EVALUATION OF EVAPORATIVE COOL CHAMBERS USING ALTERNATIVE MATERIALS FOR STORAGE OF HORTICULTURAL PRODUCE

Yogender Singh and Y.K. Yadav*

Department of Agricultural Processing and Energy
CCS Haryana Agricultural University, Hisar – 125 004, India

Received : 23-08-2010           Accepted : 29-11-2010

ABSTRACT

Study was conducted to evaluate performance of evaporative cool chambers using river bed sand and rice husk ash as alternative materials. Round the year performance was evaluated on the basis of the average environmental conditions of the four seasons. Two evaporative cool chambers were evaluated for round the year use for storage of horticultural produce and shelf life was studied inside evaporative cool chambers and ambient conditions. The average temperature inside the evaporative cool chamber with river bed sand (ECC RBS) and the evaporative cool chamber with rice husk ash (ECC RHA) was 8.6°C and 10.7°C lower whereas average relative humidity was 53% and 57% higher than the ambient, respectively. The shelf life of the horticultural produce kept inside the evaporative cool chambers could be enhanced significantly as compared to ambient storage and the evaporative cool chamber with rice husk ash (ECC RHA) was found to be more effective.

Key words : Evaporative cool chambers, Alternative materials, Storage, Horticultural produce.

INTRODUCTION

India stands second in the world for fruits and vegetables, production and owing to the remarkable diversity of its geographical conditions, produces a great variety of these invaluable horticultural produce for common use. The fruits and vegetables consumption in India is mainly in the fresh form. It is essential that they are stored in a system that can maintain their freshness until when consumed without any noticeable physiological disorder. It has been estimated that the post-harvest losses of horticultural produce in India are of the order of 20-30 percent (Chandra and Kar, 2004). Evaporative cooling principle has been found to be an efficient, economical, environmental friendly and healthy means for reducing the temperature and increasing the relative humidity in an enclosure and has been extensively tried for increasing the shelf life of horticultural produce. The low-cost evaporative cool chambers (zero energy cool chambers) are reported to enhance shelf life of fruits and vegetables by lowering down the temperature and maintaining high humidity inside the chamber (Dadhich et al., 2008). The EC chambers need not be commodity specific and can be used for storage of any produce that can withstand the temperature and relative humidity ranges of these structures. The evaporative cool chambers have also been proved useful specially for storage of potato meant for further processing (Shekhawat et al. 1992) or for uniform ripening of tomato (Gopalakrishna et al., 1990) and mango (Pal and Roy, 1995) and citrus fruits (IARI, 1985). Alternative materials for the evaporative cool chambers and proper operational schedule was investigated to offer a better economic picture for these types of structures.

*Corresponding author’s E mail: profykyadav@yahoo.co.in
MATERIALS AND METHODS

Two evaporative cool chambers of 0.37 m³ capacity each (Fig. 1) were constructed with the help of baked bricks for safe storage of fresh fruits and vegetables. Two platforms of 165 cm x 115 cm were prepared with single layer of bricks. A double layered wall on all four sides around both the platforms was erected with the bricks leaving approximately 7.5 cm space to a height of 67.5 cm. River bed sand was filled into the gap in one whereas the other was filled by rice husk ash. Once the evaporative cool chambers were saturated with water, the river bed sand and rice husk ash were kept moist with optimum quantity of water through drip system with plastic pipes and micro tubes connected to an overhead water tank. Experimental tests were carried out in the Department of Agricultural Processing and Energy, College of Agricultural Engineering and Technology, CCS HAU, Hisar. The temperature was recorded using digital thermometer attached to thermocouples located at the centre of the evaporative cool chambers and ambient environment. The relative humidity of air was monitored with digital thermo hygrometer located at the centre of the evaporative cool chambers and in an open air where the commodities were stored. The data was collected throughout the day at an interval of one hour to study the temperature and relative humidity profile inside and outside of the evaporative cool chambers for round the year use. The shelf life of fruits and vegetables stored in evaporative cool chambers was compared on the basis of physico-chemical parameters and overall acceptability. The fruits and vegetables were organoleptically evaluated by semi-trained panel members by using 9-point hedonic rating scale. The samples were evaluated for appearance, taste; aroma etc. and mean of all these characteristics was expressed as overall acceptability score of the sample.

The performance of both the evaporative cool chambers was compared on the basis of cooling efficiency.

Cooling Efficiency (CE)

\[
CE (%) = \frac{T_a - T_s}{T_a - T_w} \times 100
\]

- \( T_a \) = dry bulb temperature of ambient air, °C
- \( T_s \) = dry bulb temperature of the cooled space air, °C
- \( T_w \) = wet bulb temperature of ambient air, °C

RESULTS AND DISCUSSION

Thermal performance of the evaporative cool chambers for round the year at no load

Thermal performance of the evaporative cool chambers for round the year at no load was evaluated on the basis of average dry bulb temperature, average relative humidity and average cooling efficiency. Fig. 2 shows the effect of day time on ambient and evaporative cool chambers air temperatures averaged for round the year. The air temperature inside the evaporative cool chamber with river bed sand (ECC RBS) and the evaporative cool chamber with rice husk ash (ECC RHA) ranged from 21.1°C to 24.2°C and 20.4°C to 22.1°C, respectively when the dry bulb temperature of ambient air varied from 28.8°C to 34.0°C with an insolation level of 217 W/m² to 836 W/m². The average difference in dry bulb temperature between ambient and ECC RBS was 8.6°C and between ambient and ECC RHA was 10.7 °C.

The evaporative cool chambers consistently recorded higher relative humidity then ambient (Fig.3). The average relative humidity in ECC RBS and ECC RHA varied from 88% to 93% and 94% to 97%, when the ambient relative humidity varied from 29% to 52%. The average difference in relative humidity between ambient and ECC RBS was 53% and ambient and ECC RHA was 57%, respectively.
FIG. 1: Structural details of evaporative cool chamber.

FIG. 2: Effect of day time on average dry bulb temperature of ambient environment and evaporative cool chambers for round the year no load.
Fig. 3: Effect of day time on average relative humidity of ambient environment and evaporative cool chambers for round the year at no load.

Fig. 4: Effect of day time on yearly average cooling efficiency of evaporative cool chambers for round the year at no load.

Fig. 4 shows that the cooling efficiency of the evaporative cool chambers ranged from 58% to 69% and 72% to 83% in ECC RBS and ECC RHA, respectively. The average difference in cooling efficiency between ECC RBS and ECC RHA was 14%.
The results are in conformity with the findings of Dadhich et al. (2008) for the evaporative cool chamber with river bed sand.

**Shelf life of horticultural produce stored in evaporative cool chambers**

The shelf life of fruits and vegetables in summer as well as in winter was studied in both evaporative cool chambers. The various physico-chemical parameters were monitored continuously and overall acceptability was assessed for the shelf life. The experimental results presented in Table 1 shows that the evaporative cool chambers has remarkable potential for extending the shelf life of fruits and vegetables. The evaporative cool chambers were more effective in summer as compared winter and the shelf life could be increased significantly. The extension of shelf life of fruits and vegetables stored in evaporative cool chamber may be attributed to the combined affect of the low temperature and high humidity maintained in evaporative cool chambers. Dash et al. (2006) reported that the evaporative cooling has the capabilities to maintain lower temperature and high humidity having enough promise for short term storage of fresh produce.

The ECC RHA established its superiority in terms of thermal performance as well as the extension in shelf life of fresh fruits and vegetables and lesser loss in quality.

**CONCLUSION**

It may be concluded that evaporative cool chamber with rice husk ash (ECC RHA) established its superiority in terms of thermal performance as well as the extension in shelf life of fresh fruits and vegetables and lesser loss in quality. The evaporative cool chamber with rice husk ash as alternative material was found to be more effective as it maintained the quality and enhanced the shelf life by more than double for the commodities stored in it for round the year. The proposed evaporative cool chamber with rice husk ash (ECC RHA) can be used for on farm storage of fresh fruits and vegetables in place of evaporative cool chamber with river bed sand (ECC RBS).

**REFERENCES**


<table>
<thead>
<tr>
<th>Commodity</th>
<th>Season</th>
<th>Ambient condition</th>
<th>ECC RBS*</th>
<th>ECC RHA**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td>Summer</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Cucumber</td>
<td>Summer</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Guava</td>
<td>Winter</td>
<td>4</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Kinnow</td>
<td>Winter</td>
<td>6</td>
<td>15</td>
<td>24</td>
</tr>
</tbody>
</table>

* Evaporative cool chamber with river bed sand

** Evaporative cool chamber with rice husk ash.

The ECC RHA established its superiority in terms of thermal performance as well as the extension in shelf life of fresh fruits and vegetables and lesser loss in quality.