Preservation of tender jackfruit (*Artocarpus heterophyllus* Lam.) with hurdle technology

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ABSTRACT

Jackfruit, *Artocarpus heterophyllus* is a typical Indian fruit. Different stages of jackfruit is being utilised for several purposes in various parts of India. The present study reports the use of hurdle technology in pre-cut form of tender jackfruit. Hurdle technologies applied include in-pack sterilisation, use of food additives, mild heat treatment and gamma irradiation. The treated samples were then stored at room and subroom temperature for further studies. The results suggested that the product developed can remain excellent for over one year even after the next harvest of the tender fruit assuring continuous supply of this seasonal fruit.

Keywords: *Artocarpus heterophyllus* Lam, tender jackfruit, post harvest preservation, hurdle technology, gamma irradiation

Jackfruit, *Artocarpus heterophyllus* Lam. is a typical Indian fruit mainly grown in West Bengal, Bihar, Assam and the West Coast of India. It is also cultivated throughout Burma, Ceylon, Southern China, Malaya, East Indies and Philippines. In India, jackfruit is consumed from its tender stage to its ripe form. It is used as a starchy vegetable for curry preparations in tender stage and as a dessert fruit while ripe [1]. Edible bulbs of ripe jackfruit are consumed for their fine taste and pleasant aroma. Though several studies were carried out on ripe fruit, aroma and preservation, comparatively little information is available on tender jackfruit. Even though the season of jackfruit is from December to June, its tender form is available only for a short period of December to February. After its differentiation, it remains in the tender form only for two to three weeks. Tender Jackfruit on storage without any processing or treatment was found to be deteriorating by browning. Basic characteristics like texture, colour, flavour and aroma vary drastically when it differentiates to other stages during maturation. Hence any technology developed to preserve the tender fruit without losing its flavour, aroma and taste could be of immense value to the jackfruit processing technology. Since there are no studies on preservation of tender jackfruit, the present study was performed to develop a technology to preserve tender jackfruit with its flavour retention. According to Brown and Williams [2], shelf life testing is carried out by holding representative samples of the final product under conditions likely to mimic those that the product will encounter from manufacturer to consumption.

Tender jackfruits were collected from local market. Conventional methods were employed in order to identify the maturity of the fruit. Since the cut opened tender jackfruit deteriorates by browning, the cut portions were immediately dipped in 0.9% sodium chloride and 1.0% turmeric to
retain the colour and texture. Since tender fruits are devoid of seeds, the whole fruit was used for processing and treatment after separating the pericarp and central spongy stem. Ascorbic acid, salt, turmeric and calcium chloride were used as additives for the treatment of tender jackfruit. Ascorbic acid was used as antioxidant to avoid the browning of fruit besides contributing to the nutritional quality of fruit. Calcium chloride retains the texture and toughness of jackfruit. Numerous studies reported improvements in fruit and vegetable firmness when supplemental calcium is supplied [3-5]. The pre-cut samples were treated with the selected combinations of additives along with mild heat treatment.

Tender jackfruits were cut into small uniform pieces and dipped in solution with selected combinations of food additives. Mild heat treatment (60°C) was given to samples treated with preservatives for 15 minutes. Then pieces were sieved out of the solution using a sterile colander. Samples were dried in sterile blotting paper after sufficient heat treatment. Samples were then packed to polypropylene bags under aseptic conditions. Appropriate formulations of the additives were decided after the trial of all combinations. The samples were thus treated using 0.9% sodium chloride + 1.0% turmeric and 0.75% calcium chloride + 0.3% ascorbic acid + 0.9% sodium chloride + 1.0% turmeric.

Gamma irradiation of tender jackfruit samples at different doses showed the dose dependency of jackfruit in extending the shelf life. Gamma irradiation has proved to be effective in reducing bacterial and mold contamination, inactivating food-borne pathogens [6-12]. Gamma radiation doses of 1 K Gy, 3 K Gy and 5 K Gy were applied to the pre-processed and packed samples. Proper controls were also maintained for each additive as well as for radiation processing. After irradiation, these samples were stored at both room and subroom temperature (10°C). Samples after hurdle technology were stored at room and subroom temperature for further storage studies. Organoleptic evaluation was performed to see the retention of quality of stored and fresh samples. Evaluation was done using a hedonic scale of 10 to 1 on a weekly basis.

Nutritional assessment of stored samples was performed by analysing total soluble solids (TSS) and total insoluble solids (TIS). About 1 g of weighed sample was ground well with 5 ml water and centrifuged at 10000 rpm for 30 minutes. Supernatant and pellet were collected in the pre-weighed Petri plates and kept for drying at 60°C in hot air oven. Weight was measured in every 12 hours for first two days and then in every 3 hrs afterwards. Weighing continued until two consecutive weights were identical for each sample. Then the weight of supernatant alone calculated as TSS value and weight of pellet calculated as TIS value. Fresh samples were also used for comparative analysis of stored tender jackfruit samples. Microbiological analysis was also performed by plating the samples to nutrient agar and potato dextrose agar media.

The product quality and consumer acceptability of the samples were determined using the products prepared out of it. An Indian culinary called ‘thoran’ or ‘subji’ was prepared using the treated and control tender fruit samples for organoleptic evaluation on a weekly basis. In organoleptic evaluation, sensory qualities were analyzed for appearance, colour, odour, flavour and texture. Texture was assessed by conventional methods. Overall acceptability was determined using a hedonic scale of 10 to 1, (10 - excellent; 1 - bad). Organoleptic evaluation showed that the combination with calcium chloride giving good texture as the toughness of sample is maintained compared to other samples. Similar result in minimizing tissue damage and retaining quality of fruits during processing using calcium chloride treatment is reported earlier [6]. Combinations with turmeric were found to have good shelf life extension with the retention of flavour and aroma. Though a number of combinations were tried with different concentrations of additives, only a few combinations were found to be successful in retaining the taste without spoilage. Use of individual additives was not as successful as the combinations in extending the shelf life. Use of gamma radiation along with additives further helped to extend the shelf life considerably when compared with those with the additives alone. Positive result for a combination of calcium chloride and
gamma radiation in retaining the quality as well as shelf life of fruits is already reported by Hussain et al. [6]. Shelf life extension obtained by different samples is presented in table 1. This result suggested that the product developed in these conditions can remain excellent for a long time even after the next harvest of the tender fruit assuring continuous supply of this seasonal fruit.

Table 1. Shelf life stability of processed tender fruits using hurdle technique.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Texture</th>
<th>Flavour and Aroma</th>
<th>Consumer Acceptability</th>
<th>Shelf-life (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>7.4</td>
<td>7.3</td>
<td>7.1</td>
<td>4</td>
</tr>
<tr>
<td>Sample 1 (1 K Gy)</td>
<td>5.9</td>
<td>6.0</td>
<td>6.0</td>
<td>6</td>
</tr>
<tr>
<td>Sample 2 (3 K Gy)</td>
<td>6.0</td>
<td>6.6</td>
<td>6.3</td>
<td>25</td>
</tr>
<tr>
<td>Sample 3 (5 K Gy)</td>
<td>6.1</td>
<td>5.8</td>
<td>6.0</td>
<td>37</td>
</tr>
<tr>
<td>Sample 4 (0.75% calcium chloride + 0.3% ascorbic acid + 0.9% sodium chloride + 1.0% turmeric)</td>
<td>5.9</td>
<td>5.7</td>
<td>5.9</td>
<td>4.7</td>
</tr>
<tr>
<td>Sample 5 (0.9% sodium chloride + 1.0% turmeric)</td>
<td>6.0</td>
<td>5.6</td>
<td>5.8</td>
<td>10.5</td>
</tr>
<tr>
<td>Sample 6 (0.75% calcium chloride + 0.3% ascorbic acid + 0.9% sodium chloride + 1.0% turmeric) + 1 K Gy</td>
<td>5.5</td>
<td>5.4</td>
<td>5.5</td>
<td>10.4</td>
</tr>
<tr>
<td>Sample 7 (0.75% calcium chloride + 0.3% ascorbic acid + 0.9% sodium chloride + 1.0% turmeric) + 3 K Gy</td>
<td>6.0</td>
<td>6.0</td>
<td>5.9</td>
<td>60</td>
</tr>
<tr>
<td>Sample 8 (0.75% calcium chloride + 0.3% ascorbic acid + 0.9% sodium chloride + 1.0% turmeric) + 5 K Gy</td>
<td>7.0</td>
<td>6.0</td>
<td>6.4</td>
<td>68</td>
</tr>
<tr>
<td>Sample 9 (0.9% sodium chloride + 1.0% turmeric) + 1 K Gy</td>
<td>6.0</td>
<td>5.7</td>
<td>5.8</td>
<td>13.4</td>
</tr>
<tr>
<td>Sample 10 (0.9% sodium chloride + 1.0% turmeric) + 3 K Gy</td>
<td>6.7</td>
<td>6.2</td>
<td>6.4</td>
<td>68</td>
</tr>
<tr>
<td>Sample 11 (0.9% sodium chloride + 1.0% turmeric) + 5 K Gy</td>
<td>6.4</td>
<td>6.1</td>
<td>6.3</td>
<td>68</td>
</tr>
</tbody>
</table>

The data also suggested that the hurdle technology could extend the shelf life more than that of the individual treatments of additives or of radiation. Among different doses of gamma radiation applied, 3 K Gy and 5 K Gy were effective in extending the shelf life without losing its flavour and aroma. Hence 3 K Gy could be considered as the optimum dose for best results. Organoleptic evaluation of preserved jackfruit samples suggested that samples 7, 8, 10 and 11 were maintained at subroom temperature without any damage for over one year. Evaluation results showed that they were as fresh as the fresh jackfruit samples even after the storage of one year. Those preserved samples were taken for the quality analysis by measuring their total soluble solids (TSS) and total insoluble solids (TIS).

Total soluble solids (%) and total insoluble solids (%) of treated samples (samples 7, 8, 10 and 11) showed that those samples could maintain the quality with the retention of total soluble and insoluble solids as good as the fresh one even after the storage over one year. The values obtained are based on the weight of the whole tissue. The data obtained are the average of at least three independent experiments. Results revealing the similarity of TSS and TIS of treated samples with that of fresh tender jackfruit indicate that there was no degradation or fermentation of any sort.
happening in the tissue during the storage of the samples. This showed that even after the storage of samples over one year, the nutritional adequacy is completely retained in the samples. This opens a way to make the tender jackfruit available throughout the year.

Various preservation strategies had been optimised for different fruits and vegetables. Preservation of tropical fruits like jackfruit is always been a challenge as these fruits are prone to earlier deterioration compared to other fruit varieties. Though several studies were carried out on ripe stages of jackfruit, researchers thus far have not given much importance to tender stage of fruit. It is to be noted that it is a delicacy in southern part of India. The above study suggested that the tender jackfruit with mild heat treatment and hurdle technology involving gamma radiation can extend the shelf life for over one year. These studies can be exploited to commercialise the tender jackfruit availability round the season. A few varieties of jackfruits are known for its slimy and soft nature when ripened. This study could be a path breaker for the utilisation of such highly nutritive fruits. Also, the availability of tender fruits in packets can attract jackfruit lovers from all parts of India as well as overseas.

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REFERENCES