

Original Research Article

Implication of nanocomposite edible coating for shelf life extension of Indian olive (*Elaeocarpus floribundus* Blume)

ABSTRACT

Aims: To study the efficacy of nanocomposite edible coating on shelf life extension of Indian olive. **Study design:** Completely randomized design. **Methodology:** We examined the effects of different concentration of guar gum as an edible coating on shelf life of Indian olives. There are five treatments and four replication viz. T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control. Different observations recorded are: loss in weight (LW), decay percentage, fruit length and breadth, Total soluble solids (TSS), Acidity, Ascorbic acid, Total sugar and reducing sugar. **Results:** Investigation revealed that the highest results were obtained in T₃ (guar gum 1.5%) in term of lowest LW% (16.85%) and decay percent (34.68%) along with preserving the chemical composition of the fruits whereas T₅ gave lowest performance. **Conclusion:** Among the different treatments, T₃ (Guar gum 1.5%) appears adequate in significantly delay in all physico-chemical parameters during storage as compared to fruits under control.

Key words: Jalpai; Guar gum; Fruit quality; Antioxidant capacity; Storage life

1. INTRODUCTION

Indian olive (*Elaeocarpus floribundus* Blume) is a species belongs to family Elaeocarpaceae that commonly occurs in the lowland, hills and mountains in Bangladesh, India, Burma, Thailand, Vietnam, Malaysia and Indonesia up to 1500 m elevation. Leaves are ovate-elliptic, thinly leathery, varying from 6.5 x 3 cm to 19 x 8.5 cm, with a long pointed tip and toothed margin [1]. In West Bengal conditions flowers appear in the summer months (April to May) and fruits are harvested during August to October [2]. Fruits are greenish, single seeded, drupe and the edible portion of the fruit is the mesocarp around the seeds. The fruits are mainly marketed locally and a very small quantity in other parts of West Bengal. However, it has a short postharvest life due to several factors such as high rate of respiration, weight loss and enhanced ripening, which result in the early deterioration of fruit quality. Cultivation of Indian olive (locally known as Jalpai) is popular in present days in homestead garden for production of several value added products likes chutneys, pickles etc. But due to the surplus of fruits

in the local markets during peak season (August to October), a substantial quantity goes to waste, resulting in heavy postharvest losses. Several techniques such as refrigeration, modified atmosphere storage, chemical preservatives and packaging are being used to minimize deleterious effects. Controlled atmosphere and hypobaric storage can lengthen the storage life of fruits but these processes are capital intensive and costly to run [5]. Among several techniques, uses of nanomaterials have potentiality to revolutionize the agricultural and horticultural food industry. Thus it can potentially enhance yields, nutritional values, ability of plants to absorb nutrients or pesticides and improved post-harvest life [3]. The using of edible coating of nanoparticles (Chitosan, Gum tragacanth, Guar gum etc.) has received more attention in recent years, due to the growing interest for low purchasing cost, reducing environmental pollution caused by plastics, the need to extend the shelf life of foods, and the increasing demand for healthier and ecological foods [4]. Among different types of edible coating, Chitosan, Gum tragacanth and Guar gum are known to extend the shelf life of guava [6], star fruit [7] and tomato [8]. However, very little information in this regard is available for this area with Indian olive. In view of the above facts this experiment was carried out to determine whether guar gum as a novel edible coating for increasing the shelf life as well as maintaining the physico-chemical properties of the fruit.

2. MATERIAL AND METHODS

2.1 Sample collection

Fully matured, uniform size Indian olive fruits were collected from a homestead garden at Nadia, West Bengal in August, 2016 and immediately brought to the laboratory of the Department of Fruits and Orchard Management, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal for ambient storage after necessary treatments. The fruits after washing in running tap water were dried in the shade for few minutes.

2.2 Treatment details and formulation

A set of 120 fruits with 30 fruits per replication were taken each of the following treatments having four replications. The fruits were subjected to edible coating of following treatments: T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control. Guar gum (purchased from HIMEDIA, Mumbai, India) coating solution was prepared on the percentage of weight basis with distilled water. 0.5g, 1g, 1.5g and 2g guar gum powder was mixed with 100mL of water for the

59 preparation of 0.5%, 1%, 1.5% and 2% solutions, respectively. Solutions were heated in oven, cooled
60 in air followed by Wijewardane *et al.*, [9].

61 **2.3. Observations recorded**

62 Fruit samples were analysed for physico-chemical properties up to 12 days of storage at an interval of
63 3 days after coating treatments.

64 **2.3.1 Loss in weight**

65 The loss in weight was calculated based on initial weight and weight at subsequent intervals. The
66 decay percentage of fruits were calculated as the number of decayed fruit divided by initial number of
67 all fruit multiplied by hundred [10].

68 **2.3.2 Length and breadth**

69 The length and breadth (millimeter scale) of Indian olive fruits were measured as an index for
70 shrinkage and it was measured by digital vernier callipers at zero time of storage (beginning) and 3
71 days interval during the storage period.

72 **2.3.3 Fruit colour**

73 The fruit colour was recorded with the help of Royal Horticulture Society Mini Colour Chart (Fifth
74 edition, 2007).

75 **2.3.4 Total Soluble Solids**

76 Total Soluble Solids (TSS) content of the fruit was recorded by hand Refractometer following the
77 principle of total refraction which was calibrated at 0°Brix at 20°C along with a temperature correction
78 correlation chart. A few drops of fruit juice from each sample were installed on the plate to record the
79 Refractometer reading, in °Brix at different temperature [12].

80 **2.3.5 Titrable acidity**

81 The titrable acidity of the fruit juice was estimated by titrating against standard alkali solution (0.1 N
82 NaOH) using the phenolphthalein indicator and is expressed in percentage [25].

83 **2.3.6 Ascorbic acid**

84 Ascorbic acid content was estimated based on the oxidation of ascorbic acid to diketogluconic acid
85 followed by coupling with 2,4 DNPH. It was measured colorimetrically by UV/Vis spectrometer (Perkin
86 Elmer, Lambda 25) and expressed as mg per 100g fruit pulp [25].

87 **2.3.7 Total sugar and reducing sugar**

88 Total sugar and reducing sugar were estimated by the method described by Mazumdar and Majumder
89 [12].

90 2.4. Statistical analysis

91 This experiment had a completely randomized design with five (5) treatments and four (4) replications.
92 The data were analysed following Analysis of Variance (ANOVA) technique and mean differences
93 were adjusted by the multiple comparison test [11] using the statistical computer based programme
94 MSTAT-C v.2.1. [26]. The significance of different source of variance was tested by error mean
95 square of 'F' test at probability level 0.05. Fisher and Yate's tables were consulted for the
96 determination of critical difference at 5% level of significance.

97 3. RESULTS AND DISCUSSION

98 3.1. Loss in weight (LW %)

99 Loss in weight increased in all the treatments as the storage period progressed (Table 1). On 3 days
100 after treatment, the LW % was found minimum (8.93%) in fruits treated with T₃ (guar gum 1.5%)
101 followed by T₄ (8.99%), whereas, it was maximum (12.73%) in the fruits under control (T₅). On 12
102 days after treatment, it (LW%) was found minimum (16.85%) in T₃ followed by T₄ (18.36%) where as
103 it was maximum (23.66%) in control (T₅). Loss in weight for all treated fruits were statistically
104 significant ($p < 0.05$) during the storage periods. The reduction in weight loss was probably due to the
105 effects of these coatings as a semi permeable barrier against oxygen, carbon dioxide, moisture and
106 solute movement, thereby reducing respiration, water loss and oxidation reaction rates [20].
107 Oluwaseun *et al.*, [14] observed that coated cucumber showed a significant delay in weight loss
108 compared to uncoated ones.

109 **Table 1. Effect of nanocoating (guar gum) on loss in weight (%) of Indian olive**

Treatments	Loss in weight			
	3 DAS	6 DAS	9 DAS	12 DAS
T ₁	9.06 (17.51)	12.16(20.42)	15.25(22.99)	18.77(20.42)
T ₂	9.05(17.51)	12.05(20.32)	15.10(22.87)	18.54(20.32)
T ₃	8.93(17.39)	10.84(19.24)	13.73(21.74)	16.85(19.24)
T ₄	8.99(17.44)	11.53(19.84)	14.53(22.40)	18.36(19.84)
T ₅	12.73(20.92)	15.66(23.32)	19.47(26.19)	23.66(23.32)
SEm (±)	0.03	0.02	0.02	0.02
CD(0.05)	0.08	0.07	0.07	0.06

110 DAS= DAYS AFTER STORAGE; T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄-
111 Guar gum 2%, T₅- Control

112 3.2 Decay percent

Observation during storage of Indian olive fruits revealed that incidence of decay percent is increased in all the treatments as the storage period progressed. However, fruits treated with 1.5% guar gum coating (T₃) showed minimum decay (34.68%) after 12 days of storage than uncoated fruits (T₅) which showed maximum decay (68.79%). The decrease in decay percentage was probably due to the effect of the coating which delaying the senescence and makes the commodity less vulnerable to pathogenic infection [21]. Similar results also reported by Rehman *et al.*, [] in strawberries and Ali *et al.*, [27] in tomatoes due to microbial inhibition characteristics of edible coatings.

Table 2. Effect of nanocoating (guar gum) on decay percent of Indian olive

Treatments	Decay			
	3 DAS	6 DAS	9 DAS	12 DAS
T ₁	8.03(16.49)	18.63(25.57)	29.35(32.80)	58.05(49.63)
T ₂	6.82(15.15)	15.45(23.15)	32.84(34.97)	45.54(42.45)
T ₃	3.53(10.82)	7.55(15.95)	15.14(22.93)	34.68(36.09)
T ₄	7.65(16.06)	18.45(25.44)	38.66(38.46)	60.15(50.86)
T ₅	12.48(20.70)	18.85(20.74)	42.15(40.50)	68.79(56.06)
SEm (±)	0.03	2.23	0.02	0.02
CD(0.05)	0.09	6.72	0.05	0.05

DAS= DAYS AFTER STORAGE; T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control

3.3. Fruit length and breadth

Observation during storage of Indian olive fruits revealed that the shrinkage percentage (Table 3) was increased in all the treatments as the storage period progressed. T₃ (Guar gum 1.5%) showed a lower percentage of shrinkage compared to other treatments and control fruits. The shrinkage percentage of T₃ was 3.12% (from 30.65 cm to 29.70 cm) for fruit length and 5.35% (from 20.77 cm. to 19.66 cm.) for fruit breadth. It might be due to the anti-senescent action of coatings which had an inhibitory effect on ethylene biosynthesis and retard the activity of enzymes responsible for ripening, cell degradation was prevented which in turn facilitated reduced moisture loss and lesser respiratory gas exchange, hence delay in senescence and lower the shrinkage percentage [13].

Table 3. Effect of nanocoating (guar gum) on length and breadth (cm) of Indian olive

Treatments	Days after treatments									
	3		6		9		12		Shrinkage	
	Length	Breadth	Length	Breadth	Length	Breadth	Length	Breadth	Length	Breadth
T ₁	30.44	20.35	30.07	19.93	29.56	19.34	28.95	18.85	4.91	7.40
T ₂	31.15	20.19	30.85	19.74	30.14	19.23	29.15	18.50	6.41	8.36
T ₃	30.65	20.77	30.43	20.52	30.16	20.24	29.70	19.66	3.12	5.35
T ₄	30.36	20.25	30.05	19.86	29.44	19.22	28.35	18.41	6.65	9.09
T ₅	29.63	20.45	28.13	19.35	27.22	18.26	25.85	16.54	12.74	19.16
SEm (±)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-	-
CD(0.05)	0.05	0.05	0.05	0.05	0.05	0.07	0.05	0.05	-	-

T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control

3.4. Fruit colour

Fruit colour of Indian olive fruits changed from different shades of green to yellowish-green during storage (Table 4). At the end of the storage, fruits became yellow and reduced their marketability. However fruits treated with guar gum 1.50% (T₃) maintained the green colour (GG143C) up to 9th day of storage, compare to other treatments and maintained consumer acceptability. Guar gum coating (1.5%) was more effective in delaying the ripening of jalpai fruits compared to control samples might be due to an increase in CO₂ and decrease in O₂ levels. Ghosh *et al.*, [22] observed that tomato coated with guar gum helped to maintain the colour during storage. Generally the yellowness increased with storage time due to ripening of fruits [23].

Table 4. Effect of nanocoating (guar gum) on fruit colour of Indian olive

Treatments	Days after treatments			
	3	6	9	12
T ₁	YGG146B	YGG146B	YGG146C	YGG146C
T ₂	YGG144B	YGG144B	YGG144B	YGG144C
T ₃	GG143A	GG143B	GG143C	YGG144B
T ₄	YGG144B	YGG144B	YGG144C	YGG144C
T ₅	YGGN144A	YGGN144B	YGGN144C	YGG144C

YGG= YELLOW GREEN GROUP; GG= GREEN GROUP; T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control

3.5. Total soluble solids (TSS)

The Total soluble solids content of the fruits were significantly affected by all the treatments. However it is decreased with the storage period progressed (Table 5). On 3 days after treatment, the TSS content was found highest (9.97 °brix) in T₃ followed by T₂ (9.46 °brix), whereas, it was lowest (8.84 °brix) in control (T₅). However, on 12 days after treatment, the TSS content was also found maximum (7.65 ° brix) in T₃ followed by T₄ (7.23 °brix) and was minimum (6.14 °brix) in T₅. These results are similar with Smith and Stow, [16] who concluded that coatings or films significantly affected TSS. Decreased respiration rates slow down the synthesis and use of metabolites resulting in lower TSS [17]. The loss of soluble solids during the storage period is as natural as sugars which are the primary constituent of the soluble solids content of a product, consumed by respiration and used for the metabolic activities of the fruits [15].

Table 5. Effect of nano coating (guar gum) on TSS (°brix) of Indian olive

Treatments	Days after treatments				
	0	3	6	9	12
T ₁	9.96	9.37	8.27	7.45	6.90

T ₂	9.99	9.46	8.25	7.65	6.95
T ₃	9.97	9.97	8.78	8.34	7.65
T ₄	9.98	9.55	8.37	8.08	7.23
T ₅	9.99	8.84	7.57	7.03	6.14
SEm (±)	0.02	0.02	0.02	0.02	0.02
CD(0.05)	NS	0.06	0.05	0.07	0.06

T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control

3.6. Titrable Acidity

The titrable acidity values of coated and uncoated fruit during storage decreased with storage time (Table 6). The value was found highest (0.61%) in T₃ on 12th days after treatment and the lowest (0.52%) in control (T₅). However, all the data were statistically significant under all the treatments from beginning to the end of storage. The low level of titrable acidity in control fruit compared to coated fruit suggests that the guar gum coating delayed ripening by providing a transparent coating around the fruit. It is also considered that coatings reduce the rate of respiration and may therefore delay the utilization of organic acids. Retention of titrable acidity has been reported previously for various fruit treated with edible coatings and films [17].

Table 6. Effect of nano coating (guar gum) on titrable acidity (%) of Indian olive

Treatments	Days after treatments				
	0	3	6	9	12
T ₁	0.66	0.64	0.63	0.58	0.56
T ₂	0.69	0.68	0.67	0.63	0.57
T ₃	0.72	0.71	0.67	0.64	0.61
T ₄	0.67	0.65	0.63	0.59	0.54
T ₅	0.65	0.63	0.59	0.56	0.52
SEm (±)	0.02	0.01	0.01	0.01	0.02
CD(0.05)	NS	0.04	0.04	0.04	0.05

T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control

3.7. Total sugar

Total sugar percentage is an important factor for determining the quality of Indian olive fruits. The flavour depends on total sugar percentage (Nandane and Jain 2011). It was decreased in all the treatments as the storage period advanced (Table 7). On 3rd days after treatment of sample, the total sugar content was found highest (8.34%) in T₃, where as it was lowest (7.89%) in the uncoated fruit. On 9th days after treatment, total sugar content was found maximum (7.85%) in T₃ where as it was minimum (7.14%) in T₅ (control). However all the treatments were statistically significant throughout the storage periods. The change of sugar content is occurred due to utilization of sugar as a respiratory substrate [19].

Table 7. Effect of nano coating (guar gum) on Total sugar (%) of Indian olive

Treatments	Days after treatments				
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	0	3	6	9	12
T ₁	8.25	8.15	7.84	7.28	6.94
T ₂	8.30	8.27	8.09	7.64	7.26
T ₃	8.36	8.34	8.24	7.85	7.65
T ₄	8.27	8.25	8.17	7.69	7.55
T ₅	8.26	7.85	7.57	7.14	6.79
SEm (±)	0.03	0.02	0.02	0.02	0.02
CD(0.05)	NS	0.05	0.05	0.05	0.05

T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control

3.8 Reducing sugar

It can be observed from Table 8, that in general reducing sugar content showed a decreasing trend with the storage time (Table 8). The reducing sugar content was found highest (5.14 %) in T₃ on 3rd days of storage whereas the lowest content (4.86 %) was found in T₅. On 12th day of storage, T₃ showed highest (4.35 %) result and the lowest (4.20 %) result was observed in control. However, the data of all coated fruit were statistically significant throughout the storage periods. The changes in reducing sugar content are occurred might be due to utilization of sugar as a respiratory substrate [19].

Table 8. Effect of nano coating (guar gum) on reducing sugar (%) of Indian olive

Treatments	Days after treatments				
	0	3	6	9	12
T ₁	4.99	4.95	4.85	4.64	4.34
T ₂	5.08	5.05	4.97	4.84	4.27
T ₃	5.16	5.14	5.05	4.85	4.35
T ₄	5.12	5.10	5.03	4.75	4.31
T ₅	4.89	4.86	4.81	4.54	4.20
SEm (±)	0.06	0.02	0.02	0.02	0.02
CD(0.05)	NS	0.05	0.05	0.05	0.06

T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control

3.9 Ascorbic acid

Observations on ascorbic acid content of Indian olive fruits presented in Table 9 revealed that all data were statistically significant under different treatments. The highest level of ascorbic acid (48.86 mg/100g pulp) was observed in T₃, closely followed by fruits in T₄ (48.45 mg/100g pulp) and the lowest level (47.57 mg/100g pulp) in control fruit on 3rd days after storage. On 12th days of storage, it was observed maximum (43.95 mg/100g pulp) and minimum (43.14 mg/100 g pulp) in T₃ and untreated fruits, respectively (Table 9). From the experimental result it is clear that coated fruits retained more amount of ascorbic acid. This was probably because guar gum coating acted as a gas barrier, inhibiting oxygen from entering the fruit, thus reducing the oxidation of ascorbic acid. Ascorbic acid is lost at later stage due to the activities of phenol oxidase and ascorbic acid oxidase enzymes during storage [24].

Table 9. Effect of nano coating (guar gum) on Ascorbic acid (mg/ 100g pulp) of Indian olive

Treatments	Days after treatments				
	0	3	6	9	12
T ₁	48.97	47.95	46.15	45.07	43.15
T ₂	48.97	48.37	46.17	45.20	43.25
T ₃	48.97	48.86	46.73	45.23	43.95
T ₄	48.98	48.45	46.27	45.20	43.45
T ₅	48.97	47.57	45.94	44.67	43.14
SEm (±)	0.01	0.02	0.02	0.02	0.02
CD(0.05)	NS	0.06	0.06	0.06	0.05

T₁- Guar gum 0.5%, T₂- Guar gum 1%, T₃- Guar gum 1.5%, T₄- Guar gum 2%, T₅- Control

4. Conclusion

Application of guar gum coating could be beneficial in prolonging the postharvest life, maintaining fruit quality and antioxidant capacity (Ascorbic acid content) of Indian olive fruits. Besides this, coatings also protected the fruits from emergence of decay by delaying the senescence as compared to the uncoated fruits. From this, we can suggest that guar gum coatings (1.5% concentration) is very promising to extend the shelf life of Indian olive fruits.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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