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STANDARDIZATION OF POSTHARVEST TREATMENTS TO ENHANCE THE SHELF LIFE OF ATHALAKKAI (MOMORDICA CYMBALARIA)

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ABSTRACT
The study was carried out to Postharvest Handling Techniques for Athalakkai to Improve Storage Life (Momordica cymbalaria) .There were five treatments in factor one Viz.,C1- Control (No coating), C2 - Ascorbic acid @ 0.5 %, C3 - Calcium chloride @ 0.3 %, C4- Aloe vera extract @ 2% and C5- Gelatin starch – 5% and six treatments in factor two, P_1- Control (Without packaging), P_2- Polyethylene bag 100 gauge with 0.25 % vent, P_3- Polyethylene bag 100 gauge with 0.50 % vent, P_4- Polyethylene bag 200 gauge with 0.25 % vent, P_5- Polyethylene bag 200 gauge with 0.50 % vent, P_6- Poly shrink wrapping with three replications. Among the different treatment, best one was subjected to storage conditions Viz., Ambient condition (S1) and Refrigerated condition (S2). The results revealed that, fruits treated with Calcium chloride @ 0.3 % packed with poly shrink wrapping showed significantly lowest physiological loss in weight (PLW per cent), highest fruit firmness (Kg cm-1) and longest shelf life (days) were recorded in the fruits stored under refrigerated condition (S2).

KEYWORDS: Athalakkai; coating material; medicinal properties; packaging; shelf life; storage

1. INTRODUCTION

Athalakkai (Momordica cymbalaria), a perennial herbaceous climber belonging to the Cucurbitaceae family, closely resembles the bitter gourd. Commonly referred to as Karchikai in Kannada, Athalakkai in Tamil, Kasarakayee in Andhra Pradesh and Kakrol in other parts of India, this underutilized vegetable is widely distributed across tropical regions of Africa and India. The plant thrives as a trailing vine along the ground or climbs with the support of tendrils (1).

Athalakkai is predominantly found in Andhra Pradesh, Maharashtra, Madhya Pradesh and Tamil Nadu, where it is often cultivated along field bunds, fences and within agricultural fields for its edible fruits .Traditionally consumed as a vegetable by rural communities in South Tamil Nadu, its popularity has increased due to its rich nutritional profile and therapeutic properties. It contains significantly higher levels of essential minerals such as calcium (Ca), potassium (K) and sodium (Na) along with an abundance of Vitamin C and dietary fiber, surpassing bitter gourd in nutritional value (2).

The fruit is valued for its long shelf life and tender seeds, while its medicinal benefits extend to treating rheumatism, ulcers, skin disorders, and diarrhea. Additionally, it exhibits potent antioxidant properties. The tubers serve as a traditional remedy for diabetes mellitus and function as an anti-ovulatory agent. In Tamil Nadu, Athalakkai is cultivated in black cotton soils (Vertisols), particularly benefiting small-scale farmers who grow it alongside cucumber (3). The fruit which is recognized as a therapeutic plant has been extensively used in Asian traditional medicine for centuries. It is rich in bioactive compounds such as tannins, alkaloids, amino acids, macro- and micronutrients, phenolic acids, flavonoids, carotenoids, cucurbitane triterpenoids, and phytosterols (4). Despite its health benefits, its widespread adoption remains limited due to its bitter taste, lack of awareness regarding its nutritional value, and the absence of standardized culinary applications. A compound known as momordicin and charantin**,** found in athalakai (Momordica cymbalaria), has been reported to exhibit hypoglycemic properties, aiding in the reduction of blood sugar levels (3). The characteristic bitterness of fruit (Momordica cymbalaria) is attributed to the presence of triterpene glycosides**,** specifically momordicoside K and L**,** along with cucurbitacin-like alkaloids**,** namely momordicine I and II**.** These bioactive compounds contribute not only to the plant's distinct taste but also to its medicinal properties, including its antidiabetic, anti-inflammatory, and antioxidant effects. The tender fruits, however, are highly regarded for their medicinal properties, particularly as a functional food for diabetic individuals (5).

Athalakkai propagates through both seeds and tubers. In Tamil Nadu, it is primarily found in Virudhunagar, Madurai, Theni, Tuticorin, Dindigul, and Ramanathapuram districts and the peak market availability of vegetables occurring between November to January. Even though, it has high nutritional properties, shelf life of the fruit is very low due to its high moisture content (6). Hence, a study was conducted to standardize the postharvest treatments to enhance the shelf life of athalakai.

2. Nutritional Composition of Momordica cymbalaria

The nutritional composition of athalakkai fruit is very high. It is a rich source of vitamins, minerals, and antioxidants, and is considered very beneficial for health (9) (Table 1).

3. MATERIALS AND METHODS

The study was conducted during 2024 at Department of Postharvest Technology, Horticulture College and Research Institute, TNAU, Periyakulam to standardize the postharvest treatments with different Packing material and the storage condition to extend the shelf life of athalakai (Momordica cymbalaria). The experiment was laid out in Factorial Completely Randomized Design with five treatments in factor one, C_1- Control (No coating) ,C_2 - Ascorbic acid @ 0.5 %, C_3- Calcium chloride @ 0.3 %, C_4- Aloe vera extract @2%, C_5- Gelatin starch – 5% and six treatments in factor two, P_1- Control (Without packaging), P_2- Polyethylene bag 100 gauge with 0.25 % vent, P_3- Polyethylene bag 100 gauge with 0.50 % vent, P_4- Polyethylene bag 200 gauge with 0.25 % vent, P_5- Polyethylene bag 200 gauge with 0.50 % vent, P_6- Poly shrink wrapping with three replications . The data were analyzed statistically and interpreted.

4. RESULTS

4.1. Experiment I

4.1.1. Physiological loss in weight (%)

All the two factors, viz., different coating materials (C) and packaging materials (P) and their interaction effect differed significantly in influencing the physiological loss in weight of the fruits. Among the different coating treatments, fruits treated with Calcium chloride 0.3% (C3) recorded the lowest physiological loss in weight (9.98%) compared to the other treatments. This was followed by C5 (11.40%) and C4 (13.12%), whereas the highest loss in weight was observed in the control treatment C1 (20.10%). Among the different packaging materials, P6 (shrink wrapping) recorded the lowest physiological loss in weight (11.88%), followed by P5 (12.66%) and P4 (13.18%). The highest physiological loss in weight was recorded in P1 (control – without any packaging) with a value of 19.74%. With regard to the interaction effect, fruits treated with Calcium chloride (C3) and packed in shrink wrapping (P6) recorded the minimum physiological loss in weight (6.7%), whereas the maximum loss in weight was observed in the untreated control (C1P1) (24.3%). This clearly indicates that the combined application of appropriate coating and packaging significantly reduces weight loss during storage (Table 1) (Fig. 1).

4.1.2. Firmness of the fruit (kg/cm^2)

All the two factors, viz., different coating materials (C) and packaging materials (P), and their interaction effect showed significant differences in influencing the firmness of the fruits. Among the different coating treatments, fruits treated with Calcium chloride 0.3% (C3) recorded higher firmness (3.58 kg/cm²) compared to the other treatments. This was followed by C5 (3.50 kg/cm²) and C4 (3.37 kg/cm²), whereas the lowest firmness was observed in the control treatment C1 (2.40 kg/cm²). The results clearly indicate that coating treatments, particularly calcium chloride, helped in maintaining better fruit firmness during storage. Among the different packaging materials, P6 (shrink wrapping) recorded the highest firmness (3.90 kg/cm²), followed by P5 (3.58 kg/cm²) and P4 (3.44 kg/cm²). The lowest firmness was recorded in P1 (control – without any packaging) with a value of 2.42 kg/cm², indicating greater softening in unpackaged fruits. With regard to the interaction effect, fruits treated with Calcium chloride (C3) and packed in shrink wrapping (P6) recorded the maximum firmness (4.4 kg/cm²), whereas the minimum firmness was observed in the untreated control (C1P1) (1.9 kg/cm²)(Table 1). This clearly shows that the combined application of calcium chloride coating and shrink wrapping was most effective in retaining fruit firmness during storage (Fig. 2).

4.1.3. Shelf Life (days)

All the two factors, viz., different coating materials (C) and packaging materials (P), and their interaction effect differed significantly in influencing the shelf life of the fruits. Among the different coating treatments, fruits treated with Calcium chloride 0.3% (C3) recorded the maximum shelf life (2.53 days) compared to the other treatments. This was followed by C2 (2.22 days) and C4 (2.18 days), whereas the minimum shelf life was observed in the control treatment C1 (1.82 days). This indicates that calcium chloride treatment effectively delayed senescence and extended the storage life of fruits. Among the different packaging materials, P6 (shrink wrapping) recorded the highest shelf life (3.02 days), followed by P5 (2.76 days) and P4 (2.20 days). The lowest shelf life was recorded in P1 (control – without any packaging) with a value of 1.38 days, indicating faster deterioration under ambient conditions. With regard to the interaction effect, fruits treated with Calcium chloride (C3) and packed in shrink wrapping (P6) recorded the maximum shelf life (3.7 days), whereas the minimum shelf life was observed in the untreated control (C1P1) (1.3 days). (Table 2).This clearly indicates that the combined application of calcium chloride coating and shrink wrapping significantly enhances the shelf life of fruits (Fig. 3).

4.1.4. Splitting fruit (%)

All the two factors, viz., different coating materials (C) and packaging materials (P), and their interaction effect differed significantly in influencing the splitting percentage of fruits. Among the different coating treatments, fruits treated with Calcium chloride 0.3% (C3) recorded the lowest fruit splitting (9.75%) compared to the other treatments. This was followed by C4 (13.02%) and C5 (14.03%), whereas the highest splitting was observed in the control treatment C1 (20.27%). Among the different packaging materials, P6 (shrink wrapping) recorded the lowest splitting (10.04%), followed by P5 (11.86%) and P4 (13.34%). The highest splitting was recorded in P1 (control – without any packaging) with a value of 23.52% (Table 2). With regard to the interaction effect, fruits treated with Calcium chloride (C3) and packed in shrink wrapping (P6) recorded the minimum splitting (5.8%), whereas the maximum splitting was observed in the untreated control (C1P1) (31.0%). This clearly indicates that calcium chloride coating combined with shrink wrapping effectively reduces fruit splitting during storage (Fig. 4).

4.2. Experiment II

The best treatments identified in the present experiment clearly demonstrated that the different coating and packaging combinations (C × P), along with storage conditions (S) and their interaction effects, significantly influenced the postharvest quality of the fruits. Among the various treatment combinations**,** C3P6S2 was found to be the most effective, recording the lowest physiological loss in weight (3.6%)**,** and indicating superior moisture retention during storage. The same treatment also maintained the highest fruit firmness (5.2 kg/cm^2)**,** reflecting better textural integrity and delayed softening. Further, it exhibited the longest shelf life (9.5 days)**,** suggesting enhanced storability under the given conditions. In addition, fruit splitting was minimized (2.2%) in this treatment, indicating improved structural stability of the fruits (Table 3). Overall, the treatment combination of C3P6S2 (C3 – treatment, P6 – packaging, S2 – storage condition) proved to be the most efficient in preserving postharvest quality attributes and extending the storage life of fruits compared to other combinations (Fig.5).

5. DISCUSSION

Bitter gourd has a short shelf life of approximately four days under ambient conditions due to its high moisture content, thin cuticle and corrugated surface (6). Being a perishable fruit, it is highly prone to senescence, which leads to early yellowing and softening when stored at room temperature .Therefore, storing bitter gourd at lower temperatures could be an effective method to extend its shelf life (7). Treatment with calcium chloride slows down colour changes and delays the ripening and senescence of fruits. By sealing the openings on the fruit's skin surface, it reduces metabolic activities, including respiration and transpiration, thereby effectively extending shelf life (10, 11).

Bitter gourd fruits treated with calcium chloride exhibited lower physiological weight loss compared to those coated with chitosan, aloe vera or ascorbic acid. In fresh fruits and vegetables, weight loss primarily results from water loss due to transpiration and respiration. Applying calcium chloride coating effectively forms a physical barrier that minimizes moisture loss, thereby preventing dehydration and shrivelling. Similar results were reported by (12, 13).

The fruits will shrink or turn yellow as a result of the physiological weight loss that happens continuously during storage due to moisture loss. The current investigation suggests that the bitter gourd fruits' turgor may have been reduced by transpiration and respiration (14). The rate of deterioration varied greatly depending on the product, packing material, and storage circumstances, according to numerous studies. The bitter gourd's fruits kept well for three to five days (15).

The reduction in physiological weight loss of gherkin stored in polythene bags was due to the prevention of moisture loss, which helped maintain fruit turgidity. In the shrink-wrap technique, polythene bags were utilized; however, they led to oxygen depletion and CO_2 accumulation, resulting in a lower respiration rate (16).

Fruits stored in polythene bags using the shrink-wrap technique exhibited lower spoilage compared to other packaging materials. This could be attributed to the film's high gas permeability, which helps prevent anaerobic respiration (17). The longest shelf life was observed in fruits packed in polythene and stored under refrigeration, where spoilage was delayed, effectively extending the shelf life of bitter gourd. These findings were supported in cabbage and gherkin (18).

The reduction in weight loss may be attributed to calcium chloride ($CaCl_2$), which regulates oxygen and carbon dioxide levels within the fruit, creating a modified atmosphere that lowers water vapor transmission and respiration rates. Additionally, $CaCl_2$ strengthens cell walls, reducing permeability and minimizing moisture loss (19).

Packaging preserved a high level of firmness by reducing moisture stress and softening. Splitting of fruits is a major issue in athalakkai to overcome this problem fruits might be treated with the calcium chloride treatment preserves the firmness of the fruits and reduces the splitting of fruit. Shrink wrapping can be considered a form of modified atmosphere packaging for storing fresh fruits and vegetables. This method involves using shrink films that limit the exchange of respiratory gases, leading to increased carbon dioxide levels and reduced oxygen concentration around the produce. Such conditions help extend the storage life of the crop (20).

6. CONCLUSION

According to the study's findings, fruits coated with 0.3% calcium chloride and wrapped in shrink wrap effectively minimize physiological weight loss (PLW), preserve fruit firmness, reduce fruit splitting, and increase the shelf life of athalakkai fruit when stored in a refrigerator. The combined effect of the storage conditions and the packing

materials is probably what led to this result. Among the tested combinations, $C_3P_6S_2$ was identified as the most effective in preserving fruit quality and prolonging shelf life.

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Table 1. Effect of different coating and packaging treatments on PLW and firmness of fruits of athalakkai

Treatment	Physiological Loss in weight (%)							Firmness of the fruit(kg/c $m^{2)}$						
	P1	P2	P3	P4	P5	P6	Mean	P1	P2	P3	P4	P5	P6	Mean
C1	24.3	21.0	19.6	18.9	18.5	18.3	20.1	1.9	2.2	2.1	2.6	2.6	3.0	2.4
C2	19.8	16.5	16.3	16.1	15.4	14.8	16.48	2.1	2.9	2.8	3.6	3.7	3.7	3.13
C3	18.5	9.4	8.8	8.5	8.0	6.7	9.98	2.9	3.1	3.5	3.7	3.9	4.4	3.58
C4	18.7	12.7	12.4	12.2	11.8	10.9	13.12	2.7	2.8	3.2	3.6	3.8	4.1	3.37
C5	17.4	11.6	10.9	10.2	9.6	8.7	11.40	2.5	3.3	3.3	3.7	3.9	4.3	3.5
Mean	19.74	14.24	13.6	13.18	12.66	1.88	14.22	2.42	2.86	2.98	3.44	3.58	3.9	3.2
	SED				CD (5%)			SED			CD (5%)			
C	0.805				1.610			0.715			0.350			
P	0.735				1.470			0.160			0.320			
C x P	1.790				3.580			0.390			0.780			

Table 2. Effect of different coating and packaging treatments on shelf life and splitting of fruits of athalakkai

Treatment	Shelf life (days)							Splitting of fruits (%)-24 hrs						
	P1	P2	P3	P4	P5	P6	Mean	P1	P2	P3	P4	P5	P6	Mean
C1	1.3	1.6	1.7	1.9	2.3	2.1	1.82	31.0	19.5	20.8	18.3	18.0	14.0	20.27
C2	1.5	1.6	1.7	2.1	3.1	3.3	2.22	24.4	18.9	15.8	16.8	14.8	13.3	17.33
C3	1.7	1.9	2.1	2.6	3.2	3.7	2.53	22.0	9.2	7.9	6.8	6.8	5.8	9.75
C4	1.2	1.6	1.8	2.1	2.9	3.5	2.18	21.2	16.8	10.8	11.0	10.5	7.8	13.02
C5	1.2	16.	1.9	2.3	2.3	2.5	1.97	19.0	17.9	15.0	13.8	9.2	9.3	14.03
Mean	1.38	1.66	1.84	2.20	2.76	3.02	2.14	23.52	16.46	14.06	13.34	11.86	10.04	14.88
	SED				CD (5%)			SED			CD(5%)			
C	0.118				0.236			0.885			1.770			
P	0.108				0.216			0.810			1.620			
CxP	0.265				0.530			1.980			3.960			

Table 3. Effect of different coating, packaging treatments and storage conditions on postharvest qualities of athalakkai fruits

Treatment	PLW (%)			Firmness (kg/cm^2)			Shelf Life (days)			Split fruit (%)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
C_1P_1	23.3	7.4	15.35	3.0	4.3	3.65	2.1	3.5	2.8	15.1	10.3	12.7
C_3P_5	12.2	4.3	8.25	3.8	4.8	4.3	3.2	8.1	5.65	14.4	3.1	8.75
C_3P_6	10.4	3.6	7.0	4.2	5.2	4.7	3.5	9.5	6.5	9.1	2.2	5.65
C_5P_5	13.3	4.5	8.9	4.0	4.8	4.4	2.6	6.1	4.35	11.3	6.3	8.8
C_5P_6	12.1	4.4	8.25	3.9	4.6	4.25	3.1	6.9	5	10.1	5.2	7.65
Mean	14.3	4.8	9.55	3.78	4.74	4.26	2.9	6.8	4.86	12.0	5.42	8.71
	SED		CD (5%)	SED	CD (5%)		SED		CD (5%)	SED		CD (5%)
C P	0.605		1.260	0.230	0.480		0.300		0.620	0.530		1.100
S	0.940		1.960	0.360	0.750		0.470		0.980	0.830		1.730
CP X S	1.330		2.770	0.510	1.060		0.660		1.370	1.170		2.430

Fig. 1. Physiological Loss in Weight (%)

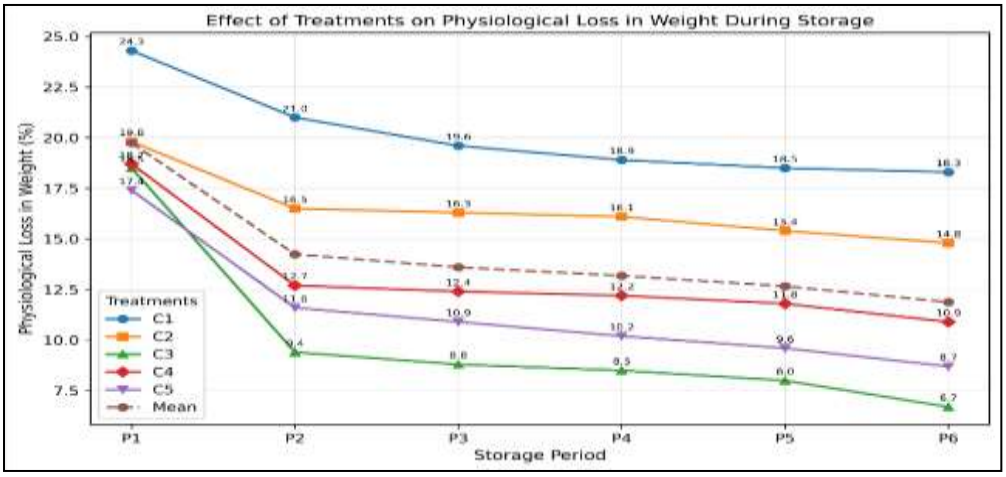

Fig. 2. Firmness (kg/cm^2)

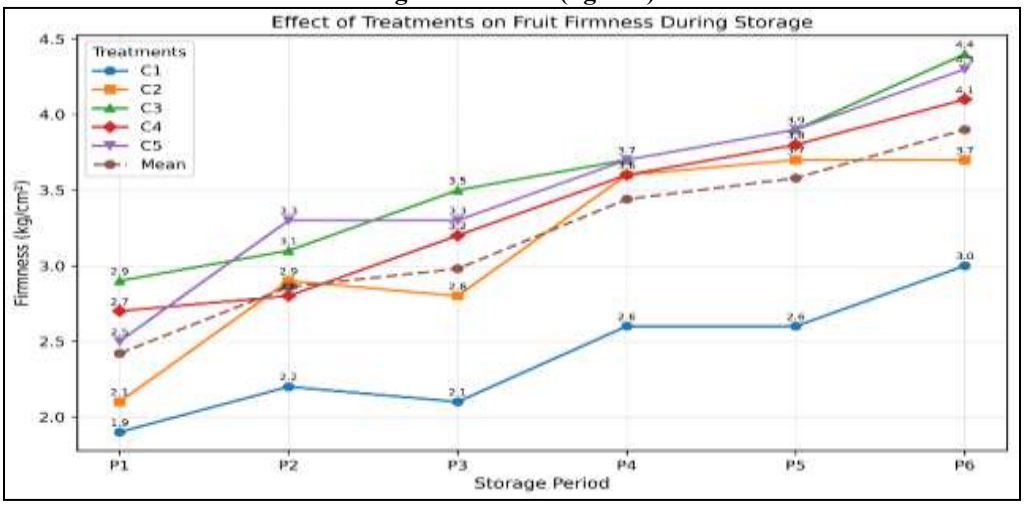

Fig. 3. Shelf life (days)

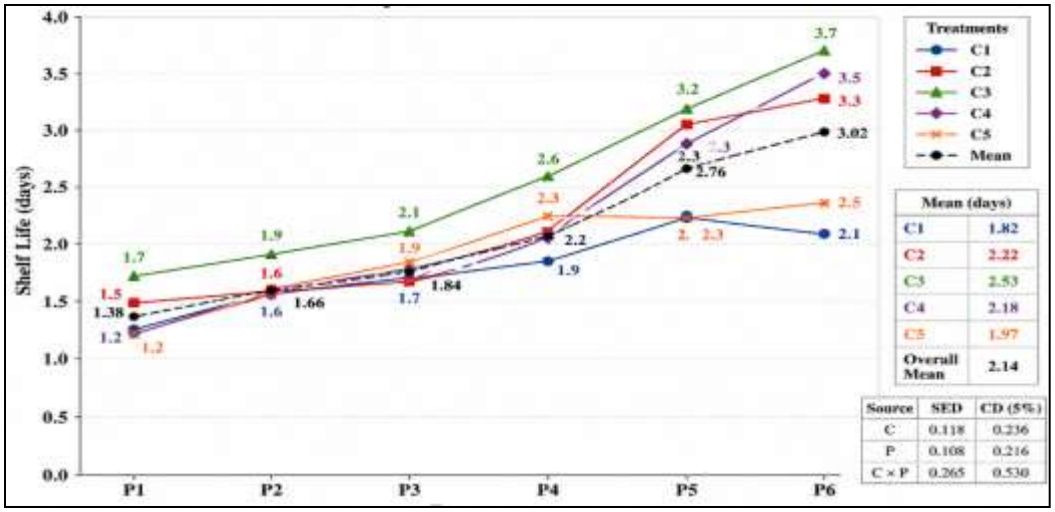

Fig.4. Fruit Splitting (%)

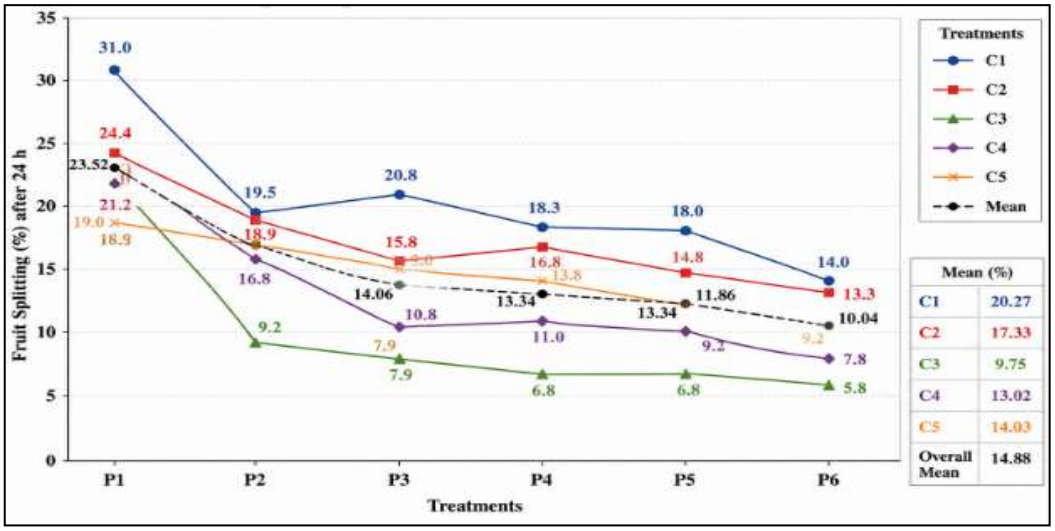

Fig.5. Effect of different coating, packaging treatments and storage conditions on postharvest qualities of athalakkai fruit