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ON-FARM STORAGE OF LEMONS AND TOMATOES BY LOW COST ZERO ENERGY COOL CHAMBER

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ABSTRACT

On-farm, low cost zero energy cool chamber with small capacity was constructed at the Faculty of Agriculture of the Eastern University, Sri Lanka by using locally available materials. The doubled walled chamber constructed of bricks, sand and straw is kept soaked with water. The evaporative cooling effect reduced the inside temperature by as much as 13-15^{0} C and kept the relative humidity above 90% during peak hot season. It was found that this chamber could also maintain temperature at 8-12^{0}C lower than the ambient temperature with relative humidity of around 90% in normal days. Freshly harvested lemon and tomato fruits were used for evaluating their storage performance in this chamber. The cool chamber was found to increase the shelf life of lemons and tomatoes and reduced the physiological loss in weight appreciably as compared to room temperature. Higher firmness due to delay in ripening and delay in increase of total soluble solids, increasing the total sugars, decrease in acidity and less rotting of fruit was observed leading to recovery of higher percent marketable fruits. Lemon and tomato fruits could be stored in cool chamber up to 16 and 12 days as against 7 and 4 days at room temperature(32^{0}C) respectively.

Key words: Zero energy, cool chamber, Physiological loss in weight, Shelf life, Shrivelling, Temperature, Relative humidity, Total soluble solids.

INTRODUCTION

The shelf life of horticulture produce is dependent upon variety, preharvest crop management, postharvest technology etc. A huge quantity of fruits and vegetables are wasted due to lack of proper on-farm storage facilities. The ancient Egyptians used a primitive form of evaporative cooling dating back to 2500 B.C and so did Moghals for better living during hot summer. Evaporative cooling consists of a wet porous bed through which air is drawn, cooled and humidified by evaporation of water. Water during the process of evaporation takes the heat from its surrounding to effect cooling. Based on the principle of direct evaporative cooling, Scientists of the Indian Agricultural Research Institute developed a Zero Energy Cool Chamber using locally available materials such as bricks, sand and bamboo (Roy and Khurdiya, 1986). Continuous research has been carried out on the zero energy cool chamber storage of fruits, vegetables, flowers, propagation materials, processed products and production of mush room. The zero energy cool chamber is being widely used by many farmers in India. (Wasker and Roy, 2000). However, it needs to be tested in our condition for its storage performance. Therefore, the present study was undertaken at the Faculty of Agriculture, Eastern University, Sri Lanka to investigate the efficacy of low cost on-farm zero energy cool chamber in our condition for improving quality and extending shelf life of lemons and tomatoes.

MATERIALS AND METHODS

Design and Construction of cool chamber

Small size zero energy cool chamber was constructed as described by Roy and Pal (1991) at the farm of Faculty of Agriculture, Eastern University, Sri Lanka. Raw materials required for the construction of the cool chamber were: bricks, sand , straw and bamboo. The floor space was made with a single layer of bricks. The side walls were made with a double layer of bricks leaving approximately 7.5 cm space between

the bricks. The cavity between the bricks was filled with riverbed sand. About 400 bricks were required to make a chamber of the dimensions given in plate 1. The top of the storage space was covered with straw in a bamboo frame structure. The cool chamber was constructed under a shed with a lot of aeration. The site was close to the source of water. After construction, bricks of the walls, floor and the sand used in cavity were completely wet by sprinkling water till they were saturated. Once the cool chamber was completely wet, sprinkling of water daily on the sand, once in the morning and once in the evening, was enough to maintain the required temperature and humidity. Water was sprinkled carefully in order to prevent flowing out of sand from the cavity of the walls and also avoid direct contact with stored lemons and tomatoes.

Procurements of lemons and tomatoes

Mature lemons and tomatoes were harvested from the Faculty farm, Eastern University, Sri Lanka and there were divided into two lots each. There were 60 fruits in each lot consisting three replicates. These fruits were subjected to the storage conditions viz. in zero energy cool chamber and room temperature storage with the objective to study the effect of zero energy cool chamber on quality and shelf life of lemons and tomatoes.

Temperature and Relative Humidity

The temperature and relative humidity data of the cool chamber were recorded with the help of thermometer and hygro thermo meter.

Chemical Parameters

The total soluble solids were determined by hand refractometer and expressed in terms of ^{0}Brix.

The acidity was determined in terms of percent anhydrous citric acid by the method AOAC (1998). The total sugars were determined by the method given by Ranganna (1995). Ascorbic acid was determined by 2,6 dichlorophenol dye method (AOAC, 1998).

Physiological loss in weight

The physiological loss in weight was determined by periodical weighing of fruits and the different weight loss was expressed in percent with respect to storage time and storage conditions (Waskar *et al,* 1999).

Shelf life

The shelf life of fruit was determined by judging the marketability parameter such as shriveling, which was mainly due to physiological loss in weight. The percent physiological loss in weight (more than 10%) was considered as an index of end point of shelf life of fruits.

RESULTS AND DISCUSSION

Temperature and Relative Humidity

The range of fluctuation in the maximum and minimum temperature and relative humidity of cool chamber and out side for 10 days during the study periods is given in figure 1 and figure 2 respectively. The evaporative cooling effect reduced the inside temperature by as much as 13-15^{0}C and kept the relative humidity above 90% during peak lot season. It was found that cool chamber could also maintain temperature at 8-12^{0}C lower than the ambient temperature with relative humidity around 90% in normal days. There was a direct correlation between the outside relative humidity and the temperature difference between the cool chamber and outside.

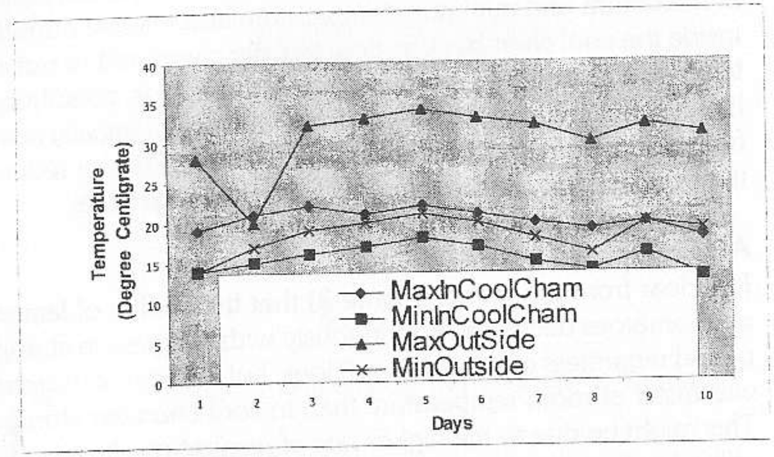


Figure 1: Average maximum and minimum temperature within the chamber and outside (^{0}C)

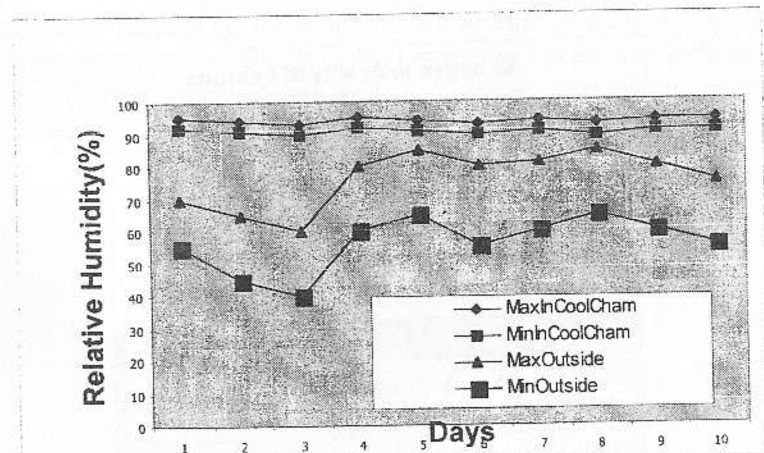


Figure 2: Average Maximum and Minimum Relative Humidity within the chamber and outside

It was interesting to note that apart from maintaining the low temperature and high humidity in all seasons, the fluctuation in maximum and minimum temperature and relative humidity inside the cool chamber was very narrow compared to outside temperature and relative humidity. This storage condition is highly desirable from the point of view of physiologically active fruits and vegetables. This in addition, advantage as it reduces the possibility of chilling injury to fruits and vegetables .

Acidity

It is clear from the results (Figure-3) that the acidity of lemons and tomatoes decreased continuously with progress in storage period regardless of storage conditions, but the rate of decrease was faster at room temperature than in cool chamber storage. This might be due to the higher rate of respiration since acid is utilized to form the necessary respiratory substrate for catabolic process in fruits. Similar observations were noted by Reddy and Nagaraju (1993) in sapota fruits cv. Kalipatti when stored in evaporative cool chamber.

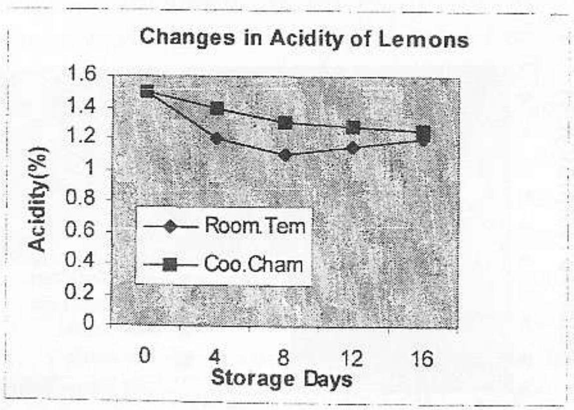


Figure 3: Changes in Acidity during storage of Lemons

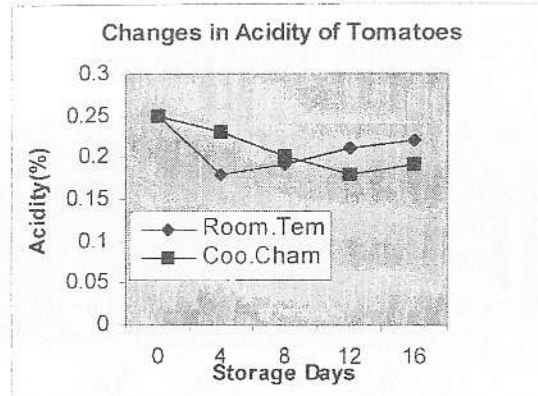


Figure 3: Changes in Acidity during storage of Tomatoes

Total Soluble Solids(TSS)

It was noticed that the TSS content in lemons and tomatoes increased till it reached the peak up to their shelf life followed by a gradual decline in the change regardless of storage conditions (Figure-4). The changes in TSS were slower in the fruits stored under cool chamber storage than that under room temperature storage. Singh (1987) reported the similar findings in the storage study of ber fruit cv. Gola in zero energy cool chamber and room temperature.

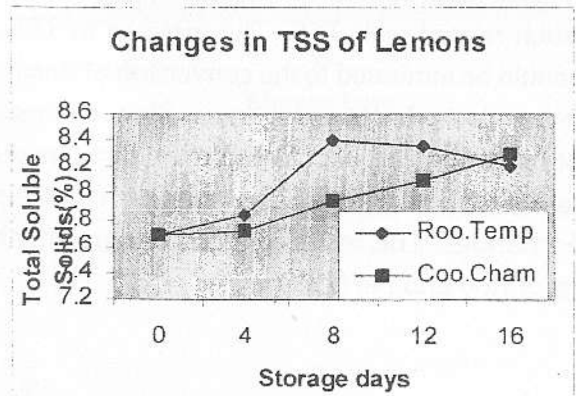


Figure 4: Changes of Total Soluble Solids during storage of Lemons

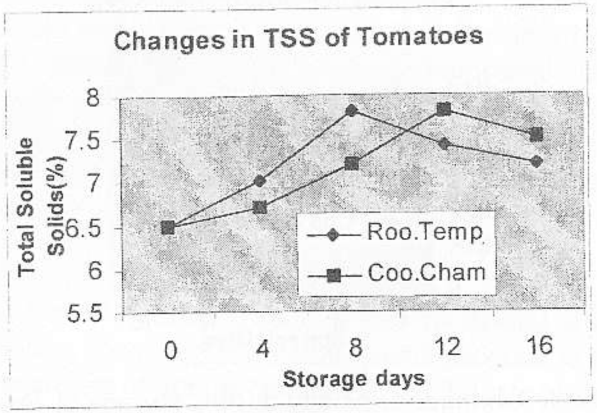
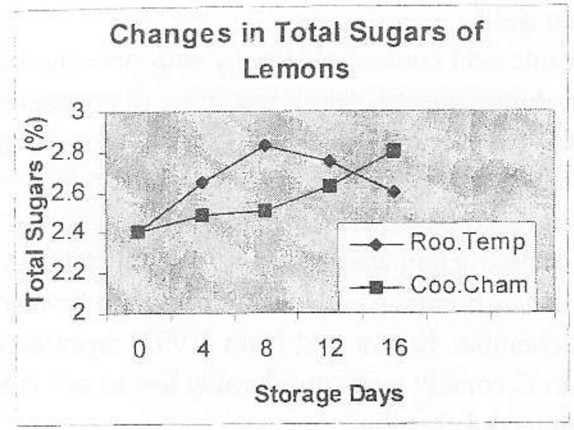


Figure 4: Changes of Total Soluble Solids during storage of Tomatoes

Total Sugars

The result of total sugar analysis revealed that the sugar content of lemon and tomatoes increased gradually up to their shelf life in both the storage conditions (Figure- 5). These changes were very much related with TSS. The increase in TSS and total sugars could be attributed to the conversion of starch and other insoluble carbohydrates into sugars. Slow changes in sugar content of fruits stored in cool chamber might be due to slow physiological changes and conversions of starch and polysaccharides. The result is in close agreement with the findings of Roy and Pal (1991).



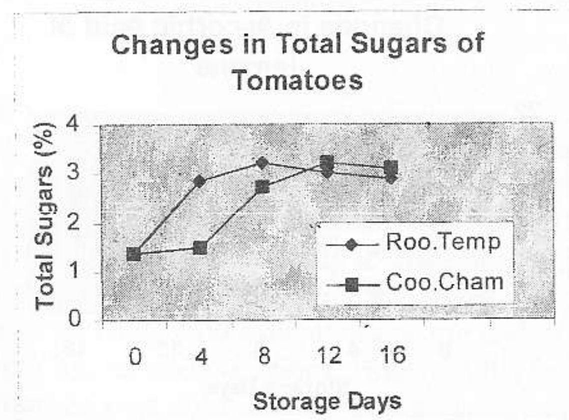


Figure 5: Changes of Total Sugars during storage of Lemons and Tomatoes

Ascorbic acid

The ascorbic acid content of lemons and tomatoes decreased gradually during storage periods regardless of storage conditions (Figure-6). The rate of decline was faster at room temperature storage than the cool chamber storage. This might be due to the fact that ascorbic acid being highly sensitive to the heat and the rate of destruction was slower in the cool chamber storage as high relative humidity and low temperature prevailing inside the cool chamber. Kumar and Nath (1993) reported that loss of vitamin C content was considerably less in aonla stored in zero energy cool chamber.

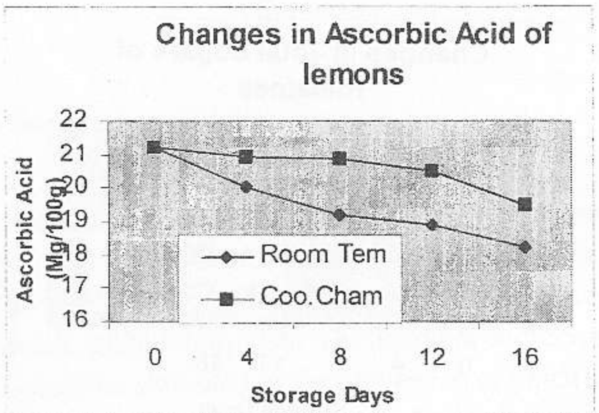


Figure 6: Changes of Ascorbic Acid during storage of Lemons and Tomatoes

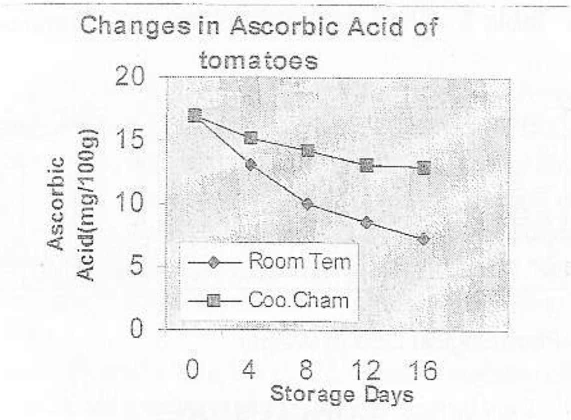


Figure 6: Changes of Ascorbic Acid during storage of Tomatoes

Shelf life

The data presented in Table 1 clearly indicate that the shelf life of lemons and tomatoes stored in zero energy cool chamber are better than that at room temperature. Lemons and tomatoes could be stored in cool chamber up to 16 and 12 days against 7 and 4 days at room temperature respectively. All the fruits were found to have good acceptance at the end of shelf life under both the storage conditions. However, the fruits stored in cool storage were more fresh, firm and glossy appearance and attractive as compared to that stored at room temperature. This might be due to less shriveling percentage and physiological loss in weight from the surface of fruits stored in the zero energy cool chamber owing to the lower rate of respiration as high relative humidity and low temperature prevailing in cool chamber. The cool chamber storage significantly reduced physiological loss in weight and shriveling of sapota fruits (Reddy and Nagaraju, 1993). Joshi *et al* (1993) reported that cool chamber was found to increase the shelf life of fruits like mango, sapota, banana, seedless lemon, kokum and karonda.

Table 1 : Shelf Life of Lemons and Tomatoes

	Room Temperature					Cool Chamber				
	Shelf Life (Days)	PLW (%)	Decay (%)	Shriv.(%)	Mark. (%)	Shelf Life (Days)	PLW (%)	Decay (%)	Shriv.(%)	Mark.(%)
Tomato	4	9.50	15.80	8.00	75.00	12	9.00	15.00	5.00	81.00
Lemon	7	8.00	16.70	11.00	80.00	16	6.00	14.50	7.50	85.00

* PLW- Physiological Loss in Weight

CONCLUSIONS

This study revealed that cool chamber developed by the Indian Agricultural Research Institute could be well adopted under our condition to retain the freshness of fruits and vegetables for a substantial period and extend storability. However, different type of fresh fruits and vegetables have to be tested for their storage performance in this chamber at various locations of our region. In this way, small farmers can easily construct this chamber near their fields and store the harvest in fresh form before dispatching to the market. Perhaps, it needs more efforts to popularize among the village farmers in our region.

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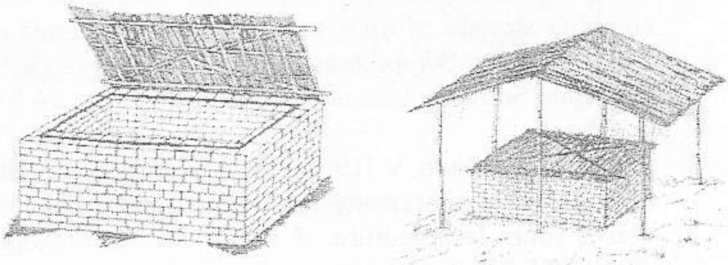
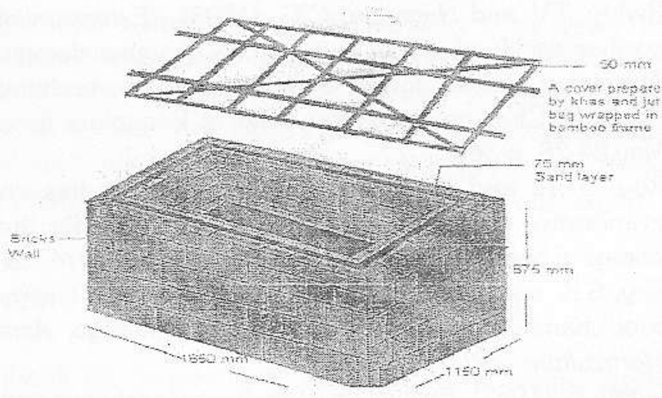
Plate 1: Pictorial views of a Cool Chamber with a capacity to store 100kg of fruits and vegetables (Roy and Pal, 1991)





Zero-energy cool chamber