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Quality of papaya variety 'Rathna' as affected by postharvest handling

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ABSTRACT

In addition to the high post harvest losses (46%), the quality of ripe papaya in the market place is very poor. High level of mechanical damage, disease development, the presence of 'green islands' on the skin and poor quality of the flesh contribute to the loss of quality. Experiments were conducted to find out the effect of the stage of maturity at harvest on the quality of ripe papaya of 'Rathna' variety. The maturity stages tested were trace yellow, 25% yellow, 50% yellow and full yellow. Harvesting at trace yellow stage, did not result in the development of attractive yellow skin colour. In addition, shriveling of fruits, excessive weight loss and high incidence of diseases in fruits reduced visual quality rating. Although fruits harvested at full yellow stage developed bright yellow skin colour, susceptibility to damage during handling resulted in low visual quality rating. Of the packaging materials tested Styrofoam sleeves proved better than newspaper and rice straw. The spongy nature of Styrofoam sleeves would have helped to absorb vibration and reduced mechanical damages during transport. The development of 'green islands' as physiological disorder was more on fruits harvested at trace yellow and 25% yellow colour. This disorder was further aggravated by mechanical injuries caused during transport. Although hot-water treatment significantly reduced the postharvest disease of papaya, the treatment increased the 'green island' formation when fruits were harvested at trace yellow and 25% yellow stages of maturity.

Key words: 'green islands', harvesting maturity, hot-water treatment, packaging, quality of papaya.

INTRODUCTION

Papaya is a nutritive fruit, which has a high demand. Currently variety 'Rathna' is the only variety that has been released by the Department of Agriculture. Dark yellow skin colour and the orange colour flesh of the ripe fruit attract consumers. In addition, firm flesh even at fully ripe stage prevents mechanical damage during transport. Further, the medium size of the fruit has an advantage in transport and quick selling as fresh fruit for small families.

Postharvest loss of papaya is reported to be 46% (Sarananda, 2000). Mechanical damages caused during harvesting and transport and postharvest diseases are the major causes for post harvest losses. The internal firmness of papaya variety 'Rathna" is an advantage, which renders reduced post harvest loss due to mechanical damage. However, slightly lesser taste of fruits, very high incidence of 'green islands' on the skin has reduced the consumer Demand for this variety. In addition, relatively higher disease incidence in ripe fruits increases the postharvest losses.

The formation of 'green islands' (areas of skin that remain green and sunken when the fruit is fully ripe is apparently induced by mechanical injury (Quintana and Paull, 1993). Of the mechanical injuries, abrasion and puncture injuries have been reported as causes for the 'green islands' formation. Abrasion damage of papaya is associated mainly with fruits hitting against the walls of storage basket. If proper packaging is not used, the possibility of abrasion damage is greater, reducing the quality of papaya at the retail market. Even if improper packaging is used, packing materials may help to reduce vibration damage to fruits during transport resulting in abrasion to a lesser extent. Therefore, the objectives of the study was to assess the effect of the stage of harvesting maturity, method of packaging and hot water treatment on the postharvest quality of papaya,

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variety 'Rathna'.

MATERIALS AND METHODS

Experiment 1. Effect of stage of maturity at harvest on the quality of ripe papaya

Twenty fruits each at maturity stages, trace yellow, 25% yellow, 50% yellow and 75% yellow were carefully harvested without sustaining damage, from a commercial papaya plantation at Neelabemma, Puttlam, Sri Lanka. The fruits were enclosed in Styrofoam net sleeves and were packed stem-end down in ventilated plastic crates as a single layer. Fruits were then carefully transported to the laboratory at the Food Research Unit, Gannoruwa. Weight of the individual fruit was recorded and fruits were stored at ambient temperature (26°C ± 2°C) and 75% RH for 7 days. Five replicate fruits from each maturity stage were randomly selected at 3, 5, 6 and 7 days after storage for analysis of physio-chemical parameters.

Percentage weight loss was determined by recording the weight of each subtracting the weight after a particular storage period and by multiplying the resulting difference in weight by 100. Peel colour development was recorded using a peel colour index (Balasuriya, 2001) of 1-7 where 1= green and 7= over ripe stage. Severity of 'green islands' was recorded using a 1-5 index (Quintana and Paull, 1993) i.e. 1= no disorder and 5= very high number of 'green islands'. The degree of shriveling of fruits was observed by using a 1-4 index (Quintana and Paull, 1993) i.e. 1= none and 4= severe. rops of the extract were placed on a hand held refractometer to measure total soluble solids. An 8 member, trained taste panel evaluated the flesh colour, taste and overall acceptability using hedonicscale. The flesh of middle1/3 of the fruit was squeezed through a muslin cloth to extract the juice and a few drops was need to measure Brix value using a hand held refractometer (Wijesinghe and Sarananda, 2002).

The experimental design used was Completely Randomized Design (CRD), and data were analyzed statistically using Analysis of Variance (ANOVA). Mean separation was done using Duncan's Multiple Range Test (DMRT) for normally distributed data. Data recorded using indices were analyzed using Kruskal Wallis Test, non-parametric test in MINITAB computer package.

Experiment 2. Effect of different packing Material on postharvest quality of ripe papaya

Eighty fruits at 50% yellow colour development stage were harvested from a papaya plantation at Neelabemma. Fruits were randomly divided into 4 batches, each batch (treatment) containing 20 fruits. Individual fruits of one batch was enclosed in Styrofoam net sleeves, packed in plastic crates stem-end down as a single layer. Individual fruits of the second batch were wrapped completely with newspapers and similarly placed in plastic crates. Fruits of the third batch were packed in plastic crates using rice straw as the packing material. The remaining batch, which was packed in plastic crates without packing, was used as the control. Fruits were then carefully transported (160 Km) to the laboratory at Food Research Unit, Gannoruwa. All packages were stored at ambient temperature 26°C ± 2°C and 75% RH. Five fruits from each treatment were removed at 3, 5, 6, and 7 days of storage, observations in 'green islands' formation, disease severity and the visual quality rating was recorded in individual fruits as described in experiment 1. The experimental design used was CRD with five replicates.

Experiment 3. Effect of stage of maturity, packing material and hot water treatment on 'green islands' formation of papaya.

Ten fruits from each maturity stage, trace yellow, 25% yellow, 50% yellow and 75% yellow were harvested from the same field. Fruits of each stage of maturity were divided into two batches. One batch(treatment) of fruits was enclosed in Styrofoam sleeves and the remaining group was maintained as the control. All fruits were packed in plastic crates stem-end down. Subsequently fruits were transported to the laboratory at Gannoruwa. All fruits were then treated with hot water at 49 ± 2°C for 18 min (Tongdee and Suwanagual, 1985). It has been reported that hot water does not impair the taste of ripe fruit. Treated fruits were stored at ambient temperature 26°C ± 2°C and 75% RH. 'Green island' formation and

disease severity were recorded as described in the experiment 1.

Four maturity levels and two packaging materials were used in a 4 x 2 factorial design CRD. Normally distributed data were analyzed statistically using ANOVA and data collected using indices were analyzed using Kruskal Wallis nonparametric Test in MINITAB computer package.

RESULTS AND DISCUSSION

Effect of stage of maturity at harvest on the quality of ripe papaya

Minimum weight loss was recorded in papaya fruits harvested at 50% yellow colour stage. Excessive weight loss was observed in papayas harvested at trace yellow stage throughout the storage period (Table 1). Higher weight loss in less mature fruits could be due to under developed cuticle resulting in a considerable loss of water (Menary and Jones, 1972). These results confirm to the excessive weight loss recorded in papaya harvested at trace yellow stage. Rates of water loss of papaya have previously been reported to rise at the beginning of the climacteric phase and further be increased during storage (Kays, 1991). The increase in weight loss of papaya harvested at 75% yellow stage may therefore be due to the same reason.

Table 1. Percentage weight loss of papaya during storage

	Storage time in days			
	3	5	6	7
	Mean % weight loss			
Trace yellow	7.2a	11.5a	11.3a	13.5a
25% yellow	4.3b	8.2b	9.9b	12.5b
50% yellow	1.8c	2.9d	3.1d	4.0d
75% yellow	1.4c	3.6c	6.4c	6.8c

Treatment means in a column having a common letter(s) are not significantly different by DMRT at 5%. Each data point represent mean of 5 fruits.

Papaya is a climacteric fruit (Burdon, 1997). Ripening associated changes such as peel colour development, increase in respiration and changes in biochemical reactions take place after harvest. Fruits harvested at trace yellow stage did not develop full yellow colour during the experimental storage (Table 2). The poor peel colour development in fruits may be due to their Inability to enter the climacteric cycle. All the fruits harvested at 25% yellow colour and above reached the maximum peel colour of CI 7.

Table 2. Mean peel colour development of papaya harvested at different stages of maturity with time.

Stage of maturity	Storage time in days			
	3	5	6	7
	Mean peel colour development			
Trace yellow	2.6c	4.3b	4.8b	5.6b
25% yellow	4.2b	4.8b	6.0a	6.6a
50% yellow	3.8b	4.8b	6.0a	6.7a
75% yellow	6.0a	6.5a	7.0a	-

Treatment means in a column having a common letter(s) are not significantly different by DMRT at 5%. Each data point represents the mean of 5 replicates.
P values under each column show the significant lèvel in Kruskal Wallis test. Peel colour index: 1= green, 2=colour break, 3=more green than yellow, 4= more yellow than green, 5= yellow with trace green 6= full yellow and 7= over ripe.

Sunken skin areas that fail to degreen in ripe papaya fruits are referred to as 'green island' (Quintana and Paull, 1993). Significantly higher levels of 'green islands' were observed in fruits harvested at trace yellow stage (Table 3). The severity of this disorder increased with storage time. A low (0.9 -1.2) severity of 'green islands' was recorded in fruits harvested at 50% yellow and 75% yellow stage. This shows that harvesting fruits at early stages of maturity aggravate the disorder. Quintana and Paull (1993) reported that 'green island' formation was induced by mechanical injury. They have further reported

that fruit with less chlorophyll in the peel or with active chlorophyll degradation at the time of mechanical injury takes place showed lesser incidence of 'green islands'. The results reported in this experiment confirm their findings, since all the fruits that developed 'green islands' were transported in plastic crates without packing material resulting more skin injuries due to vibration and bruising. The occurrence of a similar damage has been reported in cantaloupe fruits during transport (Hoffman and Young, 1982). Degree of Shriveling of ripe fruits was higher when they were harvested at the trace yellow stage (Table 3). A possible reason for this could be the less developed cuticle in trace yellow stage compared to other maturity stages. Apart from that, fruits can be subjected to bruising and abrasion damage more easily when the cuticle is less developed. Through the damaged areas, transpiration occurs rapidly and as a consequence shriveling increases.

Table 3.Mean 'green islands' formation and shriveling of papaya harvested at different stages of maturity during storage.

Stage of maturity	Storage time in days			
	3	5	6	7
	'Green islands'			
Mean of severity				
Trace yellow	2.8	3.4	4.2	4.3
25% yellow	1.6	1.9	2.2	1.2
50% yellow	1.2	1.0	1.1	1.2
75% yellow	0.9	1.0	0.9	0.9
P	0.15	0.003	0.002	0.005
Mean degree of shriveling fruit				
Trace yellow	1.2	1.4	2.7	3.2
25% yellow	1.1	1.4	2.7	3.2
50% yellow	0.9	1.1	1.2	1.4
75% yellow	0.9	0.9	1.0	1.0
P	0.767	0.735	0.014	0.004

Each data point represents the mean of 5 replicates. 'Green islands': 1= none, 2= few number of incidence, 3= moderate incidence, 4= high number of incidence and 5= very high number of incidence. Shriveling index: 1= no shriveling, 2= slight shriveling, 3= moderate shriveling and 4= severe shriveling.

No significant difference in the °Brix Value was observed with different stages of maturity (Table 4). These results show that papaya fruits harvested at the trace yellow stage have accumulated soluble solids similar to those harvested at advanced stages of maturity.

Table 4. Mean total soluble solids (°Brix) of fruits harvested at different stages of maturity.

Stage of maturity	Storage time in days			
	3	5	6	7
	Mean °Brix Value			
Trace yellow	13.0a	11.9b	11.8a	10.6a
25% yellow	13.9a	14.0a	11.6a	10.7a
50% yellow	13.7a	14.1a	12.0a	11.3a
75% yellow	11.3a	14.0a	10.5a	9.8a

Treatment means in a column having a common letter(s) are not significantly different by DMRT at 5%. Each data point represents the means of 5 replicates.

Table 5. Flesh colour, taste and overall acceptability of ripe papaya harvested at different stages of maturity.

Stage of maturity	Flesh colour	Taste	Overall acceptability
Trace yellow	2.6	2.0	2.1
25% yellow	2.7	2.7	2.8
50% yellow	2.8	2.9	2.9
75% yellow	2.7	2.7	2.7
P	0.903	0.043	0.014

Index: 1= poor, 2= acceptable and 3= very good.

There was no significant difference in the flesh colour of ripe papayas harvested at different stages of maturity (Table 5). Pigment development in the flesh of papaya harvested at trace yellow stage has taken place similar to those harvested at advanced stages of maturity. However, a significant reduction in the taste was recorded in papaya harvested at trace yellow stage (Table 5). A distinct latex flavour was observed in fruits harvested at trace yellow stage compared to those harvested at the other maturity stages. This latex flavour reduced overall acceptability in ripe papayas harvested at trace yellow stage. Results showed that there

was no significant taste difference among fruits harvested at 25%, 50% and 75% colour development stages. No significant difference in overall acceptability was recorded among fruits harvested at the other maturity stages.

Effect of packing material on the postharvest quality of ripe papaya

A higher incidence of 'green islands' was observed in fruits transported using dried straw as a packing material and also in the control (Fig. 1). Use of Styrofoam nets and newspapers significantly lowered the incidence of 'green islands'. However, the minimum incidence of green islands was recorded in fruits transported using Styrofoam nets. Wrapping individual fruits in Styrofoam net or newspaper prevents fruits from rubbing against each other and rubbing against rough surface of the crate. Minimizing impact, abrasion and vibration damages reduce the mechanical damage during transport. Reduced mechanical injuries result in lesser incidence of disorder. Spongy nature of Styrofoam nets helps absorb the mechanical forces and reduces the vibration damage during transport causing lesser skin damage (Balasuriya, 2001).

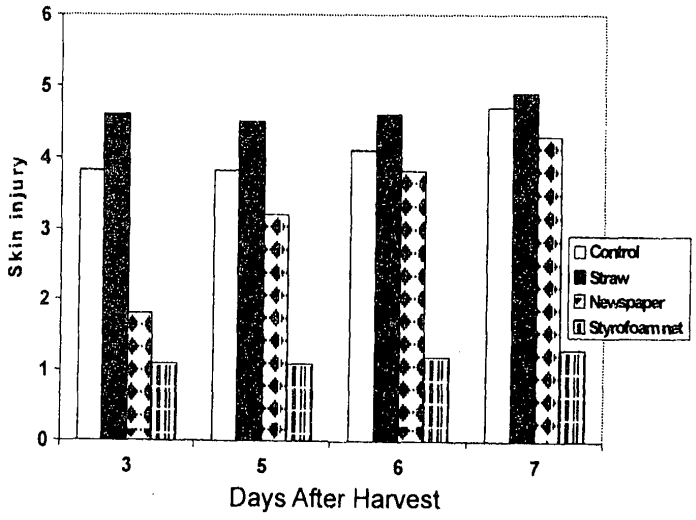

Figure 1. 'Green islands' formation of ripe papaya as affected by packaging used during transport

Fruits in the control had a higher disease incidence compared to those packed using newspaper and Styrofoam before transporting (Fig.2). Although dried straw widely used as a packing material during transport of papaya, it was observed that packing in straw results in disease development to a certain extent (1-1.5) after 6 days. The major factor that influences postharvest diseases of papaya is mechanical damage taking place during harvesting and transport. However, mechanical damage during transport would be minimal in papayas transported using Styrofoam nets. Similarly, individual wrapping of papaya using newspaper would have absorbed most of the mechanical forces by passing the very much-reduced effect to cause wounds. Relatively higher disease incidence in all fruits used for the experiment at 7 days of storage was due to over ripening. Fruits were at the table ripe stage at 5 - 6 days after harvesting.

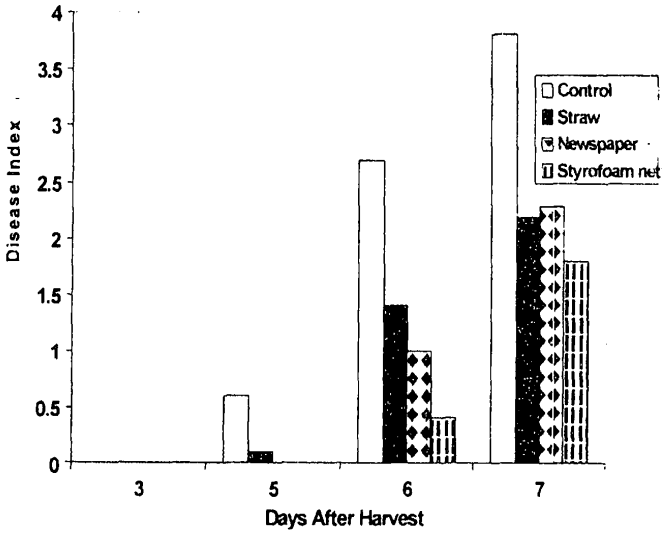

Figure 2. Disease incidence of papaya as affected by packaging used during transport

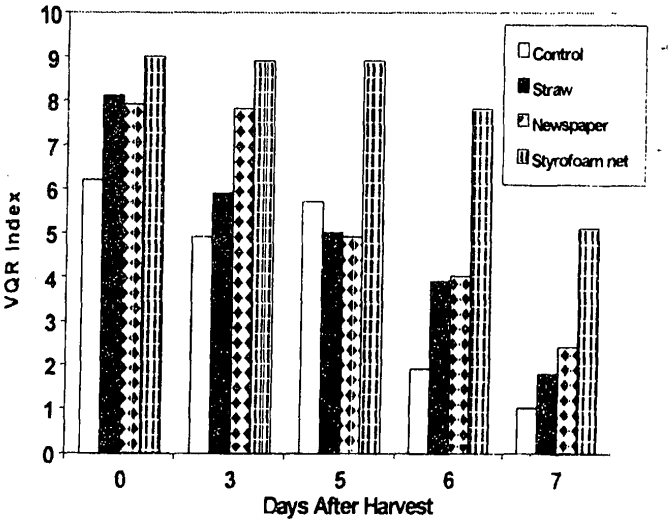

Figure 3. Visual quality rating of papaya as affected by packaging used during transport

Significantly higher visual quality rating was always observed in fruits packed with Styrofoam nets (Fig. 3). Absorbance of mechanical forces by Styrofoam nets during transport would have resulted in better quality fruits. In contrast a drastic reduction of VQR was observed in control fruits with ripening.

Effect of stage of maturity, packing material and hot water dip on 'green islands' formation of papaya.

Both stage of maturity at harvest and packaging materials used during transport showed significant results of 'green islands' formation (Table 6). However, the interaction effect of stage of maturity and packing was also significant. A significantly higher incidence of the disorder was recorded in fruits harvested at trace yellow stage. Stage of maturity did not affect the incidence of the disorder if fruits were harvested at 25% yellow and above. Aggravation of 'green islands' formation has been reported when 'Kapoho Solo' and 'Sunset Solo' papayas were subjected to hot water treatment (Quintana and Paull, 1993). The major cause for the disorder was mechanical injuries to the skin. There was a reduction in the disorder when papayas were transported using Styrofoam nets. These results confirm a reduction of mechanical damage when papayas were transported using Styrofoam nets.

Based on these results, 'Rathna' variety papaya must be harvested at 50% yellow stage in order to maintain best post harvest quality. Fruit harvested at this stage showed better physico-chemical parameters, taste and overall acceptability after ripening.Harvesting at 50% yellow stage together with damage free transporting, reduce the 'green islands' formation in ripe fruits.Styrofoam nets proved to be the best method of packing.

However, styrofoam nets can be replaced with newspapers for Papaya packing destined for the local market. If maturity and mechanical injuries are properly controlled, hot water treatment can successfully be applied to control postharvest diseases while minimizing 'green islands'.

Table 6. 'Green islands' formation of hot water treated papaya as affected by stage of maturity and packing material.

Treatment	Mean 'green Islands' Index	Significant level	Mean disease index	Significant level
Stage of maturity	4.2	0.05	2.6	NS
Packing material	4.8	0.05	2.8	NS
Stage of maturity × Packing Material	5.2	0.05	3.6	NS

Green islands: 1= none, 2= few number of incidence, 3=moderate incidence, 4= high incidence and 5= very high number of incidence.
Disease index: 1=slightly diseased, 2=moderately diseased, 3= high disease and 4= very high disease.

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