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Effect of pretreatment and packaging on quality of fresh cut jackfruit (*Artocarpus heterophyllus* L.) Bulbs

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Abstract
The effect of pre-treatment and different packaging to enhance the postharvest shelf-life of fresh cut jackfruit (*Artocarpus heterophyllus* L.) bulbs under refrigerated storage was investigated. The packages studied include low density polyethylene (LDPE) and high density polyethylene (HDPE) of 100 gauge, cling film, vacuum packaging, stand on pouches and shrink film. Jackfruit bulbs after separation from fruit were imposed a pre-treatment with $CaCl_2$(1%) along with combination of ascorbic acid (0.25%) and packed in different packages. The physico-chemical and sensory attributes revealed that, pre-treatment and packaging was found to be most effective in maintaining ascorbic acid content and minimizing deteriorative changes in sensory attributes and minimum moisture loss. Based on sensory evaluation it was inferred that pretreated and vacuum packing of bulbs resulted in maximum shelf life (33 days) whereas, lowest shelf life was observed in bulbs packed with shrink film (17.67 days).

Keywords: Fresh cut, packaging, refrigerated storage, calcium chloride, ascorbic acid, quality

Introduction
Jackfruit (*Artocarpus heterophyllus* L.) is a major tropical fruit popular in the rain forests of India, Bangladesh, Sri Lanka, Southern China, Southeast Asian countries and with limited production in Australia, Mauritius, Brazil, Surinam, Jamaica, Mexico, Hawaii and Southern Florida (Samaddar, 1985). Azizur Rahman *et al.* (1999) [1] described the fruit as a rich source of carbohydrates, minerals, carboxylic acids,dietary fiber andvitamins suchasascorbic acid and thiamine.

Consumers prefer eating the fruit in its fresh form but the edible fleshy pericarp amounts only 35 percent of the whole fruit, which is often prone to flavour loss, tissue softening, cut-surface browning and post- harvest decay (Narasimham, 1990). Minimally processed jackfruit bulbs can provide convenience for consumers and an appropriate post-harvest technology for shelf-life extension may facilitate easy transportation from production sites to far off market centers.

It is known that beneficial atmospheres within the fruit packages are attained by correctly choosing packaging materials that will provide the appropriate levels of oxygen and carbon dioxide in the packets. Polymers and gas mixturesfor packaging fresh-cut produce should be optimized for each commodity. Variations inpermeability of packaging films like low density polyethylene (LDPE), high density polyethylene (HDPE), cling film, vacuum packaging, stand on pouches and shrink film usedforpackaging affect the qualityof the product. Packaging and low temperature storage alone are usually not sufficient to extend the shelf-life of the pre cut product as the excessive physiological stress and increased susceptibility towards microbial spoilage caused by processing operations like cutting and slicing reduce their shelf-life significantly.

The use of post-harvest dip pre-treatment consisting of certain chemical preservatives such as calcium chloride along with ascorbic acid at minimum levels during minimal processing have been found to be beneficial in minimizing the stress-induced metabolism, maintaining firmness, reducing browning reaction and improving organoleptic quality of various produce along with extension of their shelf-life (Soliva Fortuny *et al.*, 2002; Martinez Ferrer *et al.*, 2002) [8, 4]. These chemical additives with various modified atmosphere packaging techniques at low temperature conditions was found beneficial in reducing decay, maintaining quality and extending the shelf-life of minimally processed produce (Cocci *et al.*, 2006) [2].

The present study was undertaken to investigate the influence of pre-treatment and packaging in enhancing the post-harvest shelf-life and quality of minimally processed jackfruitbulbs under refrigerated conditions.

Material and Methods

Sample preparation

Fresh, healthy, matured, uniform sized and good quality ripe jackfruits of *cv*. Maddur white were selected from the Jack garden, College of Horticulture, Kolar, Karnataka, India. The fruits were cut into convenient halves using sharp stainless steel knives smeared with vegetable oil to avoid sticking. The bulbs were separated from rind and core of the fruit.

Pre-treatments

Jackfruit bulbs were subjected to pretreatment with calcium chloride 1% and ascorbic acid 0.25% further packed in different packages*viz*., T_1= Low density polyethylene(LDPE 100 gauge); T_2= High density polyethylene (HDPE 100 gauge); T_3=Cling film ; T_4=Vacuum packaging; T_5 =Stand on pouches; T_6=Shrink film. Jackfruit bulbs were pre-treated for 5 minutes and drained the excess solution. Jackfruit bulbs were packed in different packages of 250 g each and stored under refrigerated condition. The jackfruit bulbs were analyzed for bio-chemical composition during storage at regular intervals. The experiment was carried out with six different treatments and four replications, using completely randomized design.

Fresh cut jackfruit bulbs were analyzed for ascorbic acid, moisture, shelf life, and sensory attributes during refrigerated storage. Various physico-chemical characteristics of the minimally processed jackfruit bulbs were analysed as per the standard methods. Moisture was analysed using electronic moisture analyzer (Model: MA 35) and the direct reading was noted down from the instrument screen and expressed in percent.

Ascorbic acid was determined by 2, 6- Dichlorophenol-Indophenol titration method. The capacity of a sample to reduce a standard dye solution is directly proportional to the ascorbic acid content. The vitamin C was expressed as ascorbic acid (mg $100g^{-1}$).The sensory attributes of samples were evaluated in terms of colour, odour, taste, texture, and overall acceptability by using a nine point hedonic scale (9: Like extremely; 8: Like very much 7: Like moderately; 6: Like slightly; 5: Neither like nor dislike; 4: Dislike slightly; 3: Dislike moderately; 2: Dislike very much; 1: Dislike extremely). The number of days the minimally processed jackfruit bulbs were in edible condition was taken as the shelf-life or keeping quality of ripe fruits.

Results and Discussion

Ascorbic acid (mg 100g $^{-1}$)

Ascorbic acid content in fresh cut jackfruit bulbs has decreased significantly in all treatments during storage (Figure 1). Better retention of ascorbic acid (27 mg 100^{-1} g) at the end of 33 day was observed in pretreatment with $CaCl_2$(1%) along with ascorbic acid (0.25%) and packed in vacuum packaging, followed by the samples packed in stand on pouches recorded 26 mg 100^{-1} g of ascorbic acid content at 33 day of refrigerated storage. Addition of ascorbic acid during dip pre-treatment resulted in a 3.5 fold increase in ascorbic acid content in pre-treated samples (Saxena *et al*., 2009) [7]. Use of ascorbic acid could maintain the visual quality of the produce with restricted browning. Higher retention of ascorbic acid in fresh-cut commodities (Odriozola-Serrano *et al*., 2008) [5] and the commodities subjected to pre-treatment with additives such as citric acid and ascorbic acid (Cocci *et al*., 2006) [2] The lower retention of ascorbic acid content (18.99 mg 100^{-1} g) was recorded in the sample packed in shrink film at the end of 15th day of refrigerated storage.

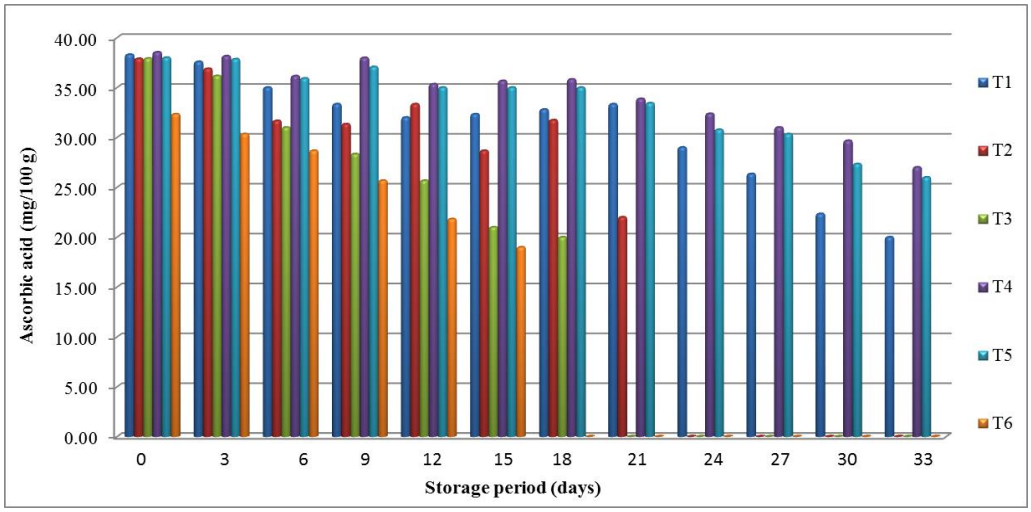

Fig 1: Effect of pretreatment ($CaCl_2$ 1% + AA 0.25%) and packaging on ascorbic acid(mg 100 g^{-1}) content of fresh cut jackfruit bulbs in refrigerated condition

T_1 – $CaCl_2$ 1% with AA 0.25% + LDPE (100 gauge)	T_2 - $CaCl_2$ 1% with AA 0.25% + HDPE (100 gauge)
T_3 - $CaCl_2$ 1% with AA 0.25% + Cling film	T_4 - $CaCl_2$ 1% with AA 0.25% + Vacuum packaging
T_5 - $CaCl_2$ 1% with AA 0.25% + Stand on pouches	T_6 - $CaCl_2$ 1% with AA 0.25% + Shrink film (100 gauge)

Moisture (percent)

The moisture content of fresh cut jackfruit bulbs recorded significant variation among treatment during refrigerated storage. The data depicted in Table 1 implies that the moisture content of 76.66 percent in vacuum packed samples (T_4), 75.33 percent in stand-on -pouch packaged samples (T_5) on 5th week of refrigerated storage. However, shrink film wrapped samples (T_6) showed highest loss of moisture

content (68.80%) at the end of 2nd week as compared to other packaged samples. The moisture loss increases due to respiration and greater susceptibility to wilting. Cutting and slicing increases moisture loss from cut surface, which is an important factor in quality loss (Gorny *et al*., 2000).

Table 1: Effect of pretreatment ($CaCl_2$ 1% with AA 0.25%) and packaging on moisture content (%) of fresh cut jackfruit bulbs in refrigerated storage

Treatments	Storage period (weeks)					
	0	1	2	3	4	5
T_1	79.92	78.65	76.77	76.77	74.66	71.00
T_2	79.61	78.31	77.00	72.00	-	-
T_3	79.61	77.33	74.67	69.87	-	-
T_4	79.60	78.67	78.33	77.33	77.00	76.66
T_5	79.48	78.64	77.33	77.00	76.33	75.33
T_6	79.61	74.33	68.80	-	-	-
F -test	**	**	**	**	**	**
SEm±	0.271	0.654	0.636	0.603	0.349	0.349
CD at 1%	1.171	2.828	2.747	2.605	1.406	1.406

Sensory evaluation

Pre-treated jackfruit bulbs packed in different packages showed significant low sensory scores in terms of overall acceptability of minimally processed jackfruit bulbs during storage (Table 2). Sensory attributes of minimally processed jackfruit bulbs showed higher ratings by the sensory panel i.e., 8.0 at 5th week for bulbs treated with calcium chloride 1% and ascorbic acid 0.25% packed in vacuum packing (T_4) due to better retention of colour, texture, odour, taste and overall acceptability. Saxena *et al*. (2008) [6] reported that the use of preservatives in minimally processed jackfruit bulbs should be at minimum levels not to alter the sensory attributes of the product. The judges had least preference for T_6 sample with sensory scores of 6.67 at 2nd week of refrigerated storage. Lowest overall acceptability scores were obtained for bulbs without treatment stored under refrigerated condition and they were detected with off-odour and off-flavour, these results were in confirmation with (Saxena *et al*., 2008) [6] in minimally processed jackfruit.

Calcium chloride (1%) along with ascorbic acid (0.25%) in synergy with vacuum packaging was very effective in maintaining the fresh-like quality of the minimally processed jackfruit bulbs.

Table 2: Effect of pretreatment ($CaCl_2$ 1% with AA 0.25%) and packaging on overall acceptability of fresh cut jackfruit bulbs in refrigerated storage

	Storage period (weeks)					
Treatments	0	1	2	3	4	5
T_1	9.00	8.33	8.67	8.00	7.33	6.33
T_2	9.00	8.67	8.33	6.33	-	-
T_3	9.00	8.33	7.33	6.00	-	-
T_4	9.00	9.00	9.00	8.67	8.33	8.00
T_5	9.00	9.00	8.67	7.67	8.00	7.33
T_6	8.66	7.67	6.67	-	-	-
F test	**	**	**	**	**	**
SEm±	0.136	0.272	0.235	0.182	0.235	0.192
CD at 1%	0.587	1.175	0.948	0.734	0.948	0.831

** Significant @1% --Terminated $CaCl_2$ – Calcium chloride AA – Ascorbic acid

Shelf-life

Shelf life of minimally processed jackfruit bulbs pretreated with $CaCl_2$at 1% in combination of ascorbic acidat 0.25% packed in different packages shown in Fig. 2, during refrigerated storage. Based on sensory attributes, juice leakage from the bulbs the shelf life of vacuum packaged samples (T_4) extended shelf life up to 33 days followed by 32.67 days in stand-on-pouch packaged bulbs (T_5).

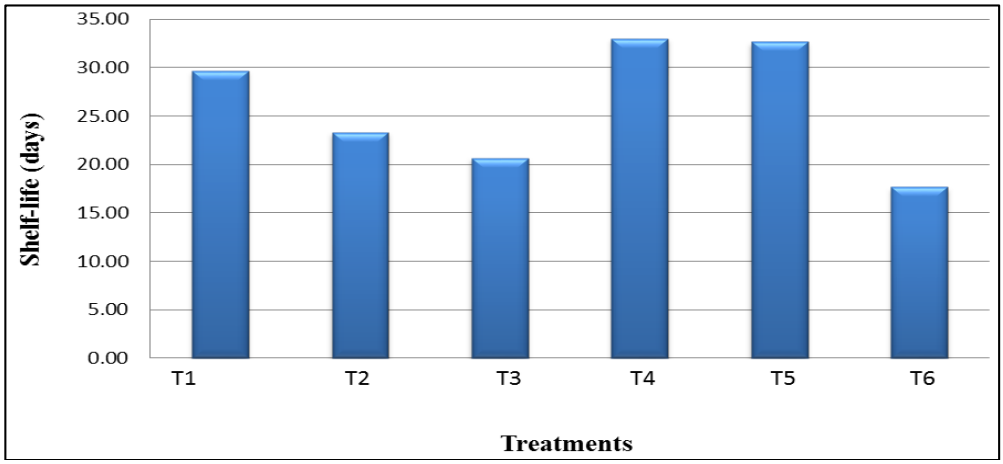

Fig 2: Effect of pretreatment ($CaCl_2$ 1.0% + AA 0.25%) and packaging on shelf-life of fresh cut jackfruit bulbs in refrigerated condition

T_1 – $CaCl_2$ 1% with AA 0.25% + LDPE (100 gauge)	T_2 - $CaCl_2$ 1% with AA 0.25% + HDPE (100 gauge)
T_3 - $CaCl_2$ 1% with AA 0.25% + Cling film	T_4 - $CaCl_2$ 1% with AA 0.25% + Vacuum packaging
T_5 - $CaCl_2$ 1% with AA 0.25% + Stand on pouches	T_6 - $CaCl_2$ 1% with AA 0.25% + Shrink film (100 gauge)

Conclusion

Jackfruit present problem is difficult to eat fruit. It is cumbersome to cut and separate bulbs in order to get ready to consume. The shelf life of the bulbs after separation from fruit is also limiting its consumption. The results of the present experiment proved that jackfruit bulbs pretreated with 1% $CaCl_2$ and 0.25% ascorbic acid combined with vacuum packaging and stand-on-pouch enhanced the shelf life up to 33 days and retained fresh like quality.

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