

Original Research Article

Implication of nanocomposite edible coating for self life extension of Indian

olive (*Elaeocarpus floribundus* Blume)

ABSTRACT

Aims: To study the efficacy of nanocomposite edible coating on self life extension of Indian olive.

Study design: Completely randomized design with 5 treatments and 4 replications.

Place and Duration of Study: Laboratory of Department of Fruits and Orchard Management, Bidhan Chandra Krishi Viswavidyalaya, in August, 2016.

Methodology: We examined the effects of different concentration of guar gum as an edible coating on self life of 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: Physiological loss in weight, decay percentage, fruit length and breadth, Total soluble solids, Acidity, Ascorbic acid, Total sugar and reducing sugar.

Results: Investigation revealed that T₃ (guar gum 1.5%) gave the best results in term of lowest PLW% (16.85%) and decay percent (34.68%) along with highest in preserving the chemical composition of the fruits viz. TSS (7.65 °Brix), acidity (0.61%), reducing sugar (4.35), ascorbic acid (43.95 mg/100gm of pulp) etc., whereas fruits under control (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: Nano material; Edible coating; Guar gum; Indian olive; Self 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 is marketed 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 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 offruits 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 them nanomaterials has potentiality to revolutionize the agricultural and horticultural food industry besides improving our understanding of the biology of various crops and thus can potentially enhance yields or nutritional values, as well as developing improved systems for monitoring environmental conditions and enhancing the ability of plants to absorb nutrients or pesticides [3]. The using of edible coating of nanoparticles 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 few or 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 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 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. 0.5gm, 1gm, 1.5gm and 2gm guar gum powder was mixed with 100ml of water for the preparation of 0.5%, 1%, 1.5% and 2% solutions, respectively. Solutions were heated in oven, cooled in air followed by Wijewardane *et al.*, [9].

2.3. Observation recorded

Fruit samples were analysed for physico-chemical properties at an interval of 3 days after treatments. The percentage of weight loss was calculated based on initial weight and weight at subsequent intervals. The decay percentage of fruits were calculated as the number of decayed fruit divided by initial number of all fruit multiplied by hundred [10]. The length and breadth (millimeter scale) of olive fruits were measured as an index for shrinkage and it was measured by digital vernier callipers at zero time of storage (beginning) and 3 days interval during the storage period. The fruit colour was recorded with the help of Royal Horticulture Society Mini Colour Chart (Fifth edition, 2007). Total Soluble Solids (TSS) content of the fruit was recorded with the help of hand Refractometer by the principle of total refraction which was calibrated at 0°Brix at 20°C with the help of a temperature correction correlation chart. A few drops of fruit juice from each sample were installed on the plate to record the Refractometer reading, in °Brix at different temperature [12]. The titrable acidity of the fruit juice was estimated by titrating against standard alkali solution (0.1 N NaOH) using the phenolphthalein indicator and is expressed in percentage and Ascorbic acid content was estimated based on the oxidation of ascorbic acid to dehydro ascorbic acid and then to diketogluconic acid

84 followed by coupling with 2,4 DNPH and measured colorimetrically by UV/Vis spectrometer (Perkin
85 Elmer, Lambda 25) expressed as mg per 100g fruit pulp [25]. Total sugar and reducing sugar were
86 estimated by the method described by Mazumdar and Majumder, [12].

87 **2.4. Statistical analysis**

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

94 **3. RESULTS AND DISCUSSION**

95 **3.1. Physiological loss in weight (PLW %)**

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

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

Treatments	Physiological loss in weight			
	3 DAS	6 DAS	9 DAS	12 DAS
T1	9.06 (17.51)	12.16(20.42)	15.25(22.99)	18.77(20.42)

T2	9.05(17.51)	12.05(20.32)	15.10(22.87)	18.54(20.32)
T3	8.93(17.39)	10.84(19.24)	13.73(21.74)	16.85(19.24)
T4	8.99(17.44)	11.53(19.84)	14.53(22.40)	18.36(19.84)
T5	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

3.2 Decay percent

Observation during storage of olive fruits revealed that coatings reduced the incidence of decay compared to control fruit for all the treatments and fruit 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 on delaying senescence, which makes the commodity more vulnerable to pathogenic infection as a result of cellular or tissue integrity [21].

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

Treatments	Decay			
	3 DAS	6 DAS	9 DAS	12 DAS
T1	8.03(16.49)	18.63(25.57)	29.35(32.80)	58.05(49.63)
T2	6.82(15.15)	15.45(23.15)	32.84(34.97)	45.54(42.45)
T3	3.53(10.82)	7.55(15.95)	15.14(22.93)	34.68(36.09)
T4	7.65(16.06)	18.45(25.44)	38.66(38.46)	60.15(50.86)
T5	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

3.3. Fruit length and breadth

Observation during storage of 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
T1	30.44	20.35	30.07	19.93	29.56	19.34	28.95	18.85	4.91	7.40
T2	31.15	20.19	30.85	19.74	30.14	19.23	29.15	18.50	6.41	8.36
T3	30.65	20.77	30.43	20.52	30.16	20.24	29.70	19.66	3.12	5.35
T4	30.36	20.25	30.05	19.86	29.44	19.22	28.35	18.41	6.65	9.09
T5	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	-	-

3.4. Fruit colour

Fruit colour of olive fruits changed from different shades of green to yellowish-green during storage (Table 4). At the end of the storage, fruits become yellow and reduced their marketability. However fruits treated with guar gum 1.50% (T₃) maintained the green colour (GG143C) up to 9th days of storage, compare to other treatments. This could be due to corn starch coating (4%) being more effective in delaying the ripening of mature lemon fruits compared to other treatment and control. Castricini *et al.*, [22] observed that papaya coated with cassava starch and carboxy methyle starch 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
T1	YGG146B	YGG146B	YGG146C	YGG146C
T2	YGG144B	YGG144B	YGG144B	YGG144C
T3	GG143A	GG143B	GG143C	YGG144B
T4	YGG144B	YGG144B	YGG144C	YGG144C
T5	YGGN144A	YGGN144B	YGGN144C	YGG144C

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, (1984) who concluded that coatings or films significantly affected TSS. Decreased respiration rates also slow down the synthesis and use of metabolites resulting in lower TSS [17]. Oluwaseun *et al.*, [14] also observed that coated cucumber showed higher TSS compared to uncoated ones. 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			
	3	6	9	12
T1	9.37	8.27	7.45	6.90
T2	9.46	8.25	7.65	6.95
T3	9.97	8.78	8.34	7.65
T4	9.55	8.37	8.08	7.23
T5	8.84	7.57	7.03	6.14
SEm (±)	0.02	0.02	0.02	0.02
CD(0.05)	0.06	0.05	0.07	0.06

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 datas 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			
	3	6	9	12
T1	0.64	0.63	0.58	0.56
T2	0.68	0.67	0.63	0.57
T3	0.71	0.67	0.64	0.61
T4	0.65	0.63	0.59	0.54
T5	0.63	0.59	0.56	0.52
SEm (±)	0.01	0.01	0.01	0.02
CD(0.05)	0.04	0.04	0.04	0.05

3.7. Total sugar

Total sugar percentage is an important factor for determining the quality of 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			
	3	6	9	12
T1	8.15	7.84	7.28	6.94
T2	8.27	8.09	7.64	7.26
T3	8.34	8.24	7.85	7.65
T4	8.25	8.17	7.69	7.55
T5	7.85	7.57	7.14	6.79
SEm (±)	0.02	0.02	0.02	0.02

CD(0.05)	0.05	0.05	0.05	0.05
----------	------	------	------	------

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 datas of all coated fruit were statistically significant throughout the storage periods. The changes in reducing sugar content is 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			
	3	6	9	12
T1	4.95	4.85	4.64	4.34
T2	5.05	4.97	4.84	4.27
T3	5.14	5.05	4.85	4.35
T4	5.10	5.03	4.75	4.31
T5	4.86	4.81	4.54	4.20
SEm (±)	0.02	0.02	0.02	0.02
CD(0.05)	0.05	0.05	0.05	0.06

3.9 Ascorbic acid

Observations on ascorbic acid content of olive fruits presented in Table 9 revealed that all datas 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

198 lost at later stage due to the activities of phenol oxidase and ascorbic acid oxidase enzymes during
199 storage [24].

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

Treatments	Days after treatments			
	3	6	9	12
T1	47.95	46.15	45.07	43.15
T2	48.37	46.17	45.20	43.25
T3	48.86	46.73	45.23	43.95
T4	48.45	46.27	45.20	43.45
T5	47.57	45.94	44.67	43.14
SEm (±)	0.02	0.02	0.02	0.02
CD(0.05)	0.06	0.06	0.06	0.05

201

202 **4. Conclusion**

203 It can be concluded from the present experiment that edible coating affects positively on the
204 physicochemical parameters of ber fruits. Among all the coating materials fruit coated with guar gum
205 1.5% (T₃) showed a significant delay in change of weight, length and breadth, total soluble solids,
206 titrable acidity, total and reducing sugar, ascorbic acid content and colour during storage as compared
207 to fruits under control. This suggests that guar gum not only extends the shelf life but also preserves
208 the ascorbic acid content which is associated with antioxidant capacity during storage and also
209 suggests that guar gum is promising as an edible coating to be used in commercial postharvest
210 applications for prolonging the storage life.

211 **CONSENT**

212 It is not applicable.

213 **ETHICAL APPROVAL**

214 It is not applicable.

215

216

217

218 **REFERENCES**

- 219 1. Singh P, Sethi A, Nigam S, Srivastava B. Hot Air Drying Characteristics of Indian Olives
220 (*Elaeocarpus floribundus*). National Conference on Emerging Technology Trends in Agricultural
221 Engineering (ETTAE), November 07–09, 2014, NERIST, Nirjuli (Itanagar).
- 222 2. Bhowmick N. Some Lesser Known Minor Fruit Crops of Northern Parts of West Bengal. Acta
223 Horticulturea. 2011;890: 61-64.
- 224 3. Tarafdar JC, Sharma S, Raliya R. Nanotechnology: Interdisciplinary science of applications. African
225 Journal Biotechnology. 2013;12(3):219-226.
- 226 4. Espino-Díaz M, De JesúsOrnelas-Paz J, Martínez-Téllez MA, Santillán C, Barbosa-Cánovas GV,
227 Zamudio-Flores PB, Olivas GI. Development and characterization of edible films based on mucilage
228 of opuntia *ficus indica* (L.). J Food Sci. 2010;75:347-352.
- 229 5. Artes F, Gomez PA, Artes-Hernandez F. Modified atmosphere packaging of fruits and vegetables.
230 Stewart Postharvest Rev. 2006;2:1-13.
- 231 6. Hong K, Xie J, Zhang L, Sun D, Gong D. Effects of chitosan coating on postharvest life and quality
232 of guava (*Psidium guajava* L.) fruit during cold storage. Scientia horticulturae. 2012;144: 172–178.
- 233 7. Nurul-Hanani MZ, Halimahton-Zahrah MS, Zaibunnisa AH. Effect of chitosan-palm stearin edible
234 coating on the postharvest life of star fruits (*Averrhoa carambola* L.) stored at room temperature.
235 International Food Research Journal. 2012;19(4):1433-1438.
- 236 8. Ghosh A, Dey K, Bhowmick N, Medda PS, Dutta P. Effect of guar gum as an edible coating to
237 improve Shelf life and quality of tomato (*Solanum lycopersicum* L.) fruits during storage. The Ecoscan.
238 2014;6:201-207
- 239 9. Wijewardane RMNA. Application of polysaccharide based composite film wax coating for shelf life
240 extension of guava (var. Bangkok Giant). International Journal of Postharvest Technology.
241 2013;1(1):16-21.
- 242 10. El-Anany AM, Hassan GFA, Rahab AFM. Effects of edible coatings on the shelf-lifeand quality of
243 Anna apple (*Malus domestica* Borkh) during cold storage. J.Food Technol. 2009;7:5-11.
- 244 11. Gomez KA, Gomez AA. Problem data. Statisticalprocedures for agricultural research, 2nd
245 edition.Wiley-Inter science Publication (John Wiley and Sons). NewYork, USA. pp. 275-315;1983.

- 246 12. Mazumdar BC, Majumder K. Determination of chemical constituents. Methods on physico-
247 chemical analysis of fruits. Daya Publishing House, Delhi. Pp.93-139; 2003.
- 248 13. Sudha R, Amutha R, Muthulaksmi S, Baby Rani W, Indira K, Mareeswari P. Influence of pre and
249 post-harvest chemical treatments on physical characteristics of sapota (*Achras sapota* L.) var. PKM-1.
250 Res. J. Agri. Bio. Sci. 2007;3(5):450-52.
- 251 14. Oluwaseun AC, Arowora KA, Bolajoko FO, Bunmi AJ, Olagbaju AR. Effect of edible coating of
252 carboxy methyl cellulose and corn starch on cucumber stored at ambient temperature. Asian J. Agri
253 Biol. 2013;1:133-40.
- 254 15. Özden C, Bayindirli L. Effects of combinational use of controlled atmosphere, cold storage and
255 edible coating applications on shelf life and quality attributes of apples. Euro. Food Res. Tech.
256 2002;214:320–26.
- 257 16. Smith SM, Stow JR. The potential of a sucrose ester coating material for improving the storage
258 and shelf-life qualities of Cox's Orange Pippin apples. Ann. Appl Bio. 1984;104: 383-91.
- 259 17. Yaman O, Bayoindirli L. Effects of an edible coating and cold storage on shelf-life and quality of
260 cherries. Lebnsn Wiss Und Technol. 2002;35:46-50.
- 261 18. Nandane AS, Jain RK. Effect of composite edible coating on physicochemical properties of
262 tomatoes stored at ambient conditions. Indian Journal of Advanced Engineering Technology.
263 2011;2(4):211-17.
- 264 19. Nandane AS, Jain RK. Effect of composite edible coating on physicochemical properties of
265 tomatoes stored at ambient conditions. Indian J. Adv. Eng. Tech. 2011;2:211-17.
- 266 20. Baldwin EA, Burns JK, Kazokas W, Brecht JK, Hagenmaier RD, Bender RJ, Peris E. Effect of two
267 edible coatings with different permeability characteristics on mango (*Mangifera indica* L.) ripening
268 during storage. Postharvest Biology and Technology. 1999;17:215-26.
- 269 21. Tanada-Palmu PS, Grosso CRF. Effect of edible wheat gluten-based films and coatings on
270 refrigerated strawberry (*Fragaria ananassa*) quality. Postharvest. Biology and Technology.
271 2005;36:199-208.
- 272 22. Castricini A, Coneglian RCC, Deliza R. Starch edible coating of papaya: effect on sensory
273 characteristics. Ciênc. Tecnol. Aliment. Campinas. 2012;32:84-92.

- 274 23. Ruzaina I, Norizzah AR, Halimahton Z, Cheow MS, Adi CS, Noorakmar MS, Mohd. Zahid A.
275 Utilisation of palm – based and beeswax coating on the postharvest life of guava (*Psidium guajava* L.)
276 during ambient and chilled storage. International Food Research Journal. 2013;20:265-74.
- 277 24. Salunkhe DK, Boun HR, Reddy NR. Storage Processing and Nutritional Quality of Fruits and.
278 Vegetables, In. Fresh Fruits Veg.. Boston: CRC Press Inc; 1991.
- 279 25. Rangana S. Ascorbic acid. In. Manual Analysis of Fruit and Vegetable Products. Tata McGraw-
280 Hill Publish. Comp. Ltd., New Delhi, pp. 94-101, 1977.
- 281 26. Russell OF. MSTAT-C v.2.1 (a computer based data analysis software). Crop and Soil Science
282 Department, Michigan State University, USA; 1994.