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To Test the Different Types of Existing Packages Material during of Transportation of Guava Fruit

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Abstract: ***The effect of different types of packages and vibration level during transportation on the shelf life of guava fruits under ambient storage environment. Guava fruits were packed in CFB box, plastic crate, wooden box and bamboo basket each. CFB box with cushioning material was also used and fruits packed in respective boxes and tested for the simulation vibration at two levels of 150 rpm and 200 rpm each for two levels and time period of 3 hours and 6 hours each. The quality of guava fruits was observed in terms of physiological loss in weight, acidity, firmness, ascorbic acid and total soluble solids. In all the treatments physiological loss in weight increased with storage duration, intensity and duration of vibration, where as ascorbic acid and firmness decreased with increasing storage period. Total soluble solids increase steadily during storage. Based upon above parameters, among four types of packages CFB box was found to be the best packaging material for maintaining the fruits more fresh and healthy during the simulated vibration treatments in an ambient storage conditions with the minimum losses. The CFB was most suitable package in all respect. Cushioning material as paper cuttings has positive correlation with the quality parameters of fruits packed in CFB box. found to result in reduction of loss and deeping the guava fruits more healthy as compared to it was observed that. CFB Box losses less and keep healthy the guava fruits as compare to other three type of packages. Other three types packages.***

Keywords: Guava, transportation, vibration, packaging and CFB box

1. Introduction

Guava (*Psidium guajava* L.) belongs to Family Myrtaceae. It is one of the most important commercial fruit crops of India, which is a good source of vitamin C but is highly perishable. It is widely grown in tropical and subtropical regions of India. It is highly nutritious fruit and can be grown on marginal land with much less care than the other commercial fruits. It occupies an important place in the fruit wealth of our nation and is popularly known as “Apple of the tropics” or the “Poor Man’s Apple”. India is the second largest fruit growing country in the world after China. It is the fourth most important fruit crop in India after mango, banana and citrus. As a commercial fruits guava is grown in more than eighteen states in India. It occupies nearly 178.7 thousand hectares of land and contributes 1856 thousand million tonnes in India during the year (2006-07). In U.P., the total area under the guava is 5.3 thousand hectares and contributes 39.7 thousand million tonnes (16.4% of total fruit production in the state) during the year 2012-13.

Guava is richest source of vitamin c (243.3 mg/100g). The whole guava is moderately good source of calcium (2.02 mg/100g), phosphorus (0.72 mg/100g), iron (0.03 mg/100g), sulphur (0.0192%), zink (0.02mg/100g), copper (0.02 mg/100g), vitamins like thiamine (0.03-0.07 mg/100g), niacin (0.20-2.32mg/100g), riboflavin (0.02-0.04 mg/100g), sugar 4.9-10.1g/100g) of fruit pulp (Wilson, 1980; Das et al.,1995; Ghosh and Chattopadhyay, 1996; Baralakshmi and Bhargava, 1998). The guava fruits are high in pectin (Nakasone and Paul, 1998) between 0.5 to 1.8% (Adsule and Kadom, 1995). Due to their astringent properties its root, bark, leaves, immature and mature guava fruits are used in local medicine for treatment of gastro-enteritis diarrhea and dysentery (Purse Glove, 1968 and Morton, 1987). Guava consumption significantly reduces in high density lipoprotein (HDL). Further, high concentration of pectin in guava fruit may play serum, total cholesterol, triglycerides and the blood pressure with opposite effect a significant role in the reduction of cholesterol and thereby decreases risk of cardio-vascular disease (Singh et al., 2003). Uttar Pradesh is the most important guava growing state in India and Allahabad has earned the reputation of producing the best quality guava in the country as well as in the world (Mittra and Bose, 1990; Attri and Singh, 2003). The fruits from autumn flowering ripen from February to April during spring season. It is generally observed that guava trees produce heavy crop in rainy season, light crop in winter and very light in spring season (Lal and Tiwari, 2002). The guava fruits follows single sigmoidal growth curve reported by Singh et. al. (1937); Leriche (1951) and Sastry (1965) and double sigmoidal by Rathore (1976).

In north India, guava bears two crops in a year i.e. in rainy season from spring season and second in winter season from rainy season. Rainy season crop is generally not preferred over the winter season crop because frequent rains decrease the sweetness and increase the attack of various insects, pests and diseases (Chundawat et al. 1976). India wastes more fruits and vegetables than consumed in the whole of the U.K. and the cumulative waste is estimated at about 20-40 percent of the total production value (Kitinoja and Gorny, 1998).

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2. Materials and Methods

The experiment was carried out in the college of Agriculture, S.V.P. University of Agriculture and Technology, Meerut, during 2012-13.

2.1 Harvesting time and methodology used

Ten to twelve years old plants of guava cv. L-49 were selected from an orchard of S.V. P.U.A. &T, Meerut from the winter season crop. Uniform and healthy fruits were harvested at green mature stage. Fruits free from injury and disease were selected for study. The guava fruits were brought to the laboratory on the same day. In the laboratory guava fruits were selected randomly for taking their dimensions for selecting the uniform size of fruits for simulating transportation. The fruits were packed in the different packages (i.e. corrugated fibre board box, plastic crate, wooden box and bamboo basket) (Table 1) with known quality of guava fruits.

Table 1: Experimental design

Sr. No.	*Parameters*	*Description*
1	Guava Variety	Lucknow-49
2	Type of Package	Bamboo basket, wooden crate, CFB box, Plastic Crate
3	Frequency of Vibration	Two levels: 150 and 200 rpm
4	Duration of Vibration	Two levels: 3 and 6 hours
5	Storage Environment	Room temperature (RT)
6	Storage temperature	RT: 20°C± 2°C
7	Storage relative humidity	RH: 50 to 75%
8	Observations	PLW, Firmness, total soluble solids, acidity, ascorbic acid, mechanical injury and storage temperature and relative humidity.
9	Observation interval	3 days
10	Replication	Three
11	Place of study	Department of Agricultural Engineering and Food Technology, S.V. P.U.A & T, Meerut.

2.2 Packages of fruits

Different types of packages viz. corrugated fibre board box with 0.1% Perforation (50cm x 33cm x 30cm) having capacity of 25 kg. Wooden box (52cm x 21cm x 36cm) and bamboo basket of capacity 10 kg each, filled with known quality of fruits which were tested for the simulated vibration study.

2.3 Laboratory simulation of vibration

Laboratory vibration tester powered with 3 hp electric motor was used to provide amplitude and resonance frequency (frequency which caused maximum vibration to the fruits). This frequency was adjusted by the frequency adjusting knob which is situated in the control panel of the vibration tester. At same time, time was also adjusted by the time adjusting knob. Four types of packages were used for the simulation study. Two levels of time duration i.e., 3 and 6 hours and two levels of vibration 300 and 600 rpm were selected for simulation study. After carrying out the simulation vibration of 300 rpm for the duration of 3 hours, it was observed that, all the fruits got seriously damaged (deep bruising) in all the packages and fruit lost their marketing value. Hence, the frequency of vibration was reduced to 150 rpm. The guava fruits were filled in the four types of packages (i.e. CFB box, plastic crate, wooden box and bamboo basket) with known quality of fruits. All the packages were then put on the vibrating machine for testing packages at the vibration level 150 rpm for 3 hours and 6 hours. Also the same procedure was repeated at 200 rpm for 3 hours and 6 hours respectively. Just after the treatment, fruits were selected randomly from the respective packages and tested for the following parameters with three replications.

1. Physiological loss in weight (PLW)
2. Firmness
3. Total Soluble Solids (TSS)
4. Acidity
5. Ascorbic acid
6. Mechanical injury

After the simulating vibration the fruits were stored at room temperature conditions and the observations of the above mentioned parameters were taken at a regular interval of 3 days up to 9 days of storage. At vibration level of 150 rpm, it was found that the corrugated fibre board box and plastic crate showed better results than the wooden box and bamboo basket by comparing all the physiological and quality parameters which were measured initially. Therefore, for the study of higher intensity of simulated vibration experiment i.e. at 200 rpm for 3 hours and 6 hours, two packages corrugated fibre board (CFB) box and plastic crate were selected for further simulated vibration experiment. The similar observations for physiological and quality parameters were taken after the treatment and the results were optimized. This time it was found that the corrugated fibre board box showed better results than the plastic crate. Hence one more vibration experiment with corrugated fiber box using paper cutting as a cushioning material at 200 rpm for 3 hours was carried out. From the results obtained, the suitable package was optimized and developed for the Transportation and storage of guava fruits.

2.4 Statistical Analysis

The observations taken from experiment were analyzed in terms of types of packages and duration of storage on shelf-life of guava variety Lucknow-49. All the observations were taken after a gap of 3 days for guava stored at room temperature. The parameters studied were physiological loss in weight, firmness, total soluble solids, acidity and ascorbic acid and mechanical injury. The data was statistically analyzed by employing two/three factors Complete Randomized Design (CRD) using OPSTAT programmed package. Means were computed and tested at 5 percent level of significance of critical difference to arrive at the best results of the treatments.

3. Results and Discussion

To study the effect of different packaging materials on the physiological and quality parameters during the transportation and storage of the guava fruits. The guava fruits, cv. L-49, were packed in corrugated fibre board (CFB) box, plastic crate, wooden box and bamboo basket. The

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known quantity of guava fruits was taken in the respective packages and kept those packages on the vibrating machine for studying the effect of vibrations during the transportation. The vibration frequency was selected as 150 rpm and 200 rpm for 3 hours and 6 hours each as a short distance and long distance transportation. The guava fruits after vibration were stored at room temperature in respective packages. The various physiological and bio-chemical parameters of fruits observed just after vibration and storage including physiological loss in weight (PLW), firmness, mechanical injury, total soluble solids (TSS), acidity and ascorbic acid. All the parameters were recorded at 3 days interval at room temperature. The experimental results were statistically analyzed. Taking into consideration all the parameters, the best package among all the four packages was determined and developed. The results of various parameters are summarized as below:

3.1 Physiological loss in weight (%) [PLW]

There was a progressive increase in PLW of fruits during simulated transportation in different packages and during storage as well. The average values of PLW in guava fruits cv. L-49 as affected by different treatments during different period of storage are shown in Table 4.1 and Table 4.2 and the trends of change in PLW in all treatments are shown in Fig. 4.1, Fig. 4.2 and Fig. 4.3, Physiological loss in weight increased with increasing period of storage in all the packages from just after vibration up to 9th day of storage. The CFB box was found significantly effective to reduce the physiological loss in weight during different period of storage with respect to other three types of packages i.e. plastic crate, wooden box and bamboo basket. It is clear from all the figures (Fig. 4.1, Fig. 4.2 and Fig. 4.3), that PLW percentage increased at a steady rate with the storage and rate of loss in weight was least in fruits packed in CFB box, while the fruits packed in bamboo basket showed the highest loss in weight among all the four types of packages. The PLW percentage in fruits packed in CFB box was 0.47, 2.97, 4.93, 6.63% on 0, 3rd, 6th and 9th day of storage respectively, after vibration treatment of 150 rpm for 3 hours.

At the 9th days of storage period, it was observed that, the bamboo basket contribute to higher PLW of fruits followed by wooden box, plastic crates and CFB boxes. The effect of different durations and level of vibration treatments also gave the same results. Also, CFB boxes gave the best results when the fruits were packed with cushioning material (paper cuttings). The increase in weight loss of fruits with increase in duration of vibration may be attributing to the different time period of vibrations. Since, the fruits were vibrated at the ambient conditions in all the cases hence except temperature and relative humidity (RH), it is only the duration of vibration, which results in more weight loss with the passes of time.

Table 2: Physiological loss in weight (%) of guava fruits in different packages stored after vibration at 150 rpm

Treatment	Storage duration (Days)				
	0 days	3 days	6 days	9 days	Mean
	Simulated vibration – 3 hours				
CFB box	00.47 (03.93)	02.97 (09.92)	04.93 (14.67)	06.63 (14.92)	3.75 (10.86)
Plastic crate	01.69 (07.47)	03.77 (11.19)	05.03 (12.96)	07.58 (15.97)	4.51 (11.90)
Wooden box	02.45 (08.43)	04.12 (11.71)	05.78 (13.91)	08.59 (17.03)	5.24 (12.78)
Bamboo basket	02.54 (09.17)	06.14 (19.32)	11.78 (24.62)	12.65 (29.69)	8.28 (20.70)
Mean	01.15 (07.25)	04.25 (13.03)	06.88 (16.54)	08.86 (19.40)	
CD at 5%	T=0.67	S=0.67	T x S = 1.35		
	Simulated vibration – 6 hours				
CFB box	00.66 (04.66)	03.60 (10.93)	07.84 (16.25)	10.08 (18.50)	5.55 (12.59)
Plastic crate	02.29 (08.70)	04.05 (11.61)	08.04 (16.47)	12.99 (21.11)	6.84 (14.47)
Wooden box	03.19 (10.28)	04.13 (11.72)	08.29 (16.73)	14.92 (22.71)	7.63 (15.36)
Bamboo basket	03.45 (10.70)	10.95 (19.32)	17.37 (24.62)	24.55 (29.69)	14.08 (21.08)
Mean	02.40 (08.59)	05.68 (13.39)	10.39 (18.52)	15.64 (23.00)	
CD at 5%	T = 0.12	S = 0.12	T x S = 0.24		

T = Treatment S = Storage TXS = Treatment x Storage
The data in parentheses are angular transformed values.

Table 3: Physiological loss in weight (%) of guava fruits in different packages stored after vibration at 200 rpm

Treatment	**Storage duration (Days)**				
	0 days	**3 days**	**6 days**	**9 days**	**Mean**
	Simulated vibration – 3 hours				
CFB box	00.79 (05.10)	04.49 (12.22)	08.51 (16.95)	15.73 (23.36)	07.38 (14.40)
Plastic crate	02.04 (08.21)	06.14 (14.34)	12.06 (20.31)	18.20 (25.24)	09.61 (17.03)
Mean	01.42 (06.65)	05.31 (13.28)	10.28 (18.63)	16.97 (24.30)	
CD at 5%	**T = 0.191 S = 0.191 T x S = 0.381**				
	Simulated vibration – 6 hours				
CFB Box	01.10 (06.01)	06.41 (14.66)	16.10 (23.65)	25.97 (30.63)	12.40 (18.74)
Plastic crate	02.82 (09.66)	09.79 (18.23)	18.44 (25.44)	26.89 (31.22)	14.49 (21.14)
Mean	01.96 (07.84)	08.10 (16.45)	17.29 (24.55)	26.43 (30.92)	
CD at 5%	**T = 0.06 S = 0.09 T x S = Treatment x Storage**				

The data in parentheses are angular transformed values

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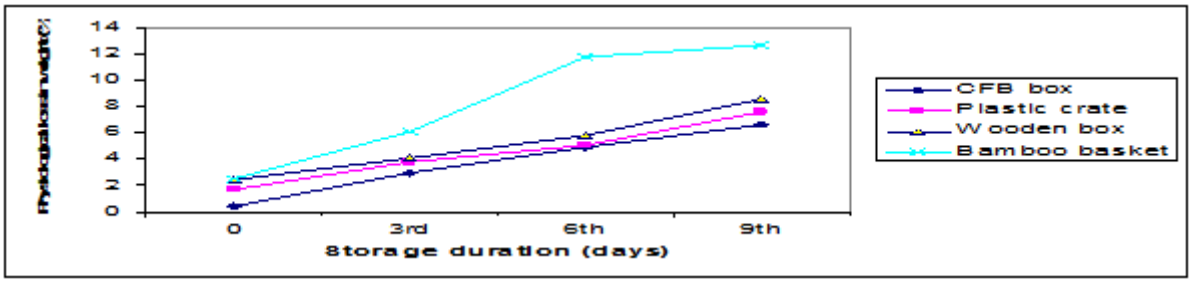


Figure 1: Physiological loss in weight (%) of guava fruits in different packages stored after vibration at 150 rpm for 3 hours

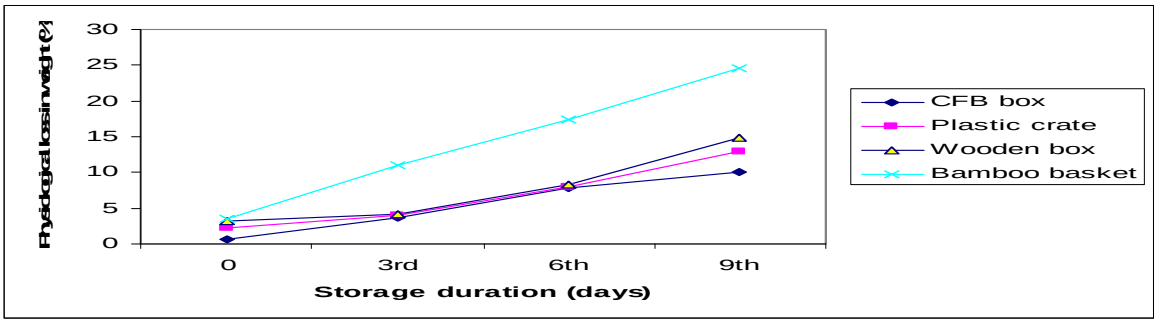


Figure 2: Physiological loss in weight (%) of guava fruits in different packages after vibration at 150 rpm for 6 hours

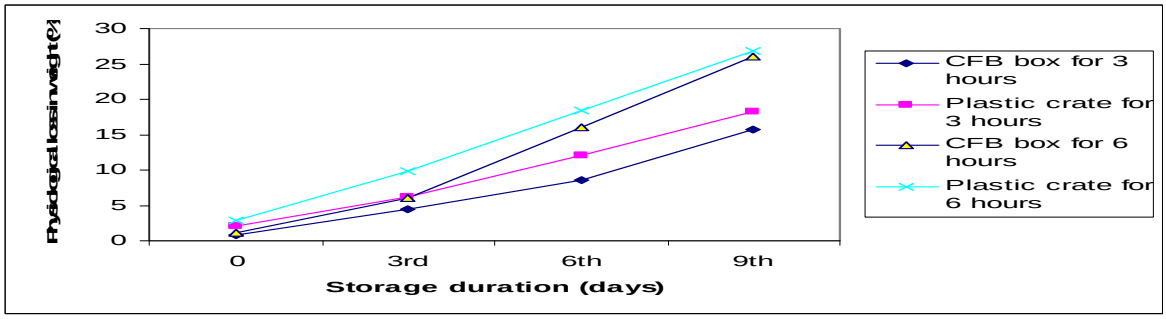


Figure 3: Physiological loss in weight (%) of guava fruits in different packages after Vibration at 200 rpm for 3 hours and 6 hours

3.2 Firmness

The firmness of fruits in an indicator for better keeping quality. Softening of tissue generally accompanies fruit ripening. The average value of fruits firmness in guava fruits cv. L-49 packed in four types of packages as affected by different treatments during different period of storage are shown in Table 3 and Table 4 the trends of change in fruits firmness in all treatments are shown in Fig. 4, Fig. 5 and Fig. 6. It is evident from the results that, firmness of the fruits in all the packages decreased with increase in duration and intensity of vibration level. It is clear from all the figures that, fruits firmness decreased at a steady rate with the storage and rate of loss of fruits firmness was the most in the bamboo basket while, the rate of loss of firmness was the lowest in the CFB box. The values of the firmness of guava fruits packed in CFB box were 15.4, 13.5, 10.8, 6.3 kg at the 0, 3rd, 6th and 9th day of storage respectively, after vibration treatment of 150 rpm for 3 hours.

The decrease was rapid and progressive in fruits packed in bamboo basket with increase in duration and intensity of vibration. However, the decrease in fruit firmness packed in CFB boxes was much slower followed by plastic crate, wooden box and bamboo basket. It was also clear from the figures that plastic crate performed better than the wooden and bamboo basket in all the cases and fruits in plastic crate exhibited a less decrease in firmness as compared to wooden and bamboo basket. Also firmness decreased as storage period was increased and this was true for all the treatments. The duration of simulated vibration and level of frequency has been found to affect the firmness of stored samples of fruits. In all the cases, longer duration and higher level of frequency resulted in decrease in fruit firmness. A slow decrease in the firmness of the fruits packed in CFB box was observed in all the treatments, however level of magnitude was different as compared to other packages. The decrease in firmness of fruits with increase in duration of vibrations may be attributed to continuous exposure of packaging boxes to the vibration loading to excessive impact to the fruits resulting in the low firmness value. The results are in close agreement with the finding of Singh and Singh (1981) and Burton et al. (1989). Singh and Singh and Burton et al. reported in their findings that during the transportation of tomatoes and apples the decrease in bruising of apples was critically affected by the transportation time and stiffness of the packaging boxes.

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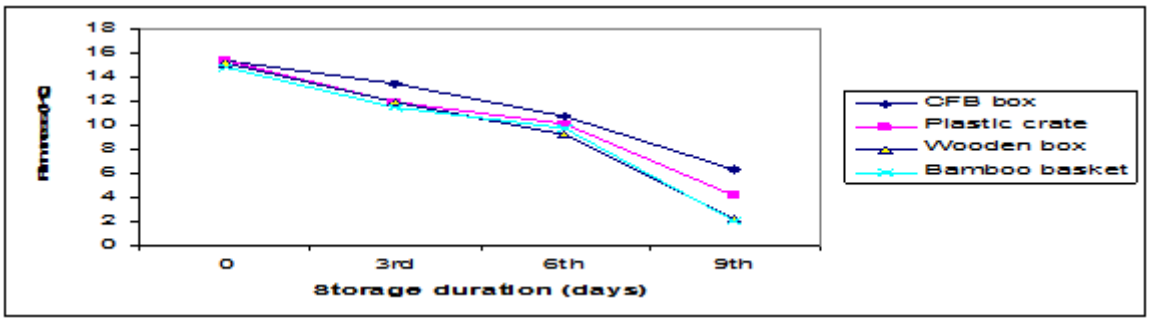


Figure 4: Firmness (kg) of guava fruits in different packages stored after vibration at 150 rpm for 3 hours

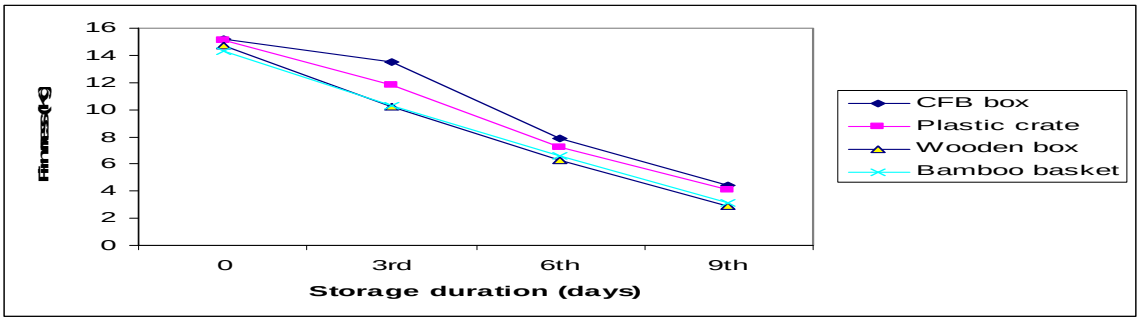


Figure 5: Firmness (kg) of guava fruits in different packages stored after vibration at 150 rpm for 6 hours

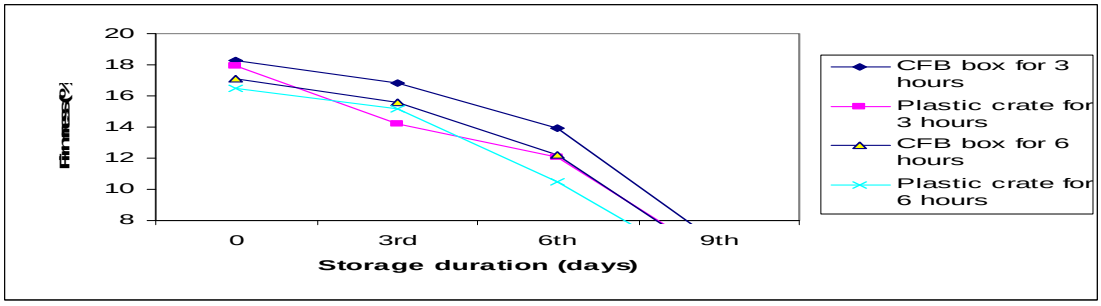


Figure 6: Firmness (kg) of guava fruits in different packages stored after vibration at 200 rpm for 3 hours & 6 hours

3.3 Total soluble solids (TSS)

Data on total soluble solids in fruits of guava cv. L-49 as affected by different treatments during different period of storage has been presented in Table 5 and Table 6. The trends of change in total soluble solids in all the treatments are shown in Fig. 7, Fig. 8 and Fig. 9. The TSS percentage increased in all the fruits samples with increase in the storage period (days) irrespective of the type of package and duration of vibration. It is clear from the figures that, the rate of change of total soluble solids in the guava fruits packed in the CFB box during the storage period was minimum followed by plastic crate, wooden box and bamboo basket. The values of the TSS of guava fruits packed in CFB box were 11.9, 12.0, 12.2 and 12.4% at the 0, 3rd, 6th and 9th day of storage respectively, with a mean of 12.1% after vibration treatment of 150 rpm for 3 hours.

The rate of change in the TSS of fruits packed in the bamboo basket was the highest. From the results obtained as shown in Table 4.6, the CFB box as a packaging material regards the minimum increase in TSS than plastic crate with increase in duration and intensity of vibration. The increase in percent TSS in fruit samples may be due to hydrolysis of polysaccharides and concentration of juice as the result of dehydration, Das and Dash (1967) and Bhullar et al. (1985).

3.4 Ascorbic acid

Data on ascorbic acid content of guava fruits cv. L-49 as affected by different types of packages during transportation and different period of storage has been presented in Table 4.7 and Table 4.8 and the trends of change in fruits acidity as affected by all the treatments are shown in Fig. 4.10, Fig. 4.11 and Fig. 4.12. From the results obtained it is clear that, there was higher retention of ascorbic acid during storage in fruits packed with CFB box. While there was highest reduction in ascorbic acid of fruits packed in bamboo basket. The values of the ascorbic acid of guava fruits packed in CFB box during the storage period, after vibration treatment at 150 rpm for 3 hours, at the 0.3rd, 6th and 9th day of storage were 203, 194, 185 and 175 mg/100 gm with a mean of 189 mg/100 gm. Also, in comparison between CFB box and plastic crate (Table 4.8), there was higher retention of ascorbic acid with slower rate of change in ascorbic acid content in the fruit packed in CFB box than in plastic crate.

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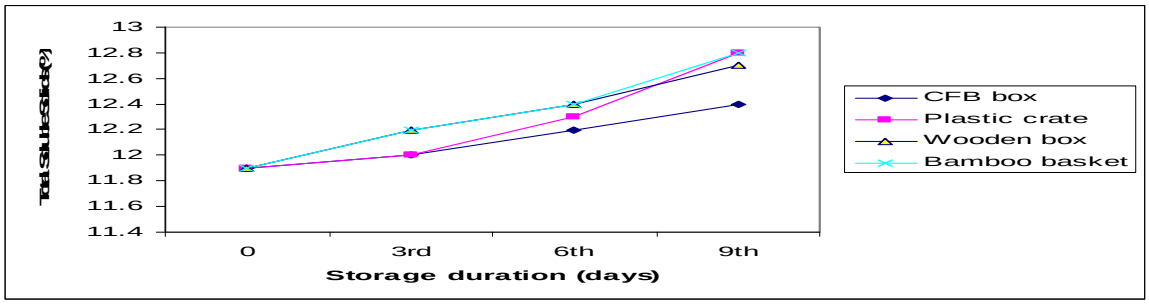


Figure 7: Total soluble solids (%) of guava fruits in different packages stored after vibration at 150 rpm for 3 hours

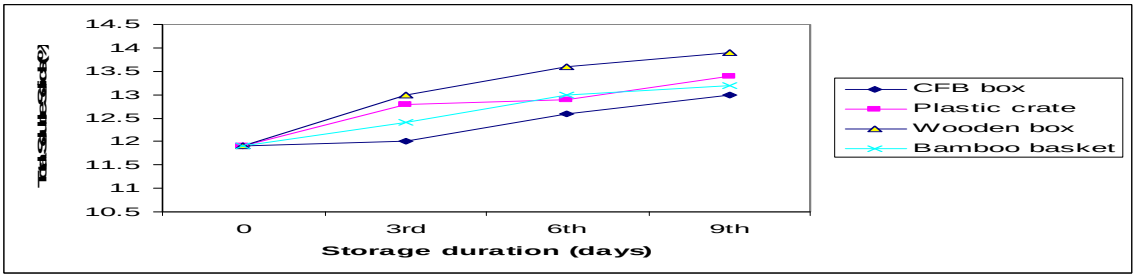


Figure 8: Total soluble solids (%) of guava fruits in different packages stored after vibration at 150 rpm for 6 hours

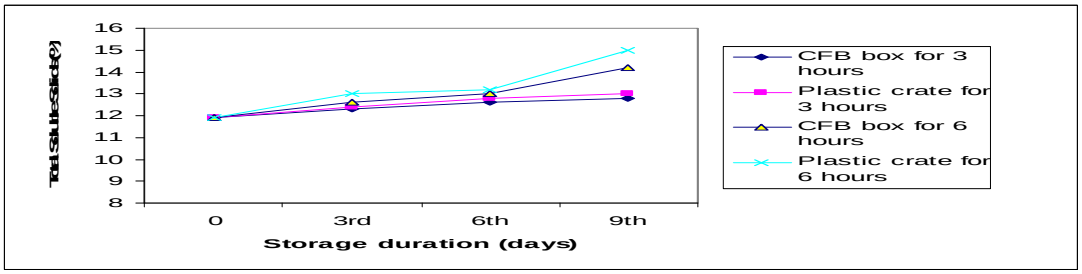


Figure 9: Total soluble solids (%) of guava fruits in different packages stored after vibration at 200 rpm for 3 hours & 6 hours.

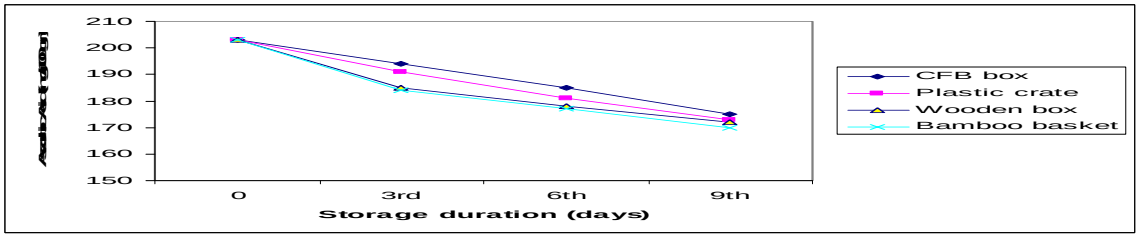


Figure 10: Ascorbic acid (mg/100 gm) of guava fruits in different packages stored after vibration at 150 rpm for 3 hours

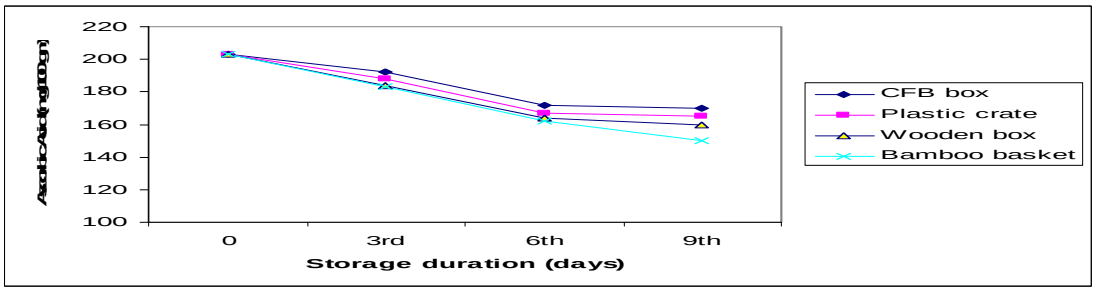


Figure 11: Ascorbic acid (mg/100 gm) of guava fruits in different packages stored after vibration at 150 rpm for 6 hours

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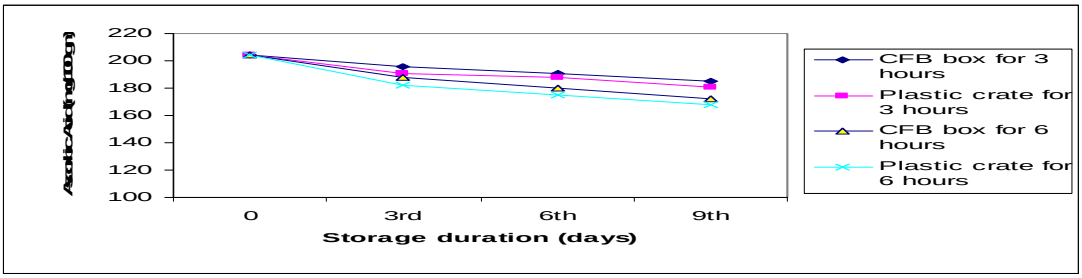


Figure 12: Ascorbic acid (mg/100 gm) of guava fruits in different packages stored after vibration at 200 rpm for 3 hours & 6 hours

3.5 Acidity

Data on acidity content of guava fruits cv. L-49 as affected by different types of packages during different period of storage has been presented in Table 4.9 and Table 4.10 and trends of change in fruits acidity as affected by all the treatments are shown in fig. 4.13, fig. 4.14 and fig. 4.15. The acidity of the guava fruits decreased slowly during the time of storage. During the storage it was observed that, the acidity of guava fruit significantly decreased in the different types of packages. The vibration level and vibration period does not affect the acidity content of the fruit. The guava fruits packed in the CFB box found lowest rate of change of acidity during storage period as compared to plastic crate, wooden box and the bamboo basket. The values of the acidity of guava fruits packed in the CFB box during storage period of 0, 3rd, 6th and 9th day were 0.62, 0.56, 0.42 and 0.33% respectively after the vibration treatment of 150 rpm for 3 hours.

3.6 Mechanical injury

Mechanical injury of the fruits was mainly due to the intensity and the duration of vibration. From the results obtained (Table 4.11 and Table 4.12), it is clear that there was a progressive increase in mechanical injury of fruits during simulated transportation in different packages, however, the magnitude of mechanical injury was the lowest in CFB box as compared to other three types of packages followed by plastic crates, wooden box and bamboo basket The effect of different durations and level of vibration treatments also gave the same results. From the table 4.12, it can be cleared that, among plastic crates and CFB boxes, the CFB boxes shows the minimum mechanical injury in fruits than plastic crates, also CFB boxes gave the best results when the fruits were packed with cushioning material as paper cuttings.

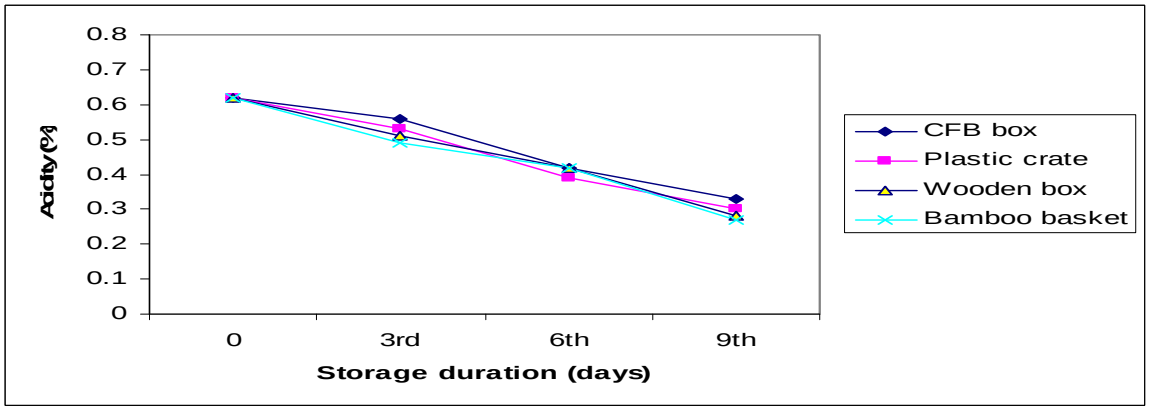


Figure 13: Acidity (%) of guava fruits in different packages stored after vibration at 150 rpm for 3 hours

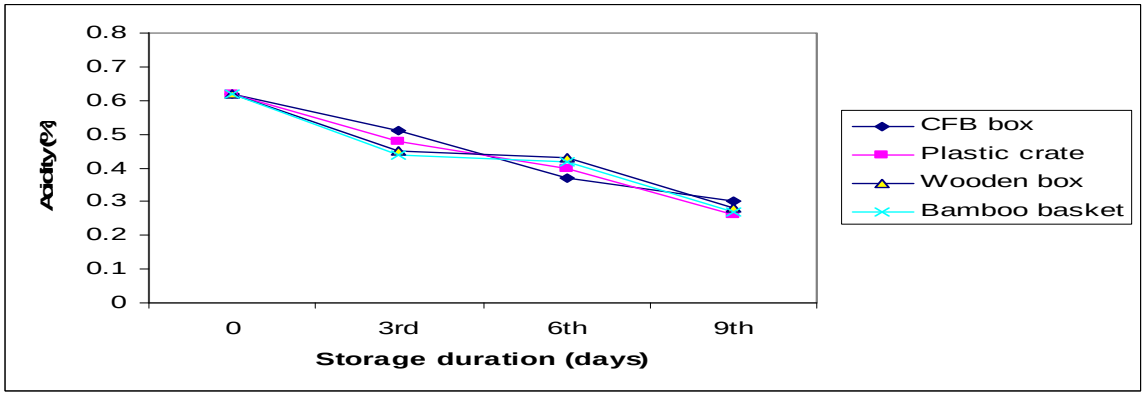


Figure 14: Acidity (%) of guava fruits in different packages stored after vibration at 150 rpm for 6 hours

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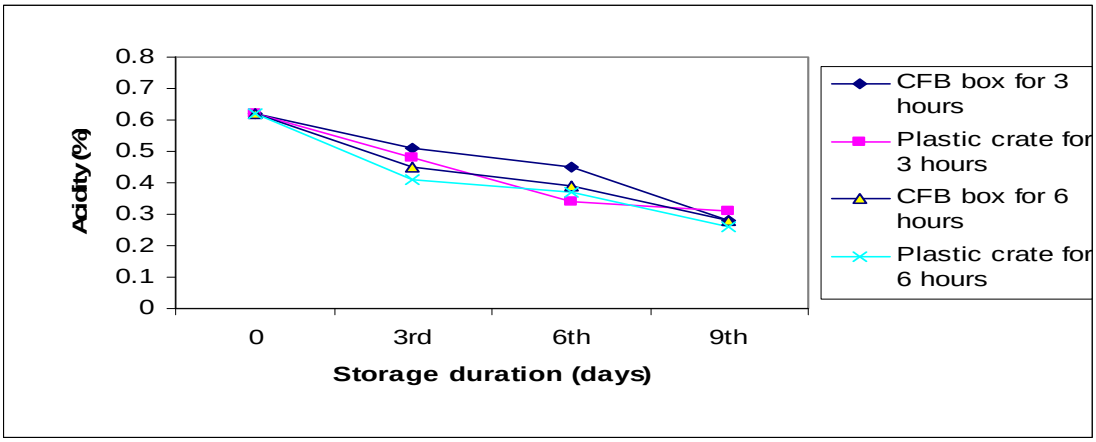


Figure15: Acidity (%) of guava fruits in different packages stored after vibration at 200 rpm for 3 hours and 6 hours.

4. Conclusions

The fruits were packed in four types of packages such as corrugated fibre board (CFB) box, plastic crate, wooden box and bamboo basket. The CFB box was punched with 0.1% of total area of package to make it perforated. All the four packages were tested for the simulated vibration at 150 rpm and 200 rpm vibration level for 3 hours and 6 hours each. The guava fruits were stored at room temperature (20 ± 2 °C) and relative humidity 50 to 75% and the different quality parameters were evaluated during the storage period up to 9 days with an interval of 3 days to optimize and develop the suitable package for guava among all the four packages. The different quality parameters evaluated during the storage were; physiological loss in weight (PLW), fruit firmness, total soluble solids (TSS), acidity and ascorbic acid content of the fruits. The following conclusions were drawn:

(1) The physiological loss in weight increased gradually and progressively with prolonged storage and increasing the duration and intensity of vibration.
(2) Fruits packed in corrugated fibre board (CFB) box found minimum physiological loss in weight whereas, the maximum loss in weight was recorded in fruit packed in bamboo basket.
(3) The firmness of the fruits subjected to simulated vibration was maintained for longer time when packed and stored in CFB box. However, maximum reduction in firmness during storage was observed in wooden box and bamboo basket.
(4) There was significant difference in firmness in the fruits packed in all four types of packages when the duration and intensity of vibration was increased.
(5) Fruit packed in corrugated fibre board box was best in terms of firmness, colour retention in keeping fruit more fresh and healthy after vibration and during storage period.
(6) The total soluble solids content of fruits was not affected after vibration but during storage period it was increased. During storage higher amount of total soluble solids were observed in fruit packed in bamboo basket.
(7) There was a significant effect of package on acidity and ascorbic acid content during storage. A decrease in acidity and ascorbic acid content was noted during storage period.
(8) The CFB box was found most effective in reducing the mechanical injury. The maximum mechanical injury was observed in fruits packed in bamboo basket. The fruit showed the higher mechanical injury when the duration of vibration and the level of intensity of vibration was increased.
(9) Among the various packages used, bamboo basket and wooden box may be cheapest for packaging of fruits but, were not found suitable for packing for transportation as the losses were more in these packages. The corrugated fibre board box held supremacy over other three packages (i.e. plastic crate, wooden box and bamboo basket) by reducing the losses in weight, loss in firmness, loss in colour and also by keeping the fruit quality acceptable.
(10) Cushioning material play a vital role in improving fruit quality during simulated vibration. As it absorbs the shocks.
(11) Duration of vibration, packaging material and cushioning material were found to affect the quality of fruits during storage at ambient conditions.

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