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Effect of packaging materials on quality losses in fresh fig (*Ficus carica* L.) fruits during transportation

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SUMMARY :

The protection of the fig fruit quality in the chains from harvesting to marketing is very important. Vibration often causes some damages to perishable fruits in transportation and reduces their quality. The fruit injury due to vibration is related to the transportation characteristics of vehicles, packaging boxes and the conditions of the roads. The objective of this study was to investigate the effectiveness of packaging materials to reduce the quality loss of fresh fig during transportation. The experiments were carried out with five packaging materials and three transportation distances. The results showed that the CFB box with news paper lining was not proper for transporting of the fresh fig fruits in all transportation distance. The mass loss and total soluble solids of fresh fig fruits packed in CFB box with paper lining was more than CFB box with polyurethane foam sheet and polyethylene foam sheet. Also the decay loss of fresh fig fruits was more in CFB box with paper lining. Fruits packed in CFB box with polyurethane foam sheet were more firm and extended shelf-life than other packaging material.

KEY WORDS : Fig, Packaging, Polyurethane foam, Quality, Transport, Vibration

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Fig (*Ficus carica* L.) belongs to the family Moraceae. The fig is a native of Southern Arabia. The main fig growing countries are Italy, Spain, Turkey, Greece, Portugal and Algeria. It is also extensively grown in California (USA) and Afghanistan. The total area under fig cultivation in India is about 6000 hectares with production of 20,000 tonnes. In India, its commercial production is limited to a few centers in Maharashtra and Karnataka. In Karnataka, it is cultivated on commercial scale in northern districts *viz.*, Bellary, Raichur, Gulbarga and Koppal and the total area under fig cultivation is 1498 ha with production of 13,643 tonnes. Bellary (1078 ha and 9234 tonnes) ranks first in area and production followed by Koppal (96 ha and 1178 tonnes), Raichur (78 ha and 1092 tonnes) and Gulbarga (115 ha and 867 tonnes) (Indiastat, 2009).

Generally the main objectives of the producers and researchers are to decrease quality losses of fruit and vegetables during handling. Peleg and Hinga (1986) stated that discarded agricultural materials because of damage in the chain between the grower and the consumer are reportedly estimated at around 30–40 per cent. Fruits and vegetables are subject to different types of mechanical stresses during harvesting, transportation and storage resulting in impact, vibration, abrasion, compression and bruising damages. Various studies have been carried out to assess the effects of these stresses on fresh fruits (Bollen and De La Rue, 1990).

Especially, during transportation, fruits and vegetables move randomly in their packages. Duration and intensity of vibration related to the extent of the repeated force deteriorates the quality of fruits and vegetables. Regarding transportation, frequent attention was devoted to delicate fruits such as apples. Singh and Xu (1993) reported that as many as 80 per cent of apples can be damaged during simulated transportation by truck, depending on the type of truck, packaging and position of the container along the column. Damage due to transport vibration was investigated on other species of fruits and vegetables, such as cling peaches (Ogut *et al.*, 1999), apricots (O'Brien and Guillou, 1969), tomatoes (Ozguven and Vursavus, 2002), grapesand apples (Acican *et al.*, 2007). The fact that these damages are noticed in the marketing place means a large amount of financial loss. In many cases, the physical damage will lead to attacks by microorganisms physiological changes, which may increase the deterioration of fragile products. Sommer (1957) found that surface discoloration was caused by vibration in-transit and the surface damage seriously affected market value of product.

Alayunt *et al.* (2000) investigated the effects of vibration, packaging materials on three important fig varieties grown in Turkey. They found that packaging materials affected vibration injury of fruit. In local transportation, cardboard boxes were more suitable for transportation than wooden ones. On the other hand, the authors also expressed that new materials and packaging methods should be investigated and used for transportation of fresh fig fruits because of their fragile structure.

EXPERIMENTAL METHODS

Sorted good quality fruits were packed in five different kind of internal packaging materials *viz.*, news paper lining, paper shavings and polyurethane foam sheet. Packaging materials and their treatments are given below :

P_1 - CFB box with news paper lining (Control)

P_2 - CFB box with paper shavings.

P_3 - CFB box with polyurethane foam sheet.

Fresh fig fruits having almost same size and without any damage or skin disorders were selected and labelled for observing different responses. The labelled fruits were randomly placed in the CFB box.Packed fruits were loaded in transport vehicle and transported for distance of 500 km. After transportation fruits were stored at ambient condition and were observed for firmness and colour upto complete spoilage of fruits.

Firmness :

The firmness of the fig fruit was determined using the Texture Analyzer (Make: Stable Micro System; Model: Texture Export Version 1.22). Penetration tests with the help of texture analyzer was used to measure the firmness of fig (Singh and Reddy, 2005).

The following instrument settings were used during the experiment:

Type of probe used	-	5 mm cylindrical probe
Test module	-	Measure force of penetration
Test option	-	Return to start
Pre test speed	-	5.0 mm/s
Test speed	-	1.0 mm/s
Post tst speed	-	10.0 mm/s
Distance	-	10 mm
Trigger force	-	25 g
Load cell	-	5 kg.

Three fruits from each treatment were analysed for the firmness. Penetration test was carried out at three different positions on the fruits. After running the test, the force required to penetrate into the fruit for given distance was directly obtained from the data recorder (Computer). Finally, the averages of three fruits from each treatment and replicate and at three different positions were taken as the firmness of fig fruit in that treatment (Singh, 2006 and Hung, 2011).

Colour :

Hunter lab colorimeter (Model: Colour Flex EZ) was used to measure the colour of fresh fig fruits.The measurements were expressed in terms of lightness (L^* darkness to lightness, on a scale of 0–100), Chroma (C, indicating intensity or saturation of the colour) and hue (H, angle that indicates the pure spectrum colour). Measurements were taken for three fruits at three spots located on sides of the equatorial region of each fruit and the average of the values for each fruit was calculated (Hung *et al.*, 2011).

Chroma and Hue of fresh fig fruits were calculated using following formula :

$$\text{Chroma (C)} = \sqrt{a^{*2} + b^{*2}} \qquad .....(1)$$

$$\text{Hue (H)} = \tan^{-1}\left(\frac{b^*}{a^*}\right) \qquad .....(2)$$

EXPERIMENTAL FINDINGS AND ANALYSIS

Effects of packaging materials and transportation on quality of fresh fig fruits were found statistically significant during storage after transportation.

Effect of different packaging materials and transportation on firmness of the fresh fig fruits during storage at ambient condition are presented in Table 1. Polyurethane foam protected the fruits from vibration. There was more vibration damage to the fruits packed with news paper as there was less cushioning effect. It was clear that the fruits that suffered less vibration damage retained greater firmness. More heavily injured fruits had a higher rate of softening during storage at ambient temperature (Zhou *et al.*, 2007). It was also observed from Table, that the firmness of the fig fruits decreased with the advancement in the storage days. The highest and lowest values of firmness were noted for the fresh fig fruits and the samples from the sixth day of storage, respectively. In the course of ripening, fruit firmness decreased and this decrease was mainly a function of time during the ripening period (Blazkova *et al.*, 2002). Similar losses of firmness due to ripening have been found in six melon cultivars during storage (Miccolis and Saltveit, 1995). Budde *et al.* (2000) studied ethylene evolution relation to fruit softening. During the earliest phases of softening, whole fruit ethylene production rose only slightly and the highest values were detected when the fruit had already softened.

The effect of different packaging materials and transportation on colour of the fresh fig fruits during storage at ambient condition are presented in the Table 2, 3 and 4. From the Tables, it was observed that the L^*, Chroma and Hue angle values decreased with the advancement in storage days. Fruits from all the treatments became darker, as reflected by a decrease in L^* value and showed less intensive (lower C value) and more

Table 1 : Effect of transportation distance on firmness of fresh fig fruits during storage

Packaging material	Storage period		
	Day 1	Day 3	Day 5
P_1 (CFB box + news paper lining)	9.74	10.33	12.03
P_2 (CFB box + news paper shavings)	8.27	9.3611	9.632
P_3 (CFB box + polyurethane foam sheet)	3.93	4.35	5.49
C.D. (P=0.05)	P	S	P×S
	0.13	0.11	0.23

Table 2 : Effect of transportation distance on L^* value of fresh fig fruits during storage

Packaging material	Storage period		
	Day 1	Day 3	Day 5
P_1 (CFB box + news paper lining)	41.94	30.67	30.54
P_2 (CFB box + news paper shavings)	34.82	28.53	29.11
P_3 (CFB box + polyurethane foam sheet)	38.22	38.30	33.54
C.D. (P=0.05)	P	S	P×S
	1.60	1.38	2.77

Table 3 : Effect of transportation distance on chroma value of fresh fig fruits during storage

Packaging material	Storage period		
	Day 1	Day 3	Day 5
P_1 (CFB box + news paper lining)	19.97	19.06	17.38
P_2 (CFB box + news paper shavings)	19.96	19.04	17.95
P_3 (CFB box + polyurethane foam sheet)	21.26	20.02	18.42
C.D. (P=0.05)	P	S	P×S
	0.90	0.78	NS

NS=Non-significant

Table 4 : Effect of transportation distance on hue angle of fresh fig fruits during storage

Packaging material	Storage period		
	Day 1	Day 3	Day 5
P_1 (CFB box + news paper lining)	70.34	69.03	66.31
P_2 (CFB box + news paper shavings)	70.41	68.81	66.77
P_3 (CFB box + polyurethane foam sheet)	71.67	69.53	66.68
C.D. (P=0.05)	P	S	P×S
	3.25	NS	NS

NS=Non-significant

red (smaller H) during the storage period. These results stand true to the finding of (Hung *et al.*, 2011) which showed decreasing trend for all the colour parameters of fig (*Ficus carica* L.) fruits during storage. Impacts on fruit causes damage and bruising leads to enzymatic changes expressed as browning of the tissue (Kuczynski *et al.*, 1994).

Polyurethane foam sheet protected the fruits from mechanical damages and hence extended the shelf-life up to 5 days. whereas shelf-life less than 3 days for the fruits packed and transported for 500 km distance in CFB box with news paper lining.

Conclusion :

According to the results of the experiment, transportation generally affected the quality of the figs. Polyurethane foam sheet in CFB boxes decreased the negative effect of transportation comparing with the news paper lining.

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