The Effectiveness of Edible Coating of Citrus Nobilis Var. Microcarpa Peel to Shelf Life of Tomatoes

Oktavia Nurmawaty Sigiro and Nabila
Polytechnic State of Sambas, Indonesia

Keyword: Citrus Peel, Edible Coating, Shelf Life, Waste of Fruits.

Abstract: The need of consumer for safe food has influenced the industry to develop the products they produce. Various methods have been used by the industry in these improvements, starting from selecting materials, modifying processes, adding a process, to packaging. Packaging can affect product quality including product shelf life. One of the packaging that has been developed is edible coating. This study aims to determine the effect of edible coating from Siam Sambas citrus waste (Citrus nobilis Var.Microcarpa) on fruit shelf life in terms of weight loss and fruit color changes. Edible coatings in this study were treated with a ratio of glycerol concentrations of 10 ml (ECg 10), 15 ml (ECg 15), and 20 ml (ECg 20). This study uses experimental methods using quantitative and qualitative approaches. The results showed that the best estimation of the shelf life of tomatoes was stage-5 (fresh) with ECg 10 and ECg 15 treatments which showed the appearance of tomatoes that still looked fresh at 21 days of storage. The best color change in ECg 10 and ECg 15 treatments at maturity stage-5 (red). The results of weight loss showed stage-3 (4.1617 %) the best maturity level of tomatoes, with ECg 10 (1.5152 %) treatment. The results of this study revealed that the best edible coating is ECg 10 because it can slow down weight loss, the color degradation of tomatoes is slower and the shelf life of tomatoes is longer.

1 INTRODUCTION

Increasing consumer demand for safe food has increased for several years. It causes industries have been improving their products to be safe food with some ways such as adding additives, tecnologies, and packaging. Food packaging is one way to maintain the safety of food products. Most packaging is use plastic while its have many negative effect for human and environment. Therefore, using organic component has been being one of alternative way to to replace hazardous materials such as plastic. It is can be made from waste of fruit or vegetable because they have many content that can still be used. The waste can be made into edible coating material to replace plastic packaging.

Edible coating is a protective coating for food that can be eaten. Research on edible coatings has been carried out on food and fruits. Research on the effect of edible coatings has been carried out on food stuffs such as Gouda cheese, fish feed, cold storage of fresh pork, ready to eat carbonado chicken, meatballs, and many more products of food industry.

This coating effects also have studied in fruits and vegetables such as red guava ‘Pedro Salto, fresh cut and preserve papaya, cashew apples, guavas, strawberries, preservation of peach fruit, and other fruit to extend shelf life.

Several authors have studied edible coating with different organik resources which from main resources or waste. This smart coating can be made with chitosan, rosemary extract, cordia myxa gum, Cumin essential, xanthan gum, and can be produced with waste of fruit namely peel.

Fruit waste can be in the form of peels, seeds and including the results of fruit extraction. The skin of the fruit is the part of the fruit that is still rarely used. Therefore, fruit waste is often disposed of and becomes a new problem in the environment. The skin of the fruit still has content that can be used, but because it cannot be eaten directly and people still do not know the content and utilization of the waste so that the waste is disposed of. Waste can still be used because it still has useful content. One of fruit peel which can be used as edible coating material is citrus waste.

Sigiro, O. and Nabila, .
The Effectiveness of Edible Coating of Citrus Nobilis Var. Microcarpa Peel to Shelf Life of Tomatoes.
DOI: 10.5220/0011770800003575
In *Proceedings of the 5th International Conference on Applied Science and Technology on Engineering Science (iCAST-ES 2022)*, pages 346-351
ISBN: 978-989-758-619-4; ISSN: 2975-8246

Orange is a plant that grows a lot in the tropics, one of which is in Indonesia. There are several types of citrus that have been cultivated in Indonesia, one of which is the Siamese orange Sambas (*Citrus nobilis* var. Microcarpa). Cultivation of this type of citrus is quite large and increases every year, but the use of fruit is still dominant in the flesh. This causes more and more waste to be wasted. The waste will be a new problem for the environment while there are still many contents that can be utilized from the orange peel waste, one of which is for the manufacture of edible coatings. The innovation of this research is the type of orange used, namely Siam Sambas citrus (Citrus nobilis var. Microcarpa), which has never been done in research on the manufacture of edible coatings.

2 MATERIAL AND METHODS

2.1 Material

Edible coating (EC) was obtained from *Citrus nobilis* var. Microcarpa peel, distilled water, citric acid 40%, ethanol 96%, pectin powder, aquades, glycerol, potassium sorbate, CMC (Carboxy Methyl Cellulose), stearic acid and baking soda. Materials to test the effectiveness of edible coatings are tomatoes with different levels of maturity (stage 3-5).

The tools used in this research are knife, basin, baking sheet, blender, scales, drainer, 60 mesh sieve, beaker, hot plate and magnetic stirrer, filter paper, filter funnel, litmus paper, filter cloth, oven, petri dish, glass measuring, analytical balance, spoon, dropper, spoon, spatula, bottle, tweezers, basket (drain), and container.

2.2 Methods

This study uses experimental methods using quantitative and qualitative approaches. This study measures weight loss, colour change, and estimating the shelf life of tomatoes.

The process of exracting pectin from Citrus nobilis var. Microcarpa

Citrus nobilis var. Microcarpa peel dried and mashed to make flour of citrus peel. The flour process with ethanol 96%, citric acid 40% with heating. The pectin as the result mashed to be material for edible coating.

The process of making an edible coating solution

Pectin 10g mixed with 500 ml of distilled water and heated using a hot plate at 70°C. Add 2 grams of CMC, stir for 30 minutes. Add 10 grams of Citrus nobilis var. Microcarpa peel pectin flour, stir for 3 minutes. Add glycerol 10 ml, 15 ml, and 20 ml stir for 3 minutes. Add 2.5 ml of potassium sorbate and 2.5 ml of stearic acid and stir for 3 minutes at 70°C. Cool the edible coating solution at room temperature (27 ° C), then check the pH of the edible coating solution.

Measurement of effectiveness of EC from Citrus nobilis var. Microcarpa

Analysis the effectiveness of EC Citrus nobilis var. Microcarpa was carried out on tomatoes with variations glycerol e.i. glycerol 10 ml (EG10), glycerol 15 ml (EG15), and glycerol 20 ml (EC20). All tomatoes storaged in 27 ° C for 21 days and observed every 3 days until 21st day.

3 RESULTS AND DISCUSSION

Tomato Fruit Weight Loss Percentage Stage-3

The study was conducted to determine the effect of edible coating of *Citrus nobilis* var. Microcarpa peel on tomato fruit weight loss at room temperature (27°C). The effectiveness of EC on tomatoes weight loss at stage 3 (Figure 1), stage 4 (Figure 2), and stage 5 (Figure 3) compared with tomatoes without coating with EC at each stage.

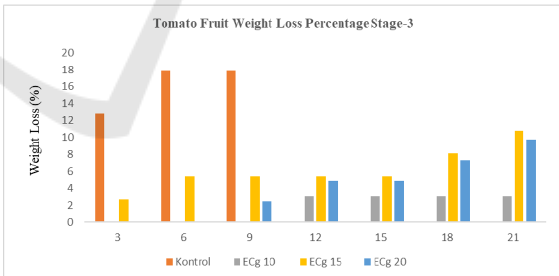

Figure 1: Tomato Fruit Weight Loss Percentage Stage-3 at room temperature (27 ° C) for 21 days.

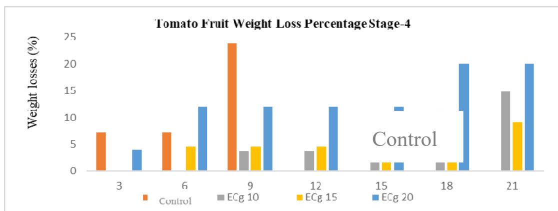

Figure 2: Tomato Fruit Weight Loss Percentage Stage-4 at room temperature (27 ° C) for 21 days.

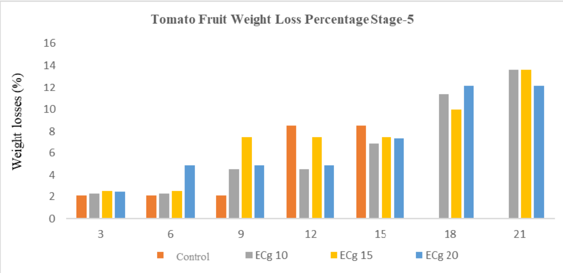

Figure 3: Tomato Fruit Weight Loss Percentage Stage-4 at room temperature (27 ° C) for 21 days.

Weight loss of tomatoes without coating with EC started from the first three days of observation. Losses of stage-3 and stage-4 of tomatoes without EC which storaged at 27 ° C were significantly affected. The tomatoes of these both stage which without coating by EC went rotten on 10th day. The stage-5 of tomatoes without EC still lasts until the 15th day and then rots.

At first three days of observation, weight loss of tomatoes which was coated by EC with 15 ml were affected i.e. stage-3 (2.7 %) and stage-5 (2.5 %). EC with glycerol 20 ml prevented losses in stage-3 until 6th day of observation. EC with 10 ml glycerol maintained tomato weight better than EC with 15 ml and 20 ml glycerol in stage-3 tomatoes. Weight loss tomatoes stage 4 was well maintained by EC with glycerol 15 ml. Stage-5 tomatoes weight loss maintained well by EC with glyserol 20 ml.

Weight loss of stage-3 of tomatoes which coated by EC with 20 ml glycerol began in 9th day about 2.44%. EC with 10 ml glycerol shows resistance to mass loss until 9th day to stage-3 and 6th day to stage-4. This study show that EC from Citrus nobilis var. Microcarpa has effect to tomatoes weight loss. It prevented respiration and oxidation of tomatoes cell and coating the fruit to prevent biological damage in the same way with other EC with different material.

Tomatoes without EC has massive weight loss because tomatoes evaporate and exchange air and microorganisms on the fruit. In the presence of contamination, tomatoes will rot more quickly. EC with 15 ml glycerol kept weight loss more than without EC but less than EC with 20 ml and 10 ml. The EC that can keep tomatoes from losing weight is EC with 10 ml of glycerol. That's because when EC coating, the surface of the tomato fruit is completely coated by EC. The EC blocks all the pores that can be a gap for water evaporation of tomatoes. EC also causes tomato fruit to avoid oxidation because the EC layer inhibits air and microorganisms from entering the fruit by closing the lenticels on the fruit skin.

EC with glycerol 10 ml is better than EC with glycerol 15 ml and 20 ml. The result shows that every 3 days observing, EC 10 ml can prevent weight loss upto 76.47% than without EC. This study shows that EC from Citrus nobilis var. Microcarpa peel can apply on tomato as a climateric fruit. Application of EC with 10 ml glycerol prevented tomatoes weight loss so EC can improve fruit storability. With the application of EC, fruit quality improves with a longer shelf life.

Fruit Colour Changes

The color change was observed by looking at the color change of the fruit based in maturity level once every three days until the twenty-first day (Table 1).

Based on the observations in table 1 above, tomatoes without EC coating experienced decay on the fourth observation, namely day 9 for stage 3 and stage 4. Tomato stage 5 underwent decay on day 12.

At stage-3, tomatoes with EC coating ran a color change from the 3rd day of observation. Tomatoes with initial yellowish green color became orange on day 21 for tomatoes with EC coating with 10 ml and 15 ml glycerol. In tomatoes that were coated with EC with 20 ml of glycerol, the fruit changed color to yellow on day 21. All tomatoes survived until the last day while tomatoes without EC underwent spoilage on the 4th observation, namely the 9th day. The results showed that the fruit could survive until the last day of observation, which was the twenty-first day and the color change was longer than without EC coating. Coating with EC resulted in better retention of ascorbid acid, delayed the increase in total soluble solids and total reducing sugars and delayed colour changes .

At stage-4, tomatoes with EC coating experienced a color change starting from the 6th day of observation on tomatoes coated with EC with 20 ml of glycerol. Tomatoes with initial orange color to red color on day 21 for tomatoes with EC coating with 10 ml, 15 ml and 20 ml glycerol. All tomatoes survived until the last day while tomatoes without EC were rotting on the 4th observation, namely the 9th day. EC has significant effect in respiration and ethylene evolution rates. It delayed the colour changes as compared to fruits without coating with EC.

At stage-5, tomatoes with EC coating did not change color, but tomatoes without EC rot on day 12. With a more mature level of maturity than stage-3 and stage-4, fruit at stage-5 lasted until day 21. This shows that EC can maintain ripe fruit longer than fruit without EC.

Table 1: Colour Changes of Tomatoes.

Sample	Day	Treatment			
		Control	**ECg 10**	**ECg 15**	**EC g 20**
Stage-3	1	Yellowish green	Yellowish green	Yellowish green	Yellowish green
	3	Yellowish green	Greenish yellow	Greenish yellow	Greenish yellow
	6	Orange	Greenish yellow	Greenish yellow	Greenish yellow
	9	Orange (rotten)	Yellowish orange	Greenish yellow	Yellow
	12	-	Yellowish orange	Greenish yellow	Yellow
	15		Orange	Yellow	Yellow
	18		Orange	Orange	Yellow
	21		Orange	Orange	Yellow
Stage-4	1	Orange	Orange	Orange	Orange
	3	Orange	Orange	Orange	Orange
	6	Orange	Orange	Orange	Reddish orange
	9	Orange (rotten)	Orange	Orange	Red
	12	-	Reddish orange	Red	Red
	15	-	Reddish orange	Red	Red
	18	-	Reddish orange	Red	Red
	21	-	Red	Red	Red
Stage-5	1	Red	Red	Red	Red
	3	Red	Red	Red	Red
	6	Red	Red	Red	Red
	9	Red	Red	Red	Red
	12	Red (rotten)	Red	Red	Red
	15	-	Red	Red	Red
	18	-	Red	Red	Red
	21	-	Red	Red	Red

(-): Sample Damaged (rotten)

4 CONCLUSIONS

The conclusion obtained from this study is that EC from the peel of the Sambas Siamese orange (Citrus nobilis Var. Microcarpa) has an effect on shelf life which is reviewed based on weight loss and changes in tomato color. In weight loss, the best orange peel EC was EC with the addition of 10 ml and 15 ml of glycerol. On color change, EC can slow down the color change of tomatoes at stage 3 and stage 4 while tomatoes without EC coating have rotted on the ninth day. In stage-5 tomatoes, EC maintained tomato color when tomatoes without EC had rotted from day 12.

REFERENCES

Ganesh KS, Sridhar A, Vishali S. Utilization of fruit and vegetable waste to produce value-added products: Conventional utilization and emerging opportunities-A review. Chemosphere [Internet]. 2022;287:132221. Available from: https://doi.org/10.1016/j.chemosphere.2021.132221

Berti S, Ollé Resa CP, Basanta F, Gerschenson LN, Jagus RJ. Edible coatings on Gouda cheese as a barrier against external contamination during ripening. Food Biosci [Internet]. 2019;31(February 2018):100447. Available from: https://doi.org/10.1016/j.fbio.2019.100447

Huang K, Nitin N. Edible bacteriophage based antimicrobial coating on fish feed for enhanced treatment of bacterial infections in aquaculture industry. Aquaculture [Internet]. 2019;502(September 2018):18–25. Available from: https://doi.org/10.1016/j.aquaculture.2018.12.026

Xiong Y, Chen M, Warner RD, Fang Z. Incorporating nisin and grape seed extract in chitosan-gelatine edible coating and its effect on cold storage of fresh pork. Food Control. 2020;110.

Huang M, Wang H, Xu X, Lu X, Song X, Zhou G. Effects of nanoemulsion-based edible coatings with composite mixture of rosemary extract and ε-poly-L-lysine on the shelf life of ready-to-eat carbonado chicken. Food Hydrocoll [Internet]. 2020;102(September 2019):105576. Available from: https://doi.org/10.1016/j.foodhyd.2019.105576

Desvita H, Faisal M, Mahidin, Suhendrayatna. Preservation of meatballs with edible coating of chitosan dissolved in rice hull-based liquid smoke. Heliyon [Internet]. 2020;6(10):e05228. Available from: https://doi.org/10.1016/j.heliyon.2020.e05228

Beikzadeh S, Khezerlou A, Jafari SM, Pilevar Z, Mortazavian AM. Seed mucilages as the functional ingredients for biodegradable films and edible coatings in the food industry. Adv Colloid Interface Sci [Internet]. 2020;280:102164. Available from: https://doi.org/10.1016/j.cis.2020.102164

Formiga AS, Pinsetta JS, Pereira EM, Cordeiro INF, Mattiuz BH. Use of edible coatings based on hydroxypropyl methylcellulose and beeswax in the conservation of red guava 'Pedro Sato.' Food Chem [Internet]. 2019;290(December 2018):144–51. Available from: https://doi.org/10.1016/j.foodchem.2019.03.142

Tabassum N, Khan MA. Modified atmosphere packaging of fresh-cut papaya using alginate based edible coating: Quality evaluation and shelf life study. Sci Hortic (Amsterdam) [Internet]. 2020;259(September 2019):108853. Available from: https://doi.org/10.1016/j.scienta.2019.108853

dos Passos Braga S, Magnani M, Madruga MS, de Souza Galvão M, de Medeiros LL, Batista AUD, et al. Characterization of edible coatings formulated with chitosan and Mentha essential oils and their use to preserve papaya (Carica papaya L.). Innov Food Sci Emerg Technol [Internet]. 2020;65(June):102472. Available from: https://doi.org/10.1016/j.ifset.2020.102472

de Oliveira Alves Sena E, Oliveira da Silva PS, de Aragão Batista MC, Alonzo Sargent S, Ganassali de Oliveira Junior LF, Almeida Castro Pagani A, et al. Calcium application via hydrocooling and edible coating for the conservation and quality of cashew apples. Sci Hortic (Amsterdam) [Internet]. 2019;256(May):108531. Available from: https://doi.org/10.1016/j.scienta.2019.05.058

Arroyo BJ, Bezerra AC, Oliveira LL, Arroyo SJ, Melo EA de, Santos AMP. Antimicrobial active edible coating of alginate and chitosan add ZnO nanoparticles applied in guavas (Psidium guajava L.). Food Chem [Internet]. 2020;309:125566. Available from: https://doi.org/10.1016/j.foodchem.2019.125566

Khodaei D, Hamidi-Esfahani Z. Influence of bioactive edible coatings loaded with Lactobacillus plantarum on physicochemical properties of fresh strawberries. Postharvest Biol Technol [Internet]. 2019; 156 (June): 110944. Available from: https://doi.org/10.1016/j.postharvbio.2019.110944

Jiao W, Shu C, Li X, Cao J, Fan X, Jiang W. Preparation of a chitosan-chlorogenic acid conjugate and its application as edible coating in postharvest preservation of peach fruit. Postharvest Biol Technol [Internet]. 2019;154(December 2018):129–36. Available from: https://doi.org/10.1016/j.postharvbio.2019.05.003

Salama HE, Abdel Aziz MS, Alsehli M. Carboxymethyl cellulose/sodium alginate/chitosan biguanidine hydrochloride ternary system for edible coatings. Int J Biol Macromol [Internet]. 2019;139:614–20. Available from: https://doi.org/10.1016/j.ijbiomac.2019.08.008

Liu X, Zhang C, Liu S, Gao J, Cui SW, Xia W. Coating white shrimp (Litopenaeus vannamei) with edible fully deacetylated chitosan incorporated with clove essential oil and kojic acid improves preservation during cold storage. Int J Biol Macromol [Internet]. 2020;162:1276–82. Available from: https://doi.org/10.1016/j.ijbiomac.2020.06.248

Hernández-López G, Ventura-Aguilar RI, Correa-Pacheco ZN, Bautista-Baños S, Barrera-Necha LL. Nanostructured chitosan edible coating loaded with α-pinene for the preservation of the postharvest quality of Capsicum annuum L. and Alternaria alternata control. Int J Biol Macromol [Internet]. 2020; 165: 1881–8. Available from: https://doi.org/10.1016/j.ijbiomac.2020.10.094

Kumar N, Pratibha, Neeraj, Ojha A, Upadhyay A, Singh R, et al. Effect of active chitosan-pullulan composite edible coating enrich with pomegranate peel extract on the storage quality of green bell pepper [Internet]. Vol. 138, Lwt. Elsevier Ltd; 2021. 110435 p. Available from: https://doi.org/10.1016/j.lwt.2020.110435

Kõrge K, Bajić M, Likozar B, Novak U. Active chitosan–chestnut extract films used for packaging and storage of fresh pasta. Int J Food Sci Technol. 2020;55(8):3043–52.

El-Mogy MM, Parmar A, Ali MR, Abdel-Aziz ME, Abdeldaym EA. Improving postharvest storage of fresh artichoke bottoms by an edible coating of Cordia myxa gum. Postharvest Biol Technol [Internet]. 2020;163(January):111143. Available from: https://doi.org/10.1016/j.postharvbio.2020.111143

Alizadeh Behbahani B, Noshad M, Jooyandeh H. Improving oxidative and microbial stability of beef using Shahri Balangu seed mucilage loaded with Cumin essential oil as a bioactive edible coating. Biocatal Agric Biotechnol [Internet]. 2020; 24 (March): 101563. Available from: https://doi.org/10.1016/j.bcab.2020.101563

Joshy KS, Jose J, Li T, Thomas M, Shankregowda AM, Sreekumaran S, et al. Application of novel zinc oxide reinforced xanthan gum hybrid system for edible coatings. Int J Biol Macromol [Internet]. 2020;151:806–13. Available from: https://doi.org/10.1016/j.ijbiomac.2020.02.085

Lara G, Yakoubi S, Villacorta CM, Uemura K, Kobayashi I, Takahashi C, et al. Spray technology applications of xanthan gum-based edible coatings for fresh-cut lotus root (Nelumbo nucifera). Food Res Int [Internet]. 2020;137(March):109723. Available from: https://doi.org/10.1016/j.foodres.2020.109723

Sigiro ON, Elysapitri, Habibah N. Edible Coating Limbah Kulit Pisang untuk Perpanjang Umur Simpan Buah Tomat Edible Coating from Banana Peel Waste to Extend Tomato Shelf Life. AGRITEKNO J Teknol Pertan. 2022;11(2):54–60.

Sigiro ON, Sukmayani, Habibah N. Potensi bahan pangan tepung biji durian setelah melalui masa penyimpanan. 2020;3(2):229–33.

Sambas B. Kabupaten Sambas dalam Angka 2020.

Ebrahimi F, Rastegar S. Preservation of mango fruit with guar-based edible coatings enriched with Spirulina platensis and Aloe vera extract during storage at ambient temperature. Sci Hortic (Amsterdam) [Internet]. 2020;265(February):109258. Available from: https://doi.org/10.1016/j.scienta.2020.109258

Ordoñez R, Contreras C, González-Martínez C, Chiralt A. Edible coatings controlling mass loss and Penicillium roqueforti growth during cheese ripening. J Food Eng [Internet]. 2021;290:110174. Available from: https://doi.org/10.1016/j.jfoodeng.2020.110174

Al-Tayyar NA, Youssef AM, Al-Hindi RR. Edible coatings and antimicrobial nanoemulsions for enhancing shelf life and reducing foodborne pathogens of fruits and vegetables: A review. Sustain Mater Technol [Internet]. 2020;26:e00215. Available from: https://doi.org/10.1016/j.susmat.2020.e00215

Xie B, Zhang X, Luo X, Wang Y, Li Y, Li B, et al. Edible coating based on beeswax-in-water Pickering emulsion stabilized by cellulose nanofibrils and carboxymethyl chitosan. Food Chem [Internet]. 2020;331:127108. Available from: https://doi.org/10.1016/j.foodchem.2020.127108

Pavinatto A, de Almeida Mattos AV, Malpass ACG, Okura MH, Balogh DT, Sanfelice RC. Coating with chitosan-based edible films for mechanical/biological protection of strawberries. Int J Biol Macromol [Internet]. 2020;151:1004–11. Available from: https://doi.org/10.1016/j.ijbiomac.2019.11.076

Arnon-Rips H, Porat R, Poverenov E. Enhancement of agricultural produce quality and storability using citral-based edible coatings; the valuable effect of nano-emulsification in a solid-state delivery on fresh-cut melons model. Food Chem [Internet]. 2019;277:205–12. Available from: https://doi.org/10.1016/j.foodchem.2018.10.117

Arnon-Rips H, Poverenov E. Improving food products' quality and storability by using Layer by Layer edible coatings. Trends Food Sci Technol [Internet]. 2018;75:81–92. Available from: https://doi.org/10.1016/j.tifs.2018.03.003

Vishwasrao C, Ananthanarayan L. Delayed post-harvest ripening-associated changes in Manilkara zapota L. var. Kalipatti with composite edible coating. J Sci Food Agric. 2017;97(2):536–42.

Chaudhary S, Kumar S, Kumar V, Sharma R. Chitosan nanoemulsions as advanced edible coatings for fruits and vegetables: Composition, fabrication and developments in last decade. Int J Biol Macromol [Internet]. 2020;152:154–70. Available from: https://doi.org/10.1016/j.ijbiomac.2020.02.276

Kumar P, Sethi S, Sharma RR, Srivastav M, Varghese E. Effect of chitosan coating on postharvest life and quality of plum during storage at low temperature. Sci Hortic (Amsterdam) [Internet]. 2017; 226 (August): 104–9. Available from: http://dx.doi.org/10.1016/j.scienta.2017.08.037

Valero D, Díaz-Mula HM, Zapata PJ, Guillén F, Martínez-Romero D, Castillo S, et al. Effects of alginate edible coating on preserving fruit quality in four plum cultivars during postharvest storage. Postharvest Biol Technol [Internet]. 2013;77:1–6. Available from: http://dx.doi.org/10.1016/j.postharvbio.2012.10.011

Kumar P, Sethi S, Sharma RR, Singh S, Varghese E. Improving the shelf life of fresh-cut 'Royal Delicious' apple with edible coatings and anti-browning agents. J Food Sci Technol [Internet]. 2018;55(9):3767–78. Available from: https://doi.org/10.1007/s13197-018-3308-6