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Postharvest surface coatings enhance storability and quality of *Elaeagnus latifolia* fruits under ambient conditions

S R Assumi[1*], Vanlalruati[2], H Rymbai[3], H D Talang[3], M Bilashini Devi[3], K Puro[3], A W Yanthan[1], H Kalita[1]
[1] ICAR Nagaland Centre, Medziphema, Nagaland, India
[2] ICAR Mizoram Centre, Kolasib, Mizoram, India
[3] ICAR RC for NEH Region, Umiam, Meghalaya, India
Corresponding Author: S. R. Assumi
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Abstract
Elaeagnus latifolia, an indigenous fruit native to the foothills of Meghalaya, Northeast India, possesses high nutraceutical value and considerable potential for commercialization. However, it's extremely short shelf life and highly perishable nature has restricted utilization largely to local, fresh consumption. Despite its promise, there has been limited postharvest research focused on extending its storability and maintaining fruit quality during storage. The present study was undertaken to evaluate the effect of polysaccharide based edible coatings on the storability and quality attributes of *E. latifolia* fruits under ambient storage conditions (20±4°C; 80-90% RH). Uniformly mature fruits were treated with four types of coatings *viz.* carboxymethyl cellulose (1%), sodium alginate (2%), chitosan (1%), guar gum (1%) and monitored at two-day intervals over six days for changes in physiological loss in weight (PLW), firmness and sensory acceptability. Comparative analysis revealed that guar gum (1%) and chitosan (1%) coatings were the most effective treatments in maintaining postharvest quality. Both significantly reduced PLW (6.77 and 7.39%, respectively) and minimized fruit softening (0.84 and 0.74N), thereby extending shelf life to six days compared to only four days in uncoated control fruits. These treatments also recorded the highest overall sensory acceptability scores (8.9 in guar gum and 8.6 in chitosan), indicating superior preservation of appearance, texture and flavour. The findings demonstrate that simple, polysaccharide based edible coatings particularly guar gum and chitosan can effectively prolong the shelf life and maintain the quality of *E. latifolia* fruits under ambient conditions. This approach offers a low cost, eco-friendly postharvest intervention that can help reduce postharvest losses, support local market expansion and enable the commercial adoption of *E. latifolia* as a value-added fruit crop in the Northeastern region of India.

Keywords: Postharvest, surface coating, *Elaeagnus latifolia*, storability

Introduction
Elaeagnus latifolia L., commonly known as Bastard Oleaster, is an edible shrub belonging to the family Elaeagnaceae. Locally, it is referred to as *Muslerhi* in Sikkim, *Sohshang* in the Khasi Hills, and *Slangi* in the Jaintia Hills of Meghalaya. The species is widely distributed in the foothills of the Eastern Himalayas and occurs abundantly in the hill regions of Meghalaya, particularly the Khasi and Jaintia Hills (Rymbai *et al*., 2020) [31]. The fruits hold strong cultural and culinary importance, traditionally consumed raw with salt, pickled or used in various local preparations. Beyond its regional identity, *E. latifolia* possesses notable nutraceutical value, being rich in bioactive compounds, essential fatty acids and antioxidants (Dutta *et al*., 2018) [9]. Recent studies have highlighted its health promoting potential, including benefits in managing obesity and related metabolic disorders (Munkong *et al*., 2024) [21], which has led to increasing local market demand.

Despite these attributes, *E. latifolia* fruits are highly perishable, exhibiting rapid postharvest deterioration that limits their storability, marketability and potential for commercialization. Currently, no systematic postharvest studies have been conducted to address these limitations and the absence of effective preservation strategies restricts utilization beyond the immediate harvest period. Among available postharvest interventions, edible coatings have gained attention as an eco-friendly and costeffective technique to extend the shelf life of fresh fruits. Polysaccharide-based coatings such as carboxymethyl cellulose (CMC), sodium alginate, chitosan and guar gum have been successfully applied in fruits like strawberries, mangoes, guavas and tomatoes to delay ripening, reduce weight loss and maintain firmness, colour and sensory quality by acting as semi-permeable barriers to moisture and gases (Soradech *et al*., 2017; Prasad *et al*., 2022; Cruz-Monterrosa *et al*., 2023 Wu *et al*., 2024) [8, 25, 33, 34] Impact of silver nanoparticles (AgNPs) infused into different biopolymer edible coatings, including beeswax, gelatin, guar gum and xanthan gum to extend the shelf life is employed (Ananth *et al*., 2025) [3].

Given the absence of postharvest research on *E. latifolia*, the present study was undertaken to test the efficacy of polysaccharide-based edible coatings (CMC, sodium alginate, chitosan and guar gum) on the storability and quality retention of *E. latifolia* fruits under ambient storage conditions.

Materials and methods
This study was conducted in Postharvest laboratory, ICAR Research Complex for NEH Region, Umiam during 2021-22.

Raw material: Physiologically mature *Elaeagnus latifolia* fruits were harvested from a private orchard and immediately transported to the laboratory at Umiam. Fruits were sorted based on uniform colour and size, and those free from visible damage or microbial infection.

Coating formulation: Four polysaccharide-based edible surfa ce coatings were prepared as per standardized methods from previous studies *viz.* Carboxymethyl cellulose (CMC, 1%) was prepared in distilled water with glycerol as a plasticizer, following Ballesteros *et al*. (2018) [4]; Sodium alginate (2%) was dissolved in distilled water based on the procedure of Poverenov *et al*. (2014); Chitosan (1%) was prepared in acetic acid solution with added surfactant as described by Han *et al*. (2004) [12] Guar gum (1%) was formulated by heating in distilled water and cooling as per Qubbaj and Daraghmah (2023) [26]. All solutions were prepared using food-grade reagents and stored at 4°C until use.

Fruit coating treatments

The fruits were divided into five treatment groups (2 kg each) *viz.* T1-Control (uncoated); T2-1% CMC; T3-2% sodium alginate; T4-1% chitosan; T5-1% guar gum. Coated fruits were immersed in their respective solutions for 4 minutes, air-dried at room temperature and stored in plastic trays under ambient conditions (20±4°C, 80-90% RH). Evaluation of fruits was up to six days, (observations taken at two-day intervals) as the control fruits deteriorated beyond this duration period.

Quality analysis

Physiological loss in weight (PLW): Fruit weight was recorded using a precision electronic balance at each interval and PLW was calculated using the formula:

PWL (%) = IW – FW x 100
IW

where, IW and FW are the initial and final weights (in g) of fruits.

Fruit firmness: Fruit firmness was measured using a texture analyzer (Model TA+Di, Stable Micro Systems, UK) through a compression test and expressed in Newtons (N).

Peel colour: Fruit surface colour was recorded using a HunterLab Color Quest XE colorimeter and expressed in CIE values *viz.* L^* (lightness). Readings were taken at three locations on each fruit.

Biochemical parameters: Total Soluble Solids (TSS) were measured by a hand refractometer and expressed in degree Brix (°B) at 20°C. Titratable Acidity (TA) was estimated by acid-base titration and expressed as % citric acid (Ranganna, 1999). Total Carotenoids were quantified total coratenoids spectrophotometrically using acetone and petroleum ether extraction, based on Silva da Rocha *et al*. (2015) [32] and absorbance measured at 450 nm.

Sensory evaluation: A panel of semi-trained judges evaluated fruits for appearance, colour, texture, odour, taste and overall acceptability using a 9-point hedonic scale (9=like extremely, 1=dislike extremely), following Amerine *et al*. (1965) [2]. Evaluations were conducted on 0, 2, 4 and 6 days of storage, as the fruits exhibited a rapid decline in marketable quality beyond 6 days under the given storage conditions.

Statistical design: Data of parameters were analysed using factorial Completely Randomized Design (CRD) and treatment effects were tested at a significance level of $p<0.05$. Data collected were also subjected to analysis of variance (ANOVA) using SAS software and comparison of the means was performed using LSD's multiple range tests and $P \leq 0.05$ was considered statistically significant.

Results and discussion

Physiological loss in weight (PLW) & firmness: *Elaeagnus latifolia* fruits have very thin peel and are thereby susceptible to rapid loss of water resulting in rapid shrinkage of the fruits. Physiological loss in weight was observed during the storage period to study the effect of the surface coatings wherein all the fruits exhibited continuous decrease in weight (Table 1). However, the uncoated fruits showed maximum (13.35%) and rapid weight loss than the coated fruits (least PLW of 6.77% in T5) on 6th day of storage. The surface coatings smoothened the pericarp surface and coated the stomata resulting in reduced transpiration rates through the pores as earlier reported by Kumar *et al*. (2017) [17] in plum and Hong *et al.* (2012) [13] in guava fruits. Guar gum likely reduced transpiration by forming a semi-permeable barrier around the fruit surface, thereby delaying tissue softening, similar findings have been reported in recent study of kinnow fruits where gum-based edible coatings reduced moisture loss, respiration and cell wall degradation, resulting in delayed ripening and better firmness retention in fruits (Bhan *et al*., 2022) [5]. The addition of glycerol in the coating solution gave good results in terms of reducing sample weight loss, according to previous reports on strawberry (Garcia *et al.*, 1998) and apple (Moldão-Martins *et al*., 2003).

Table 1: Effect of surface coatings on PLW (%) of *Elaeagnus latifolia* during storage in ambient conditions

Treatment	0 DAS	2 DAS	4 DAS	6 DAS	Mean
T1	0.00±0.00	4.52±0.11	7.64±0.53	13.35±2.21	6.38
T2	0.00±0.00	3.04±0.70	3.72±1.58	8.47±0.94	3.81
T3	0.00±0.00	2.91±1.08	4.69±1.47	11.16±1.82	4.69
T4	0.00±0.00	3.57±0.37	5.44±2.67	7.39±2.14	4.10
T5	0.00±0.00	3.37±1.39	5.45±2.10	6.77±1.99	3.90
Mean	0.00	3.48	5.39	9.43	—
CD at 5%					
Treatment (A)			1.21		
Days of Storage (B)			1.09		
Interaction (A × B)			2.43		

Table 2: Effect of surface coatings on fruit firmness (N) of *Elaeagnus latifolia* during storage in ambient conditions

Treatment	0 DAS	2 DAS	4 DAS	6 DAS	Mean
T1	1.32±0.14	0.95±0.03	0.69±0.04	0.51±0.18	0.86
T2	1.29±0.08	1.01±0.09	0.90±0.08	0.72±0.03	0.98
T3	1.25±0.12	1.15±0.40	1.04±0.07	0.67±0.07	1.03
T4	1.27±0.06	1.13±0.13	0.95±0.04	0.74±0.06	1.02
T5	1.22±0.11	1.19±0.22	0.98±0.22	0.84±0.02	1.06
Mean	1.27	1.09	0.91	0.70	—
CD at 5%					
Treatment (A)			0.11		
Days of Storage (B)			0.10		
Interaction (A × B)			0.17		

Result indicate that coating with 1% guar gum (0.84N) has significantly higher fruit firmness than uncoated fruits during storage period (Table 2) wherein the uncoated fruits rapidly softened and lost their textural integrity compared to the coated fruits. Phenomenon of softening is mainly caused by the deterioration of cell wall composition during the ripening process (Ruelas-Chacon *et al*., 2017) [30] and therefore delaying fruit softening during storage is crucial to control postharvest losses. The higher retention (54 to 67%) of firmness by the coated fruits indicated that coating was effective in retarding the metabolic and enzymatic activities and therefore the degradation process of cell wall components in *Elaeagnus latifolia* fruits. Retention of higher fruit firmness in plum by chitosan coating is given by Liu *et al*. (2014) [18] and in tomato by guar gum coating is given by Qubbaj and Daraghmah (2023) [26]. Starch-lipid composite coatings significantly reduce physiological weight loss, decay and moisture loss in Indian jujube thereby retaining fruit freshness (Kaur *et al*., 2025) [14].

Peel colour & carotenoids: The result of changes in colour of *Elaeagnus latifolia* fruits in terms of lightness (L^*) during storage is shown in Fig. 1. The uncoated and coated fruits showed a decrease in lightness over storage, showing a significant decrease (23.34%) in uncoated fruits, while 1% guar gum coated fruits showed least decrease (7.67%) followed by 1% chitosan coated fruits (9.27%). Similar trends have been reported in plum (Eum *et al*., 2009) [10], sliced nectarine (Chiabrando and Giacalone, 2016) [7] and tomato (Qubbaj and Daraghmah, 2023) [26]. Chitosan coating (0.5%) in mango fruits maintained the quality during ripening after low temperature storage storage (Nguyen *et al*., 2023) [23].

The carotenoid content in the *Elaeagnus latifolia* fruits decreased during storage under ambient conditions in all the treatments (Fig. 2), which is probably due to oxidation of carotenoid pigments. However, fruits with 1% guar gum (T5) maintained the highest carotenoid content (7.10mg/100gm). Similar reduction in carotenoid content during storage of polysaccharide based edible coated muskmelon fruits is reported by Bindhu *et al*. (2024) [6].

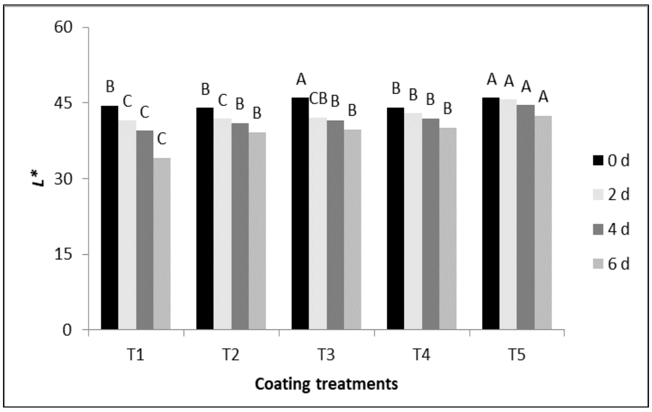

Fig 1: Effect of surface coatings on L^* of *Elaeagnus latifolia* during storage in ambient conditions

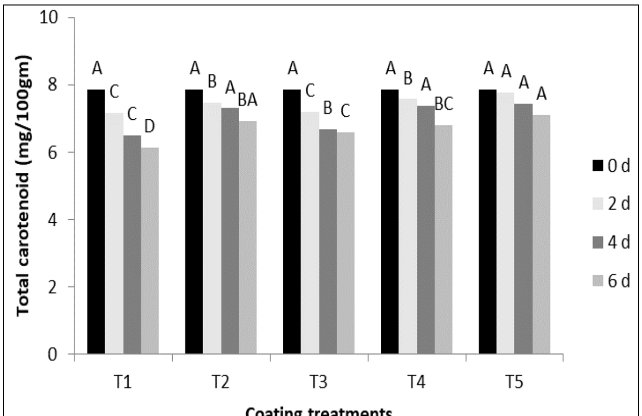

Fig 2: Effect of edible coatings on the total carotenoids of *Elaeagnus latifolia* during storage in ambient conditions

TSS & acidity: During the entire storage period, the total soluble solids (TSS) content gradually increased in all the *Elaeagnus latifolia* fruits, which could be attributed to the hydrolysis of starch to simpler sugars (Maduwanthi and Marapana, 2019). However, the coated fruits significantly delayed the increase in soluble solids content as compared to uncoated fruits (Table 3), the lowest level of soluble solids content (7.87°B) was recorded in guar gum-coated fruits throughout the storage period. Ruelas-Chacon *et al*. (2017) [30] has reported the delayed ripening and the associated raised changes in TSS with postharvest fruit coating, and our results are in conformity with those of Hong *et al*. (2012) and Ruelas-Chacon *et al*. (2017) [13, 30] where a slower rise in soluble solids content was observed in guava and tomato fruits coated with chitosan and guar gum respectively.

Table 3: Effect of surface coatings on TSS (°B) of *Elaeagnus latifolia* during storage in ambient conditions

Treatment	0 DAS	2 DAS	4 DAS	6 DAS	Mean
T1	6.61 ± 0.09	7.05 ± 0.13	7.50 ± 0.10	8.85 ± 0.05	7.50
T2	6.55 ± 0.15	7.50 ± 0.10	7.87 ± 0.10	8.41 ± 0.11	7.58
T3	6.53 ± 0.11	7.37 ± 0.06	8.18 ± 0.10	8.50 ± 0.10	7.65
T4	6.44 ± 0.07	6.87 ± 0.06	7.67 ± 0.15	8.21 ± 0.11	7.29
T5	6.51 ± 0.10	6.60 ± 0.10	7.40 ± 0.10	7.87 ± 0.15	7.09
Mean	6.52	7.08	7.72	8.37	—
CD at 5%					
Treatment (A)			0.09		
Days of Storage (B)			0.08		
Interaction (A × B)			0.19		

The titratable acidity decreased progressively during storage in uncoated as well as in coated *Elaeagnus latifolia* fruits however, sodium alginate (0.19%) and chitosan (0.18%) coating significantly retarded the decline during storage (Fig. 3). During postharvest storage, it is typical to see a decrease in total acidity which has been attributed to the use of organic acids as substrates for the respiratory metabolism (Chiabrando and Giacalone, 2016) [7]. Alginate coating delays the utilization of organic acids (Yaman and Bayoindirli, 2002 [35], and a similar pattern was found in apricot fruit coated with gum Arabic (Ali *et al*., 2021) [1].

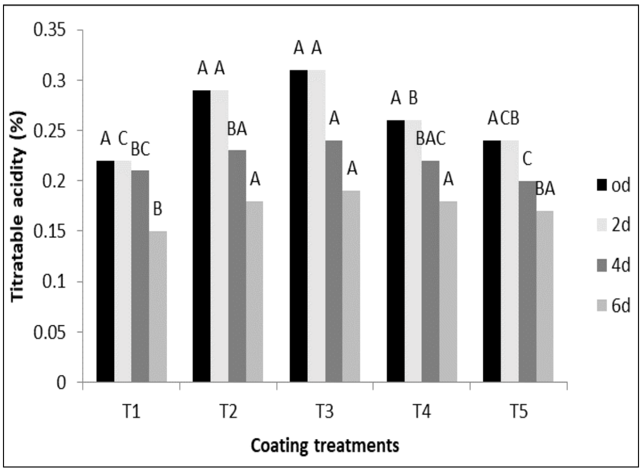

Fig 3: Effect of edible coatings on the titratable acidity of *Elaeagnus latifolia* during storage in ambient conditions

Sensory evaluation

Sensory evaluation was conducted to study the effect of surface coatings on the organoleptic acceptability. The coated fruits were more acceptable than the uncoated (control) ones at 6th days of storage and the coatings did not seem to have a negative impact on consumer acceptability (Fig 4), as it enhanced the appearance of the fruits, giving a glossy finish, resulting in higher sensory scores for appearance (8.75). Further, the uncoated fruits became unacceptable at the 4th day of storage due to increased softening (Fig. 4) as compared to the coated ones. Reinoso *et al.* (2008) and Kumar *et al.* (2018) [16, 28] have reported improved visual acceptability of coated produce and antimicrobial activity (Munoz-Tebar *et al*., 2023 [22] Romanazzi and Moumni, 2022) [29] due to its ability to inhibit the growth of spoilage and pathogenic microorganisms through disruption of microbial cell membranes and formation of a protective bioactive film on the fruit surface.

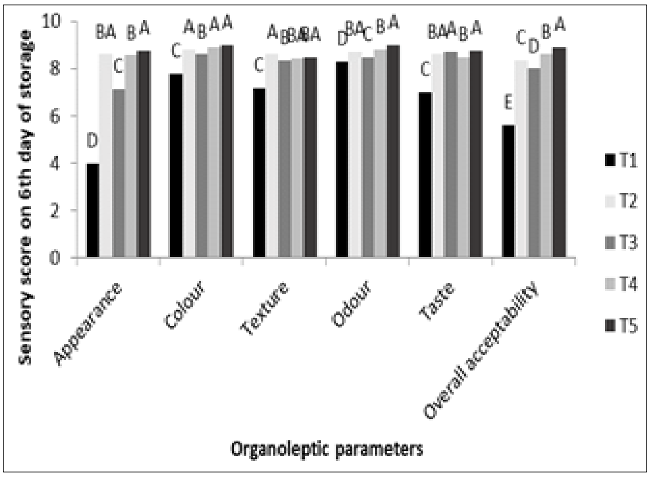

Fig 4: Effect of edible coatings on the sensory scores uncoated and coated fruits of *Elaeagnus latifolia* on 6th day of storage in ambient condition

Conclusion

The findings demonstrate that polysaccharide-based edible coatings offer a simple and effective strategy to enhance postharvest quality and extend the shelf life of *E. latifolia* under ambient storage conditions typical of Northeast India. Among the treatments evaluated, guar gum (1%) and chitosan (1%) were most effective, extending the storage life of the fruits to six days compared to four days in uncoated controls, while significantly reducing physiological weight loss and maintaining desirable texture and sensory attributes. Given the fruit's short natural shelf life and increasing local demand, the application of these coatings provides a feasible, low-cost and environmentally friendly approach to reducing postharvest losses and improving marketability. This strategy can support small-scale producers and foster local value addition, contributing to rural income generation and regional economic development. Future research should focus on assessing the efficacy of these coatings under cold storage conditions and exploring their scalability for integration into commercial supply chains, thereby strengthening the potential of *E. latifolia* as a viable value-added fruit crop.

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