

Original Research Article

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Chemical Fruit Quality of Alphonso Mango as Influenced by Packaging and Cushioning Material after Long Distance Road Transportation

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ABSTRACT

The present post harvest investigation, aimed at studying the interaction effect of different packaging and cushioning material used during road transportation on chemical properties of fruits during ripening and storage of Alphonso mango fruits, was undertaken at Department of Horticulture, College of Agriculture, Dapoli, during mango cropping season of 2013-14, in Factorial randomized block design (FRBD), with three replications. Fruit harvested at "B" stage of physiological maturity, were packed in five different packaging materials (wooden box, bamboo basket (karandi), plastic crates, and corrugated fibre board boxes) and four cushioning materials (paddy straw, grass, tissue paper) followed by road transportation for 300km, were periodically assessed for different chemical changes during ripening and storage. Result indicated that, total soluble solids (T.S.S.), total sugars and pH of Alphonso mango fruits, registered an increasing trend from 0 DAP till 14 DAP. While declining trend was found in titratable acidity. However reducing sugars was found to increase from 0 DAP to 7 DAP but decreased further from 7 DAP to 14 DAP. Similarly, wooden box with paddy straw and CFB boxes with tissue paper recorded higher values for total soluble solids (16.7⁰B and 16.4⁰B), and pH (3.07 and 3.06); whereas, CFB box with tissue paper, followed by wooden box with paddy straw, recorded higher values for total sugars (11.74% and 11.21%), reducing sugars (5.08% and 4.78%) and lower values for titratable acidity and PLW. Loose fruits without any cushioning material recorded significantly inferior values for above parameters hence found most inadvisable practice. Further all the packed fruits in their respective packaging and cushioning material were loaded on a truck in late. These fruits were transported to Ratnagiri and back to Dapoli (total 300 kilometers) and were moved to storage room. Thus amongst all different packaging and cushioning combinations tried, CFB boxes with tissue paper (P₄C₃), followed by wooden box with paddy straw (P₁C₁) were adjudged as best packaging and cushioning combinations for realising better fruit quality and shelf life of ripe Alphonso mango fruits.

Keywords

Packaging,
Cushioning,
Alphonso mango

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Introduction

Mango (*Mangifera indica* L.) undoubtedly is one of the oldest and choicest fruits in the

tropics and is acclaimed as "King" of fruits. It is the third widely produced fruit crop after banana and citrus, and occupy relatively the same position in the tropics as the apple in

Europe and North America due to its wide adaptability, high nutritive value, richness in variety, delicious taste, pleasant flavour and attractive appearance. It enjoys the unique popularity among the masses and classes throughout the tropics.

Konkan region on the west coast of Maharashtra is emerging as one of the largest mango growing belts in the country, which comprises four mango growing districts viz., Thane (43492 ha), Raigad (47400 ha), Ratnagiri (63500 ha) and Sindhudurga (25494 ha), occupying 1.65 lakh ha of area under mango (Anon., 2012f). This region which occupies about 1 per cent of the total land area of the country, accounts for 7 per cent of the total area under mango in the country. Out of total area under mango in Konkan, more than 80 per cent is occupied by a single largest growing mango variety 'Alphonso', locally called as 'Hapus' with a major export share to the tune of over 30 per cent. But mango is perishable in nature and there are many occasions for it to get spoiled till the fruit reaches consumer's table. Spoilage of fruit is the bottleneck problem of meagre export of Alphonso mangoes though its production is very large. The principle causes for post-harvest losses are by infections of pathogens, rough handling, improper packaging, improper mode of transportation and unhygienic storage conditions. It is estimated that the total losses due to spoilage may be nearly 20-30 per cent of fruit harvest. As far packaging is concerned, up till now the wooden boxes, bamboo baskets and CFB boxes are most commonly used in all over India for mangoes. But the pioneer work has done by Joshi and Roy (1985) on corrugated fibre board boxes for packaging of Alphonso mangoes now leads to an effective alternative packaging material for mangoes.

In the view of all these, the present study on "Effect of different packaging and cushioning

material on quality and shelf life of mango (*Mangifera indica* L.) fruits Cv. Alphonso was conducted with objective to find out best packaging and cushioning material material for optimum ripening and quality of Alphonso mangoes.

Materials and Methods

The present investigation on "Effect of different packaging and cushioning material on quality and shelf life of mango (*Mangifera indica* L.) Fruits Cv. Alphonso" was undertaken in Department of Horticulture, College of Agriculture, Dapoli during mango cropping season of 2013-14 and it was conducted in FRBD with three replications, During the investigation, major emphasis was given on studying the effect of different packaging material in combination with different cushioning material on changes in physico-chemical parameters, ripening pattern, shrivelling, spoilage and shelf life of Alphonso mango fruits during packaging and ripening. Alphonso mangoes were obtained from orchard of Department of Horticulture, College of Agriculture, Dapoli (M.S) India. Fruits were harvested by Nutan mango nipper in early morning hours. These harvested mangoes were then taken to packing house. At the packing house all the harvested mangoes were checked for their full maturity carefully which was done by dipping them in water at ambient temperature. The fruits which sunk in water (specific gravity > 1.0) were selected for experiment and the fruits which floated were discarded. Care was taken that no diseased, deformed or immature fruits were selected to carry out experiment. A total number of 2880 Alphonso mango fruits were selected. To study effect of packaging and cushioning material, the wooden box, bamboo basket (karandi), plastic crates, and corrugated fibre board boxes were used as a packaging material and paddy straw, grass, tissue paper was used as cushioning material. All these

materials were procured from local market and university far. All the chemicals used were procured from Hi media laboratories, Thane; Molychem India and Thomas baker chemicals Ltd., Mumbai. All the chemicals used in this investigation were of analytical grade.

For carrying out studies on changes in chemical parameters of Alphonso mango fruits during harvesting to packaging, TSS (⁰B), Reducing Sugars (%), Total sugars (%), Acidity (%) and pH were studied by different

methods. In order to examine effect of different packaging and cushioning treatments on bruising and impact damage which normally occur to fruit during long distance road transportation, further all the packed fruits in their respective packaging and cushioning material were loaded in a mini truck and these fruits were transported from Dapoli to Ratnagiri and back to Dapoli (total 300 kilometers on same day of packaging and were moved to storage room).

Table.1 Number of treatment combinations: twenty (20) as below

Sr. No.	Treatment No.	Packaging and cushioning material used
1	P ₁ C ₁	Wooden box with paddy straw
2	P ₁ C ₂	Wooden box with dry grass
3	P ₁ C ₃	Wooden box with tissue paper
4	P ₁ C ₄	Wooden box without cushioning material
5	P ₂ C ₁	Bamboo basket (karandi) with paddy straw
6	P ₂ C ₂	Bamboo basket (karandi) as cushioning material with dry grass
7	P ₂ C ₃	Bamboo basket (karandi) with tissue paper
8	P ₂ C ₄	Bamboo basket (karandi) without cushioning material
9	P ₃ C ₁	Plastic crate with paddy straw
10	P ₃ C ₂	Plastic crate with dry grass
11	P ₃ C ₃	Plastic crate with tissue paper
12	P ₃ C ₄	Plastic crate without cushioning material
13	P ₄ C ₁	Corrugated fibre board box with paddy straw
14	P ₄ C ₂	Corrugated fibre board box with dry grass
15	P ₄ C ₃	Corrugated fibre board box with tissue paper
16	P ₄ C ₄	Corrugated fibre board box without cushioning material
17	P ₅ C ₁	Loose fruits with paddy straw
18	P ₅ C ₂	Loose fruits with dry grass
19	P ₅ C ₃	Individual fruit wrapped in tissue paper
20	P ₅ C ₄	Loose fruits without cushioning material

Experimental design	Factorial RBD
No. of replications	Three
No. of fruits per treatment per replication	48
Total No. of fruits studied	2880

Results and Discussion

The results of the investigation are presented and discussed in this chapter under the following subheads.

Effect of packaging and cushioning material on changes in chemical characteristics of Alphonso mango fruits during storage.

TSS (⁰Brix)

Total soluble solids measured from 0 to 14 days after packaging, indicated significant differences between packaging and cushioning materials at all the stages except at 0 DAP, as treatments were not imposed as observed and depicted in Figure 1. At 7 DAP, total soluble solids was maximum in P₁-wooden box (15.36⁰B) followed by P₄-CFB box (15.30⁰B) and P₂-Bamboo basket (14.77⁰B) which were at par with each other. Whereas, P₅-loose fruits (12.30⁰B) recorded significantly the lowest total soluble solids at this stage. Similar trend was continued till 14 DAP. Similar trend was observed till 14DAP, as significantly highest TSS was observed in C₃-tissue paper (16.88⁰B) whereas significantly minimum TSS was observed in C₄-loose fruits without cushioning material (14.7⁰B).

Packaging X Cushioning

Data regarding interaction effect indicated that all the treatment combinations influenced the T.S.S both at 7 and 14 DAP. Amongst the different combination tried at 7th DAP, Significantly the highest T.S.S (16.70⁰B) was observed in P₁C₁-wooden box with paddy straw, which was followed by P₄C₃-Corrugated fibre board box with tissue paper (16.40⁰B), P₁C₃-wooden box with tissue paper (16.07⁰B) and P₃C₃-plastic crates with tissue paper (15.77⁰B) which were at par with each other. Whereas significantly lowest total soluble solid was noticed in P₅C₄-loose without cushioning material 10.17⁰B. Similar

trend was continued till 14DAP, as maximum TSS was observed in P₁C₁-wooden box with paddy straw (18.0⁰B), which was followed by P₄C₃-Corrugated fibre board box with tissue paper (17.63⁰B) whereas minimum TSS was observed in P₅C₄-loose fruits without cushioning material(14.13⁰B). Similar results were reported by Padhye 1997 in Alphonso, Carrillo - Lopez *et al.*, (2000) in "Haden" mango, Rathore *et al.*, (2007) in Dashehari mango, and Kumar *et al.*, (2013) in Baneshan mangoes.

Reducing sugars (%)

Regarding reducing sugars of Alphonso mango fruits as influenced by various packaging materials and different cushioning material are illustrated in Figure 2. No significant difference was observed between the treatments at 0 days as treatments were not imposed at this stage. However at 7 days after packaging (DAP) and 14 DAP which ranged from (1.68%) at 0 days to (2.94%) at 14 DAP. At 14 days after packaging irrespective of cushioning material used, all the packaging materials significantly influenced the reducing sugars. Among the five packaging materials significantly maximum reducing sugars (3.21%) was recorded by P₄-CFB box which was followed by P₁-wooden box (3.18%) where it was at par with each other.

Whereas P₅-loose fruits recorded significantly lowest reducing sugars of (2.40%). At 7 DAP, irrespective of packaging material used, all the cushioning materials significantly influenced the reducing sugars of Alphonso mango fruits at 7 and 14 DAP. Amongst the four methods adopted, the reducing sugars at 7 DAP was significantly higher in C₃-tissue paper (4.45%), followed by C₁- paddy straw (4.44 %) and C₂- grass (4.36%), which were at par with each other. Whereas, the significantly lowest reducing sugars (3.50%) was noted in C₄-loose.

Fig.1. Effect of packaging and cushioning material on TSS (⁰BRIX) of alphonso mango fruit during staorage at 14 DAP

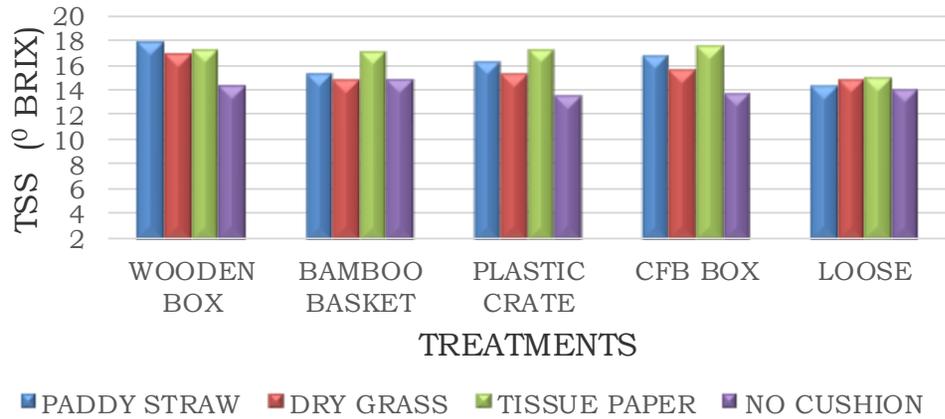


Fig. 2. effect of packaging and cushioning material on Reducing sugar (%) of alphonso mango fruits during storage at 14 DAP

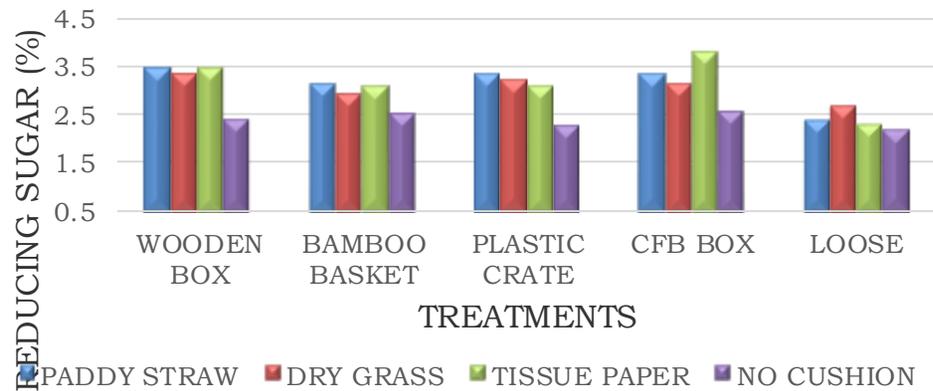


Fig.3. Effect of packaging and cushioning material on Titratable acidity (%) of alphonso mango fruits during storage at 14 DAP

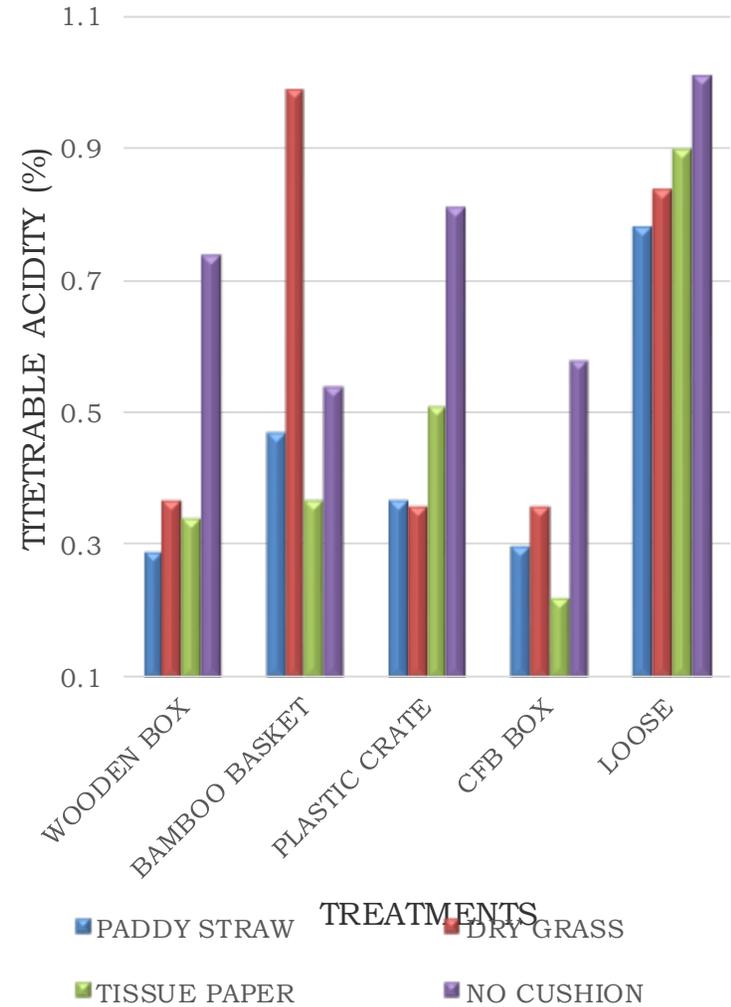


Table.2 Effect of packaging and cushioning material on pH of Alphonso mango fruits during storage

TREATMENTS	0 DAYS					7 DAYS					14 DAYS				
	C1	C2	C3	C4	MEAN	C1	C2	C3	C4	MEAN	C1	C2	C3	C4	MEAN
P1	2.53	2.57	2.43	2.55	2.52	3.07	2.72	2.93	2.60	2.83	5.77	5.13	5.34	4.90	5.29
P2	2.55	2.52	2.55	2.58	2.55	2.72	2.68	2.91	2.48	2.70	4.46	4.85	4.72	4.83	4.72
P3	2.62	2.58	2.63	2.62	2.61	2.58	2.93	2.66	2.56	2.68	4.60	4.88	4.86	4.87	4.80
P4	2.58	2.48	2.61	2.61	2.57	2.91	2.78	3.06	2.50	2.81	5.00	5.00	5.03	4.87	4.98
P5	2.66	2.57	2.58	2.57	2.59	2.54	2.49	2.48	2.35	2.47	4.87	4.47	4.83	4.44	4.65
Mean	2.59	2.54	2.56	2.58	2.57	2.76	2.72	2.81	2.50	2.70	4.94	4.87	4.96	4.78	4.89
Source of variation	SE±		CD at 5 %			SE±		CD at 5 %			SE±		CD at 5 %		
Packaging (P)	0.023		(NS)			0.030		0.087			0.029		0.082		
Cushioning (C)	0.021		(NS)			0.027		0.077			0.026		0.073		
Interaction (PXC)	0.046		(NS)			0.061		0.173			0.057		0.164		

P₁: Wooden box
C₁: Paddy straw

P₂: Bamboo basket
C₂: Grass

P₃: Plastic crates
C₃: Tissue paper

P₄: CFB box
C₄: Fruits without cushioning material

P₅: Loose fruit

Packaging X Cushioning

Reducing sugars was found to influence significantly by the interaction of packaging and cushioning conditions both at 7 and 14 DAP. Among the different treatment combinations tried, at 7 DAP, significantly high reducing sugars (5.08%) was observed in fruits ripened in P₄C₃-Corrugated fibre board box with tissue paper, closely followed by P₁C₁-Wooden box with paddy straw (4.78%) and P₁C₃-Wooden box with tissue paper (4.77%), which were at par with each other. Whereas, significantly the lowest reducing sugars was noticed in P₅C₄-Loose fruits without cushioning material (3.00%). The high reducing sugars under tissue paper (C₃), paddy straw (C₁) and grass (C₂) might be due to effective and accelerated hydrolytic changes which brought effective breakdown of complex carbohydrates into simple sugars (Rathore *et al.*, 2007). The similar trend of high reducing sugars in mangoes under different packaging, is also reported by Padhye (1997), Chang-bin Wei *et al.*, (2013) and Kumar *et al.*, (2013)

Total sugars (%)

Total sugars of Alphonso mango fruits as influenced by various packaging material and different cushioning materials. The data revealed that, at 7 DAP, irrespective of cushioning material used, all the packaging material significantly influenced the total sugars. Among the five packaging material, P₄-CFB box (10.60%) recorded significantly higher total sugars, very closely followed by P₁-wooden box (10.37%), which were at par with each other.

Whereas, significantly the lowest total sugars was recorded in P₅-loose fruits (9.38%). At 14 DAP, similar trend regarding content of total sugars was noticed as amongst four treatments, C₃-tissue paper (14.35%) recorded

significantly the highest total sugar percentage and minimum total sugars was observed in C₄-fruits without cushioning material (12.78 %).

Packaging X Cushioning

The normal ripening marks with the upsurge of ethylene and initiation of conversion of starch to sugars. Temperature due to heat of respiration around fruits during ripening plays a crucial role in controlling the ethylene production and overall starch metabolism (Lee *et al.*, 1995; Wills *et al.*, 2007). Under present study, this could be the possible reason why the packed fruit in general and in CFB box with tissue paper (P₄C₃) and wooden boxes with paddy straw (P₁C₁) in particular, exhibited rapid ripening and higher values for total sugar as compared to unpacked fruits.

The high total sugars under tissue paper (C₃) and paddy straw (C₁) might be due to effective and accelerated hydrolytic changes which brought effective breakdown of complex carbohydrates into simple sugars (Rathore *et al.*, 2007). The similar trend of high total sugars due to wooden (P₁) and CFB boxes (P₄) were also reported by Joshi and Roy (1986), and Padhye (1997), Chang-bin Wei *et al.*, (2013) and Kumar *et al.*, (2013).

Titrateable acidity (%)

The periodical data regarding acidity of Alphonso mango fruits as influenced by various packaging materials and different cushioning materials are illustrated in Figure 3. Data on pulp acidity as determined at 7 DAP, indicated that among the five packaging materials, P₄-CFB box registered significantly minimum acidity of (1.15%), followed P₁-wooden box (1.23%); whereas, maximum acidity of (1.67%) was retained in P₅ -loose fruits. At 14 DAP, irrespective of packaging material used, significantly minimum acidity

was observed in C₁-paddy straw (0.44%), followed by C₃-tissue paper (0.47%) which were at par with each other. Whereas, significantly maximum acidity was recorded by C₄-loose fruit without cushioning (0.74%).

Packaging X Cushioning

Pulp acidity was found to influence significantly due to interaction of packaging and cushioning conditions both at 7 and 14 DAP. Among all interactions, at 7 DAP, significantly rapid drop in acidity upto (1.01%) was recorded in P₄C₃-corrugated fibre board box with tissue paper, followed by P₁C₁-wooden box with paddy straw (1.08 %), P₄C₁-CFB box with paddy straw (1.09%), P₁C₃-wooden box with tissue paper (1.13%), P₃C₂, P₄C₂, P₂C₃, P₂C₁, P₃C₃, P₂C₄ and P₄C₄, which were at par with each other. Whereas, significantly more acidity was retained in P₅C₄-Loose fruits without cushioning material (1.80%). Considerable decline in the acidity content in the mango pulp during ripening can be attributed mainly to decrease in citrate and malate, which are present in high amount in unripe fruits but decrease towards ripening (Medlicott and Thompson, 1985). Further the decrease in acidity content in packed fruits was more probably due to rapid utilization of acids in respiration process such changes might lead to early and fast ripening this could be main reason for the fast loss of acidity in CFB boxes with tissue paper in which early and fast ripening was observed. This finding are in accordance with the finding observed by Joshi and Roy (1986) and Padhye (1997) in Alphonso mangoes, Rathore *et al.*, (2007), Tefera *et al.*, (2007), Chang-bin Wei *et al.*, (2013), Kumar *et al.*, (2013).

pH

The data on pH of Alphonso mango fruits which was found to be significantly influenced by various packaging and different cushioning material both at 7 and 14DAP, are presented in Table 1. Same trend of increase in pH continued till 14 DAP as among the five packaging materials, P₁-wooden box recorded

significantly highest pH (5.29). Whereas, significantly lowest pH was recorded in P₅-loose fruits (4.65). Data at 7 DAP, revealed that all the cushioning material significantly influenced the pH and amongst the four methods adapted, C₃-tissue paper (2.81) significantly recorded higher pH, followed by C₁- paddy straw (2.76) and C₂- grass (2.72), which were at par with each other. Whereas, the significantly lowest pH (2.50) was observed in C₄-loose. At 14 days also, significantly higher pH was recorded in C₃-tissue paper (4.96), followed by C₁-paddy straw (4.94) which were at par with each other. Minimum pH was, however, recorded in C₄-fruits without cushioning material (4.78).

Packaging X Cushioning

Fruit pH was found to influence significantly by the interaction of packaging and cushioning conditions both at 7 and 14 DAP. Among all treatment combinations tried, at 7 DAP, significantly maximum pH of (3.07) was recorded in P₁C₁-wooden box with paddy straw, closely followed by P₄C₃. Corrugated fibre board box with tissue paper (3.06), P₃C₂-plastic crate with dry grass and P₁C₃-wooden box with tissue paper (2.93), P₄C₁-CFB box with paddy straw and P₂C₃-bamboo basket with tissue paper (2.91), which all were at par with each other. Whereas, significantly lowest pH of 2.35 was noticed in P₅C₄-Loose fruits without cushioning material. The continuous rise in pH exhibited by the fruits packed in different packaging and cushioning materials till the end of storage period could probably be attributed to continuous fall in acidity mainly due to decrease in citrate and malate, which are present in high amount in unripe fruits but decrease towards ripening (Medlicott and Thompson, 1985). These finding are in close agreement with the findings of Tefera *et al.*, (2007), Chang-bin Wei *et al.*, (2013) and Padhye (1997). The maximum pH recorded by wooden box, CFB box and bamboo basket could be due to faster rate of ripening and decrease in acidity percentage under most optimum surroundings provided by these material.

From the present investigation, it could be concluded that, Amongst all different packaging and cushioning combinations tried, CFB boxes with tissue paper (P₄C₃) was found to be good closely followed by wooden box with paddy straw (P₁C₁).As both resulted into early and maximum ripening of fruits, development of good peel colour, attainment of higher fruit quality attributes in terms of TSS, total sugars, reducing sugars, acidity, pH and registered maximum shelf life of fruits, owing to less occurrence of shrivellage, spoilage and physiological loss in weight, during the course of study.

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