values of treated and control fruits was low during second and third weeks (Figures 3 and 4).

Table 1. Effect of edible coating on ascorbic acid content in Mauritius pineapples.

Treatments	Storage period at 8°C [weeks]	Ascorbic acid* [mg/100g flesh]
Edible coated fruits	0	19.8 a
	1	18.0 ab
	2	19.1 a
	3	12.3 b
Control	0	19.8 a
	1	6.5 c
	2	8.9 c
	3	5.4 c

* Values followed by the same letter are not significantly different at 5% level by Duncan's Multiple Range Test. Each value is the mean of 10 replicates.

Titratable acidity and pulp pH

There was no significant difference in titratable acidity between treated and control fruits. Initially the titratable acidity remained constant around 0.8. But after three weeks it increased to 0.92 and 1.45, in treated and control fruits, respectively (Figure 3).

During storage at 8°C, pH values of treated fruits decreased from 3.66 to 3.53 during first two weeks but again increased to 3.6 when storage period extended to third week. In control fruits, pH values reduced gradually from first to third weeks of storage (Figures 3 and 4). But there was no correlation, between pH values and the intensity of IB.

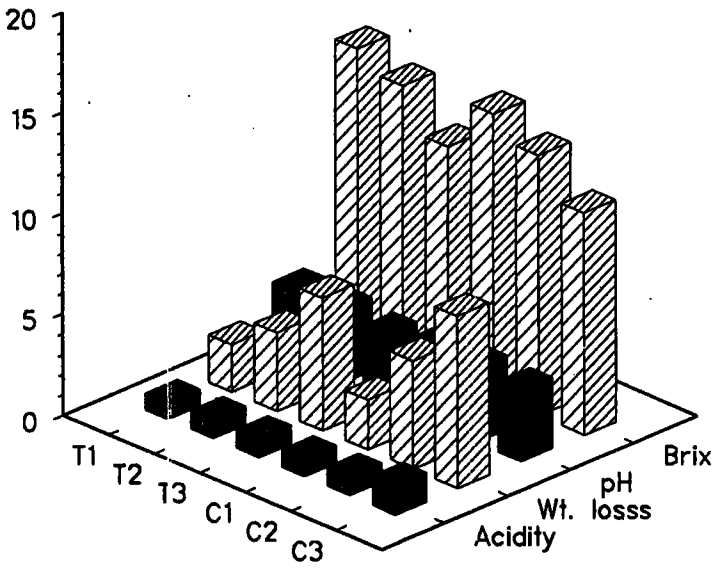

Figure 3. **Effect of edible coating on titratable acidity, pH, TSS (brix) of Mauritius pineapples during storage at 8°C.**
[Note: T - Treated; C - Control; 1, 2, 3 - Storage time in weeks
* Each value is the mean of 10 replicates.]

Internal browning development

Figure 5 shows the development of IB in control fruits, and fruits coated with edible coating. The intensity of IB in fruits coated with edible coating was found to be lower than in control fruits. IB intensity of coated fruits was less than 0.5 (browning is less than 10% of the flesh surface) during the storage which was considered to be good and acceptable for consumption. Particularly the incidence of symptoms associated with the IB disorder of pineapples was reduced when the heat treatment was combined with edible coating. It was found that non enzymatic browning (absorbance values at 440 nm) was not related to internal browning development (Figure 6).

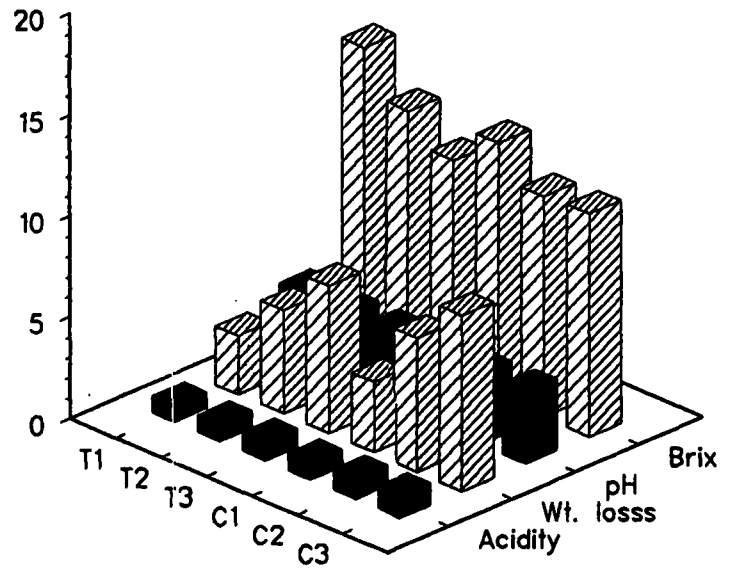

Figure 4. **Effect of edible coating on titratable acidity, pH, TSS (brix) of Mauritius pineapples during storage at 8°C. (Fruits kept in the incubator at 32°C for 24 hours and then stored at 8°C).**
[Note: T - Treated; C - Control; 1, 2, 3 - Storage time in weeks
* Each value is the mean of 10 replicates.]

DISCUSSION

Internal browning is one of the major physiological disorders in harvested pineapple fruits particularly when stored at cold temperatures. Browning results from both enzymatic and nonenzymatic oxidation of phenolic compounds. Browning usually impairs the sensory properties of products, because of the associated changes in colour, flavour and softening (Martinez and Whitaker, 1995).

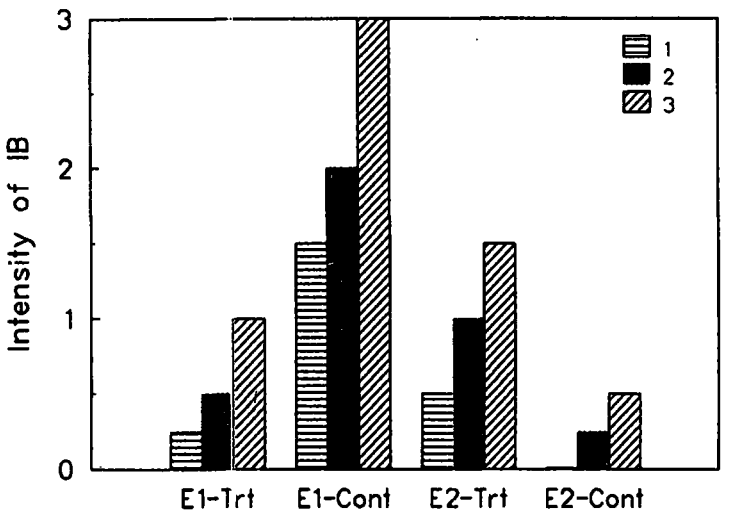

Figure 5. **Effect of edible coating on internal browning intensity of Mauritius pineapples during storage at 8°C.**
[Note: E1- experiment 1 : E2 - experiment 2; 1,2,3 - Storage time in weeks].

The increase in absorbance of a sample extract at 440 nm is taken as a measure of non enzymatic browning (Askar and Treptow, 1993). Heat inactivation of enzyme is feasible by applying temperatures of >50°C, but may produce undesirable colours and/or flavours as well as undesirable changes in texture (Martinez and Whitaker, 1995). Miller and Heilman (1952) suggested that ascorbic acid has the ability to convert quinones back to phenols, which will cause browning when the ascorbic acid supply has been consumed by the reaction. Ascorbic acid levels have been associated with the degree of expression of symptoms of IB caused by chilling (Van Lelyveld and De Bruyn, 1976). Low oxygen/high carbon dioxide concentrations act by reducing the loss of ascorbic acid (Abdullah *et al.*, 1985).

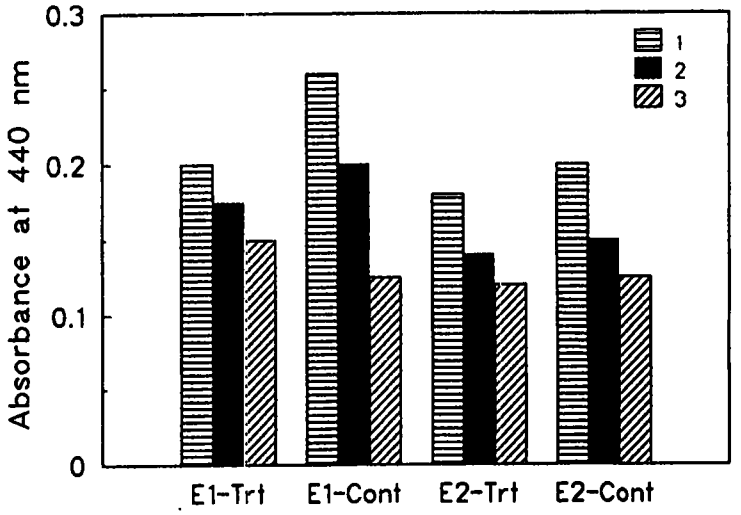

Figure 6. **Effect of edible coating on the non enzymatic browning (absorbance at 440 nm) of Mauritius pineapples during storage at 8°C.**
[Note: E1- experiment 1 : E2 - experiment 2; 1,2,3 - Storage time in weeks].

Physiological processes, such as respiration, transpiration and evaporation lead to changes in the pH, TSS values, titratable acidity, ascorbic acid content and weight of fruit. The pH is of importance as a measure of the active acidity which influences the flavour or palatability of a product and affects the processing requirements. The higher the TSS in relation to the acid content of the juice, the higher the ratio and the sweeter the taste. Titratable acidity may be expressed as the amount of free acid (mainly as anhydrous citric acid) in the product (g/100 g or g/100 ml). Percentage weight losses of fruits were high at room temperature and control conditions due to the increase in respiration and evaporation rates of fruits.

It is possible to control the exchanges of gases through the stomata of shell by applying coatings of wax or wax like material on the fruit. Waxing reduced the rate of respiration and ethylene production in Kinow fruit during storage (Farooqi *et al.*, 1988). There could be some toxic effect of synthetic wax, if it leaches through the shell of fruits, which may cause some health hazards for consumers. Even though *Neolitsea cassia* coat can leach inside the

fruits, but there is no toxic effect as it is used in the traditional sweets. Furthermore synthetic wax is more costly than *Neolitsea cassia* ('Dawul Kurundu').

Edible coating may cover the stomata aperture and reduce the transpiration rate. Due to the reduction of transpiration rate, respiration of cells also gets minimized. This results in a reduction of rate of food conversion. The ascorbic acid content and green colour of skin were better retained in fruit coated with sap of *Neolitsea cassia* while weight loss was minimized. The most significant effect of coating was on shell appearance and shell colour. Shell appearance was retained in coated fruit during and up to 3 weeks of storage at 8°C. Therefore by combining cold room condition and edible coating it is possible to minimize the deterioration rate of pineapple fruits, due to internal browning.

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