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A Study on the Quality Changes of Taktir Fruits (*Garcinia lancifolia*. Roxb) in Different Packages during Storage

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ABSTRACT

Packaging of fruits is an important postharvest management practice for increasing the shelf life, and till date there is no report on taktir fruits (*Garcinia lancifolia*. Roxb.) on the changes in physiological loss in weight (PLW), decay loss and fruit quality attributes in different packages under storage. In the study, fruits were harvested at 75% colour turning stage and packed in seven different packaging materials aimed to identify a suitable packaging material to extend the shelf life with desirable fruit quality under ambient condition. The result showed that the use of non-perforated LDPE exhibited the minimum PLW (2.73%) and decay (31.11%) followed by non-perforated HDPE, exhibiting shelf life up to 9 days. Fruit quality attributes *viz.* TSS (8.03°B), titratable acidity (1.72%), ascorbic acid (10.05 mg/100g) were found to retained better in fruits packed under non-perforated LDPE up to nine days of storage. Hence it is concluded that taktir fruits packed in non-perforated LDPE and HDPE maintained the overall quality of the fresh fruits for up to 9 days at ambient condition, and may be considered as an economic and alternative storage method. The packaging materials also effectively retained fruit firmness and reduced nutrient loss.

Introduction

Taktir (*Garcinia lancifolia*. Roxb) fruit belonging to the family Clusiaceae, is one of the indigenous fruits trees found in the state of Arunachal Pradesh, which is largely consumed by the rural and tribal masses. It is an ever green glabrous shrub, bearing in clusters and grows up to a height of 5 metres commonly under evergreen dense forest at an altitude range of 515 to 750 m above mean sea level (Kumar *et al.*, 2014). Fruits mature during the months of April to May, which tastes tangy when raw and become sweet on maturity attaining an attractive tomato red colour when fully ripe. Due to its high perishable nature, fruits exhibit shelf life of only 3-5 days at room temperature (25-30°C) without packaging and besides, lack of awareness on handling practices and packaging materials adds to postharvest loss. Packaging material is vital in extending the shelf life of fruits, and this will make fruits available for a longer period of time and help the growers to fetch better price. Singh *et al.*, (2008) reported the use of high-density polyethylene pouches to extend shelf life of strawberry up to six days. Similarly, shelf life of passion fruit increased upto five weeks when the fruits were packed in polyethylene terephthalate packaging (Patel *et al.*, 2009). Besides, packaging aids in retention of nutritive values over an extended period of time (Deka *et al.*, 2013). Keeping these facts in view, the present investigation was carried out to identify a suitable packaging material with an objective to extend the shelf life of the quality taktir fruits under ambient condition.

Materials and Methods

Uniform sized taktir fruits at 75 percent colour turning stage were collected from ICAR Research Farm, Gori, Basar, Arunachal Pradesh, sorted and washed thoroughly with water to remove dirt from surface and dried of remaining moisture. The fruits were then packed in seven types of packaging materials *viz.* T_1: Bamboo basket, T_2: LDPE (0.025 mm, Non-perforated), T_3: HDPE (0.025 mm, Non-perforated), T_4: LDPE (0.025 mm, 0.01% Perforation), T_5: HDPE (0.025 mm, 0.01% perforation), T_6: Leaf (*Phrynium pubinerve*) and T_7: CFB (6 breathing holes, 2 cm diameter). The packed fruits were stored at ambient condition (25 ± 2°C and 80 ± 5% RH) and data was recorded in triplicates at 3 days interval for up to 9 days following a completely randomised design. An electronic weighing balance (with accuracy of 0.01 g) was used to measure the weight of fruits. The PLW was calculated as the difference between the initial weight and the weight at the time of measurement, and expressed as percentage (% of initial weight). Decay loss was calculated from number of fruits infected on days of observation to the number of fruits initially taken (Ranganna, 1997).

$$\text{Decay loss (\%)} = \frac{\text{Total nos. of fruits taken - Total nos. of uninfected fruits}}{\text{Nos. of fruits taken}} \times 100$$

As far as biochemical analysis is concerned, total soluble solids (TSS) was determined with Erma hand refractometer (0-32°Brix) where a drop of the juice was used with a calibrated digital refractometer. Titratable acidity was estimated by titrating against 0.1N sodium hydroxide using phenolphthalein as indicator (AOAC, 2000). Ascorbic acid content was determined by titrating sample filtrate in 4% oxalic acid using 2, 6-Dichlorophenolindophenol dye to a pink point and expressed as mg/100g (AOAC, 2005). Total sugar and β-Carotene were estimated by Anthrone (Sadasivam *et al.*, 2005) and colorimetric methods (Srivastava and Kumar, 2002) respectively. Anthocyanin content was estimated as described by (Harborne, 1973) and expressed as mg/100g fruit weight, where the blended sample of 10g was mixed with 10 ml of ethanol–hydrochloric acid mixture (95% C_2H_5OH and 1.5N HCl in the ratio of 85:15), transferred into a 100 ml volumetric flask and kept overnight at 4°C, filtered through Whatman No. 1 and measured at 535 nm in spectrophotometer meanwhile the shelf life of packed fruits was determined based on visual and textural qualities of fruits by constituting a panel of five members.

Mean data of two years was subjected to analysis of variance (ANOVA) with packaging materials and storage time as the sources of variation, and mean comparison was performed using the Tukey's Honest Significant Difference (HSD) test. A difference was considered statistically significant when *p*-value was less than 0.05 ($p<0.05$). All analysis was performed with

SAS 9.3(TS1MO) software package developed by Statistical Analysis System Institute (2000).

Results and Discussion

PLW of taktir fruits stored in different packages indicate that there was gradual weight loss in all the treatments (Fig. 1). This could be due to transpiration and respiration resulting in continuous loss of moisture (Nath *et al.*, 2012). Maximum weight loss (15.85%) was recorded in treatment T_1 followed by T_6 (15.66%) and T_7 (11.15%) on 9^{th} day of storage. However, minimum weight loss (2.73%) was observed in treatment T_2 followed by T_3 (5.23%). Minimum weight loss in non-perforated polythene packaged fruits could be due to less availability of oxygen for respiration, which ultimately retarded the rate of respiration and thereby lowering the moisture loss due to transpiration whereas, higher rate of PLW in treatments T_1, T_6 and T_7 were probably due to higher moisture loss and increased respiration through uninterrupted atmospheric column and lower relative humidity (Wills *et al.*, 1998). The present findings were in agreement with the previous findings of (Sandhu and Singh, 2000; Baszczyk and Ysiak, 2001; Calvo *et al.*, 2002; Tijskens and Vollebregt, 2003). Fruit decay loss due to rotting increased as the storage period advanced irrespective of treatments (Fig. 2). This might be due to condensation of moisture on the surface of fruits, anaerobic condition, breakdown of enzymes, etc. which aided in multiplication of micro flora. However, minimum cumulative decay loss (31.11%) was recorded in treatment T_2 on 9^{th} day of storage while the maximum decay loss (48.89%) was recorded in treatments T_1 and T_6. Reduced decay loss might be attributed to limited permeability of gases (CO_2 and O_2) and water vapour, which can interplay with physiological processes of fruits (Tijskens and Vollebregt, 2003; Soliva and Martin, 2003). Our findings were in agreement with the reports of Drake and Gix (2000) and Dou-Shi Juan *et al.*, (2002) on fruits.

Changes in the fruit quality attributes during storage irrespective of treatments like the titratable acidity decreased throughout the storage period (Fig. 3). Minimum acidity (1.22%) was recorded in treatment T_1 followed by T_6 with (1.25 %) on the last day of storage whereas maximum (2.17%) was recorded T_3. Higher level of acidity might be due to reduced respiration rate in the later stage of storage as affected by film permeability to atmospheric gas (Nath *et al.*, 2012).

Reduction in acidity during storage might be associated with the conversion of organic acids into sugars and their derivatives, or due to their utilization in respiration (Zerbini, 2002). TSS increased throughout the storage period with maximum (10.07°B) recorded in fruits packed in bamboo basket (T_1) and minimum increase (8.03°B) in treatment T_2 on the 9^{th}day of storage (Table 1). The increase in TSS with the advancement of storage might be due to conversion of reserved starch and other polysaccharides to soluble form of sugars (Singh and Narayan, 1999). Slow increment in TSS may be due to production of higher levels of CO_2 leading to reduced physiological processes in fruits for slower ripening (Nath *et al.*, 2012). There was a progressive increase in total sugar up to 9 days (Table 1) with the highest (13.12%) recorded in treatment T_1. Total sugar increase during storage may possibly be due to breakdown of complex organic metabolites into simple molecules or, due to hydrolysis of starch into sugars as reported by (Pongener *et al.*, 2011) and (Kaur *et al.*, 2013). Ascorbic acid content declined in all the treatments during storage (Table 1).

Table.1 Effect of packaging materials on TSS, total sugars, ascorbic acid, β-carotene and anthocyanin of Taktir fruit during storage (25 ± 2°C and 80-85 RH)

Days after storage															Treat ments
Anthocyanin (mg/100g)			**β-carotene (µg/100g)**			**Ascorbic acid (mg/100g)**			**Total sugar (%)**			**TSS (°B)**			
9	**6**	**3**	**9**	**6**	**3**	**9**	**6**	**3**	**9**	**6**	**3**	**9**	**6**	**3**	
85.24^{A}	83.91^{BA}	51.91^{IJ} K	1.69^{A}	1.22^{ED}	0.93^{F}	8.68^{HG}	9.06^{HGF}	11.7^{BA}	13.12^{A}	9.27^{ED}	8.38^{E}	10.07^{A}	8.50^{BC}	5.63^{JHI}	T_1
72.51^{DE} C	66.63^{FEG}	40.78^{L}	1.50^{B} AC	1.24^{ED}	0.99^{EF}	10.05^{EBDG} CF	11.11^{BDAC}	12.46^{A}	9.25^{ED}	8.53^{E}	8.31^{E}	8.03^{DC}	7.25^{DF} E	5.00^{A}	T_2
67.46^{FE} G	61.24^{FH} G	49.04^{L} KJ	1.60^{B} A	1.17^{ED} F	0.92^{F}	9.59^{EHDGC} F	11.08^{EBDA} C	11.21^{BAC}	9.40^{ED}	8.51^{E}	8.50^{E}	8.50^{BC}	7.13^{DG} FE	5.40^{JI}	T_3
79.20^{BA} C	69.96^{FDE}	48.15^{L} KJ	1.60^{B} A	1.40^{BD} C	1.15^{ED} F	9.19^{HGF}	9.36^{EHGF}	10.23^{EBDG} CF	10.40^{BC} D	9.71^{CD}	9.20^{ED}	9.27^{BA}	7.50^{DC} E	6.10^{JHGF} I	T_4
75.26^{BD} EC	60.43^{IHG}	43.66^{L} K	1.61^{B} A	1.40^{BD} C	1.25^{ED} C	9.16^{HGF}	9.40^{EHDGF}	12.06^{A}	11.58^{BA}	11.30^{B} C	10. 65^{BCD}	8.50^{BC}	6.60^{HG} FE	6.03^{JHGI}	T_5
87.26^{A}	78.58^{BD} AC	56.46^{I} HJ	1.68^{A}	1.50^{BA} C	1.36^{BD} C	9.34^{HGF}	10.24^{EBDG} CF	10.73^{EBDA} CF	12.11^{BA}	11.58^{B} A	8. 06^{E}	9.80^{A}	7.13^{DG} FE	5.10^{JI}	T_6
81.40^{BA} C	74.09^{DE} C	59.93^{I} HG	1.58^{B} A	1.57^{BA}	1.40^{BD} C	8.14^{H}	8.97^{HG}	12.07^{A}	11.73^{BA}	9.25^{ED}	8.58^{E}	8.50^{BC}	6.23^{HG} FI	5.00^{J}	T_7

According to HSD Tukey's test, treatment values with different letters are significantly different ($p<0.05$) during storage (3, 6 and 9 days).

Fig.1 Changes in the physiological loss in weight (%) of taktir fruits in different packaging materials during storage (25 ± 2°C and 80-85% RH). Standard error of the mean values is indicated by vertical bars

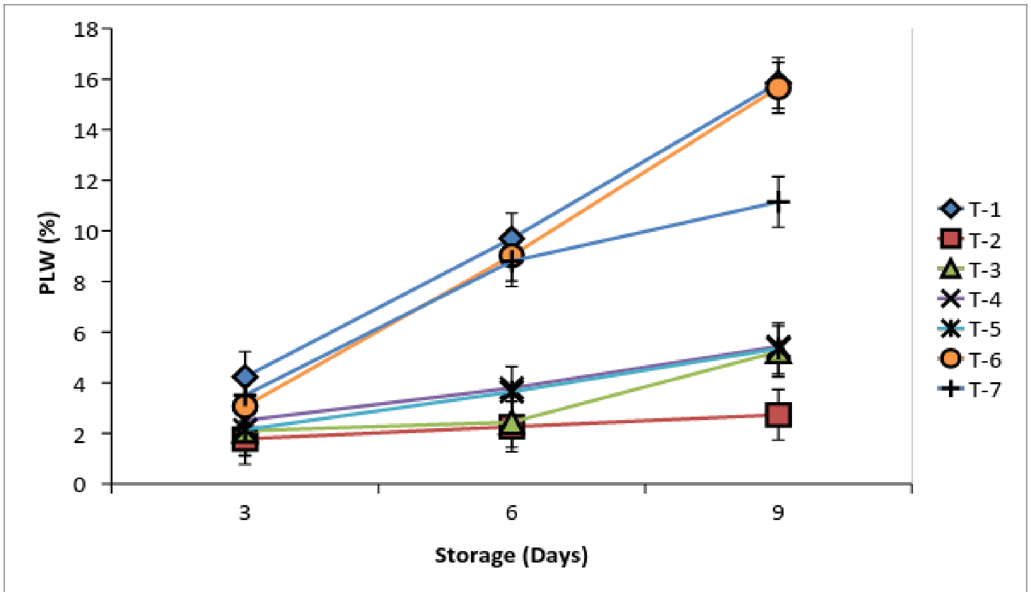


Fig.2 Changes in the decay loss (%) of taktir fruits in different packaging materials during storage (25 ± 2°C and 80-85% RH). Standard error of the mean values is indicated by vertical bars

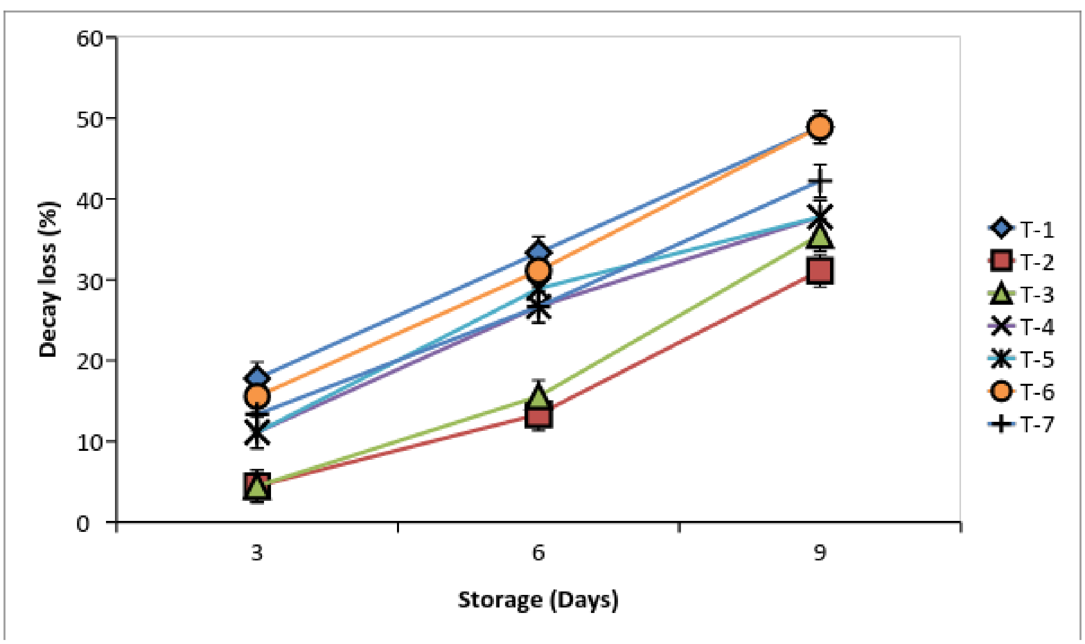


Fig.3 Changes in the titratable acidity (%) of taktir fruits in different packaging materials during storage (25 ± 2°C and 80-85% RH). Standard error of the mean values is indicated by vertical bars

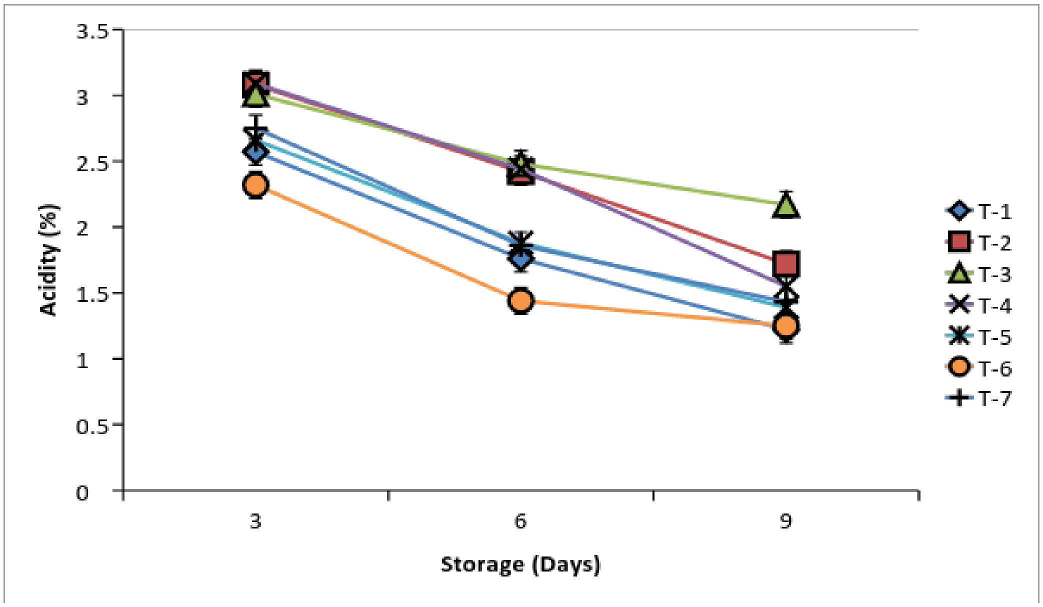
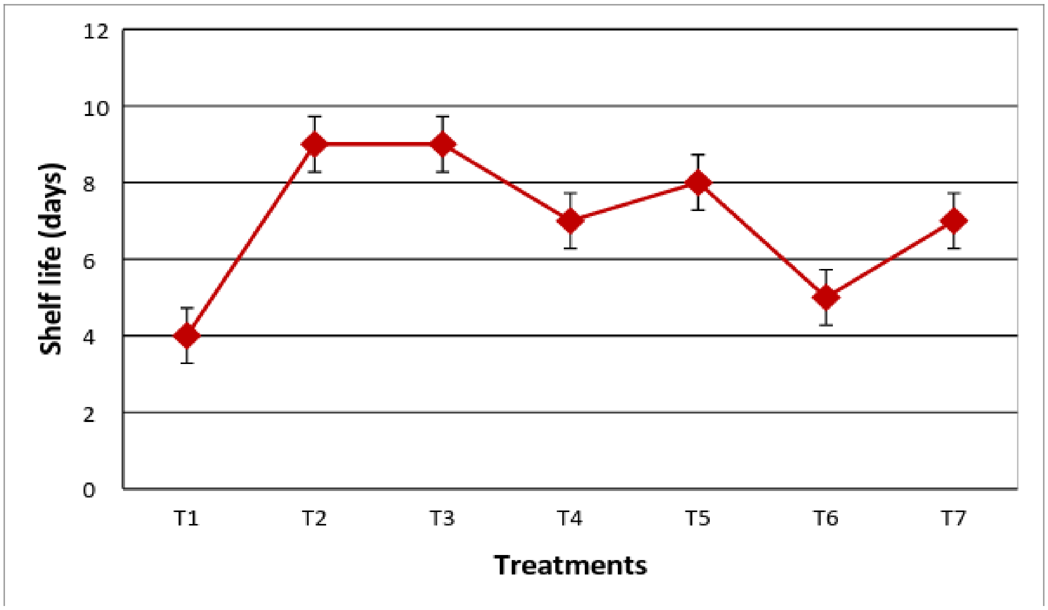


Fig.4 Shelf life (Days) of taktir fruits in different packaging materials during storage (25 ± 2°C and 80-85% RH). Standard error of the mean values is indicated by vertical bars



However on the 9th day of storage, fruits packed in LDPE non-perforated (T_2) retained higher ascorbic acid content (12.46 mg/100g) as compared to other treatments which ranged from 8.14 to 12.07 mg/100g. Oxidizing enzymes like ascorbic acid oxidase, peroxidase, catalase and polyphenol oxidase contributes in the reduction of ascorbic acid (Mapson, 1970) and activities of oxidizing enzymes might have reduced in LDPE non-perforated packages that resulted in higher retention of ascorbic acid (Nath *et al.*, 2012). Loss in ascorbic acid of kinnow mandarin during storage had been reported by Mahajan *et al.*, (2005). β-carotene content of taktir fruits increased significantly (p<0.05) with the progress of storage time (Table 1). Maximum increase (1.69 µg/100g) was observed in treatment T_1 while minimum increase (1.50 µg/100g) was recorded in fruits packed in LDPE non-perforated (T_2) on the 9th day of storage. Similar trend was reported by Ali *et al.*, (2015) confirming that LDPE non-perforated packaging delayed ripening and carotenoids synthesis. On the other hand, the increase could due to the degradation of chlorophyll and accumulation of carotenoids as the chloroplasts were transformed to chromoplasts (Kader and Grierson, 1978). On the 9th day of storage, maximum anthocyanin content (87.26 mg/100g) was found in fruits packed in leaf (T_6) followed by the treatment T_1 (85.24 mg/100g) (Table 1). This increased retention might be due to full colour development by associated enzyme - phenylalanine ammonia-lyase (Given *et al.*, 1988) and lower anthocyanin content of (67.46 mg/100g) and (72.51 mg/100g) in non-perforated HDPE and LDPE packaging material possibly of more chlorophyll content. Our finding was in agreement with that reported by Ganai *et al.*, (2015) on storage of apple. As far as shelf life is concerned, a gradual decrease in both visual and textural properties of the fruits was observed with the increase in storage time. Highest shelf life of 9 days was found in the fruits packed in both LDPE and HDPE non-perforated (T_2 and T_3) and the lowest in bamboo basket (T_1) with 4 days (Fig. 4). The extension of shelf life with different packaging materials might be attributed to the modified environment created by accumulation of CO_2, depletion of O_2 and maintenance of high humidity which helped to maintain turgidity, higher firmness and freshness during storage (Emerald *et al.*, 2001). Similar findings were reported in sapota (Joshua and Sathimurthy, 1993), kiwifruit (Bhushan *et al.*, 2002) and loquat (Amoros *et al.*, 2008). Hence, from this study it is concluded that use of non-perforated LDPE and non-perforated HDPE packaging materials can be considered as an economic and alternative method to extend shelf life of fresh taktir fruits at ambient conditions. These packaging materials besides reducing PLW and decay, also effectively retained fruit firmness, reduced nutrient loss and maintained the overall quality parameters.

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