The Pharma Innovation Journal 2021; 10(11): 809-813

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 809-813

www.thepharmajournal.com
Received: 06-09-2021
Accepted: 18-10-2021

Effect of postharvest dipping on quality and shelf life of minimally processed jackfruit (*Artocarpus heterophyllus* Lam.) flakes during storage

V Gomathi, V Premalakshmi, J Rajangam and K Venkatesan

V Gomathi
Department of Fruit Science, HC&RI, TNAU, Periyakulam, Tamil Nadu, India

V Premalakshmi
Department of Fruit Science, HC&RI, TNAU, Periyakulam, Tamil Nadu, India

J Rajangam
Department of Fruit Science, HC&RI, TNAU, Periyakulam, Tamil Nadu, India

K Venkatesan
Department of Floriculture and Landscape Architecture, HC&RI, Periyakulam, Tamil Nadu, India

Corresponding Author:
V Gomathi
Department of Fruit Science, HC&RI, TNAU, Periyakulam, Tamil Nadu, India

Abstract
Jackfruit has great scope as minimally processed (fresh cut) fruit because of its size and difficulty in peeling the skin. Jackfruit flakes in fresh cut form along with suitable postharvest technology can be convenient for consumers. In this context, the experiment was carried out to study the effect of postharvest dipping on quality and shelf life of minimally processed jackfruit (*Artocarpus heterophyllus* Lam.) var. Palur 1 during storage at postharvest laboratory, Horticultural College and Research Institute, Periyakulam, Theni, Tamil Nadu. Fresh cut jackfruit flakes were washed with cold chlorinated water followed by dipping the fruits using ascorbic acid (0.5% and 1.0%), calcium chloride (0.5% and 1.0%) and their combinations for five minutes. Then the fruits were packed in polyethylene terephthalate jar with silicon membrane window on the lid and stored at refrigerated condition. Result indicated that the jackfruit flakes treated using 1.0% of ascorbic acid with 1.0% of calcium chloride (T_8) recorded minimum PLW (4.10%), TSS (24.10ºBrix), color change (2.45) and maximum firmness (40.44 N), compared to control. The maximum shelf life of about 16 days was found in T_8 followed by ascorbic acid (0.5%) with calcium chloride (0.5%), ascorbic acid (0.5%) with calcium chloride (1.0%) and ascorbic acid (1.0%) with calcium chloride (0.5%) recorded 15 days compared to control which had minimum shelf life of about only eight days.

Keywords: Jackfruit, flakes, minimal processing, quality, shelf life

Introduction
Jackfruit (*Artocarpus heterophyllus* Lam.) is also known as “Poor man’s food” and it is one of the important under-utilized fruit crop belongs to the family Moraceae. It is indigenous to Western Ghats of India (Jagadeesh *et al.*, 2007 and Prakash *et al.*, 2009) [15, 24]. It is widely grown in tropical and subtropical countries like Brazil, Malaysia, Indonesia, India and Philippines. India is the second largest producer of jackfruit in the world with an area of about 1, 85,000 ha producing 17, 64,000 MT fruits (NHB, 2018-19) [21]. In India, jackfruits are found to be distributed in southern states like Tamil Nadu, Kerala, Karnataka, Goa, Coastal Maharashtra and other states like, Bihar, Assam, Tripura, Uttar Pradesh and foothills of Himalayas. Jackfruit type is sorosis (multiple fruit) and each fruit normally weighs about 10-30kg (Haque *et al*., 2015) [13]. The fruit has three parts, *viz.*, Rind (spike) about 50-55% of fruit weight, flakes which is golden yellow in color (30-32% of the fruit weight) and each flakes having single seed (18% of the fruit weight) (Srivastava *et al*., 2017) [36]. Lack of knowledge during handling and storage of jackfruit leads to postharvest losses of about more than 30% (Mondal *et al.*, 2013 and Swami *et al.*, 2014) [19, 37].
In the past few years, there has been a great demand for the minimally processed (fresh cut) fruits and vegetables because of its convenience, quality and better nutritional retainment (Yousuf *et al*., 2020) [41]. Jackfruit has great scope as minimally processed (fresh cut) fruit because of its size and difficult to peel the skin (FAO, 2010) [10]. Normally, fresh cut fruits are washed, sanitized, sliced, packaged and stored at refrigerated condition. Using preservatives such as ascorbic acid, calcium chloride at low levels was found to reduce browning, maintain firmness in addition to this; it also extends the shelf life of the fresh cut produce (Soliva Fortuny *et al*., 2002 and Martinez Ferrer *et al*., 2002) [33, 18].
In the packaged fresh cut fruit produce, development of desired flavor is one of the main criteria which impact the consumer preference (Robertson, 2009) [28]. The main objectives of modified atmospheric packaging are quality maintenance, shelf life extension, reduction of postharvest loss *etc*., (Caleb *et al*., 2013) [5]. Use of chemical preservatives such as anti-browning agents (citric acid, ascorbic acid etc.,) with different modified atmospheric

packaging at low temperature storage condition not only extends the shelf life but also reduce the microbial decay without altering the sensory qualities of fresh cut produce (Lee *et al*.,1995 and Cocci *et al*., 2006) [17, 9]. In the view of above, the present study was carried out to investigate the effect of minimal processing on physicochemical properties of fresh cut jackfruit at refrigerated storage condition.

Materials and Methods

Matured jackfruit var. Palur 1 without any physical damages was collected from the Central farm, Department of Fruit Science, Horticultural College and Research Institute, Periyakulam, Theni, Tamil Nadu. Jackfruits were surface sterilized using 100 ppm of chlorinated water for five minutes, then the fruits are cut opened manually and the flakes were separated from the rind. Flakes were washed using 30 ppm of cold chlorinated for five minutes. Then the flakes were divided into nine groups for postharvest treatments. Treatments were divided into T_1 (0.5% of ascorbic acid), T_2 (1.0% of ascorbic acid), T_3 (0.5% of calcium chloride), T_4 (1.0% of calcium chloride), T_5 (0.5% of ascorbic acid with 0.5% of calcium chloride), T_6 (0.5% of ascorbic acid with 1.0% of calcium chloride), T_7 (1.0% of ascorbic acid with 0.5% of calcium chloride), T_8 (1.0% of ascorbic acid with 1.0% of calcium chloride) and T_9 (control). Then the fruits were dipped for five minutes. In each treatment sodium benzoate was added as a common preservative (0.045%). Dipped fruits were dried, packed in polyethylene terephthalate jar (500ml) with silicone membrane window on the lid and packed fruits were stored at refrigerated condition. Physicochemical parameters were taken once in three days. The experiment was carried out in completely randomized design with three replications and the observations on quality parameters were taken once in three days.

Physiological loss in weight (%)

Physiological loss in weight (PLW) was calculated by using the formula given by Abound, 1974 and it was expressed in per cent (%).

$$\text{Physiological loss in weight (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Total soluble solids (⁰Brix)

Total soluble solids (TSS) were measured by using digital handheld pocket refractometer (Model: PAL-3). It was expressed as ⁰Brix.

Color

Changes in color during storage of jackfruit bulbs were observed using portable digital colorimeter. Results were obtained as L* (lightness (51-100) and darkness (0-50), a^* (a^{+ve} indicates red whereas a^{-ve} indicates green), b^*(b^{+ve} indicates yellow and b^{-ve} indicates blue). Using these values, total color change (ΔE) was calculated using the formula (Rana *et al*., 2018 and Johari *et al*., 2020) [27, 16].

$$\Delta E = \sqrt{(L_2-L_1)^2 + (a_2-a_1)^2 + (b_2-b_1)^2}$$

Where

L_1, a_1, b_1- initial value of the sample
L_2, a_2, b_2 - final value of the sample

Firmness (N)

The firmness of jackfruit flakes were measured by using Fruit Hardness Tester (Model: FR-5120) having a plunger (diameter -11mm). The fruit firmness was expressed as Newton.

Shelf life (Days)

Shelf life of minimally processed jackfruit was assessed by number of days the flakes in edible condition without any browning. Freshness assessment was based on visual appearance of the fruit *i.e*., by color, level of pathogenic decay, juiciness etc. (Nanda *et al.*, 2001).

Statistical Analysis

The experiment was carried out in completely randomized design (CRD) with nine treatments and three replications. The results obtained were subjected to analysis of variance (ANOVA) at $P < 0.05$ level of significance using AGRES software (Panse and Sukhatme, 1967) [23].

Result and Discussion

Physiological loss in weight (%)

Physiological loss in weight is an indicator of freshness. It normally increases during storage of fresh cut fruits (Antunes *et al*., 2010) [2]. Minimal processing operations generally increases the wound induced ethylene, water activity and surface area per unit volume which also increases the water loss of produce (Sandhya, 2010) [30]. Weight loss of jackfruit packed in PET jar was shown in (Table 1). Dipping the flakes using ascorbic acid and calcium chloride significantly influenced the water loss upto 15 days during refrigerated storage condition. Minimum PLW (4.10%) was observed in samples treated using 1.0% ascorbic acid and 1.0% calcium chloride (T_8) followed by 0.5% ascorbic acid and 1.0% calcium chloride (T_6) having 4.37 per cent whereas maximum PLW was found in control (11.05%) at 15th day of storage. Minimum reduction in weight loss in calcium treated fruits might be due to its role in strenghthening of cell wall. It was also found to preserve the structural and functional integrity of membrane systems (Thakur *et al*., 2019) [38]. Waghmare and Annapure, (2013) [40] stated that water loss was higher in non treated fresh cut papaya at 15th day of storage whereas no loss was found in treated ($CaCl_2$ at 1.0% and Citric acid at 2.0%) samples throughout the storage. Hussein *et al*. (2015) [14] also reported that higher weight loss was observed in minimally processed pomegranate arils in perforated packages. Similar findings were reported in strawberry (Nielsen and Leufven, 2008) [22] and litchi (Somboonkaew and Terry, 2010) [34].

Total soluble solids (ºB)

Total soluble solids increased throughout the storage period. TSS was significantly influenced by the ascorbic acid and calcium chloride treated flakes. Total soluble solids of jackfruit were increased from 19.5ºB to 28.10ºB (Figure 1). Minimum TSS (24.10ºB) was recorded in T_8 (1.0% ascorbic acid and 1.0% calcium chloride) followed by T_6 (0.5% ascorbic acid and 1.0% calcium chloride) having 24.45ºB whereas, maximum TSS was noted in control (28.10ºB). This increase in TSS content is due to solubilization of carbohydrates and it is an indicator of ripeness (Waghmare and Annapure, 2013) [40]. Somogyi *et al.* (1996) [35] stated that the increase in brix acid ratio of the fresh cut jackfruit bulbs may be due to degradation of starch into simple sugars during storage, which might be the reason for increased TSS and decreased acidity i.e., observed during sensory evaluation. Similar findings were reported by Saxena *et al*. (2008) [31] in jackfruit and Bico *et al*. (2009) [4] in fresh cut banana.

Color

One of the major factors in consumer preference is the golden yellow color of jackfruit bulbs (Saxena *et al*., 2008) [31]. In the present study, change in color value increased throughout the storage period which was shown in (Figure 2)**.** Minimum (ΔE= 2.45) color change was observed in T_8 (1.0% ascorbic acid and 1.0% calcium chloride) followed by 3.73 in T_6 (0.5% ascorbic acid and 1.0% calcium chloride) whereas, maximum (ΔE= 12.98) color change was observed in control during 15th day of storage under refrigerated condition. Vacuum packed fresh cut jackfruit bulbs had minimum change in color, moderate change in normal and MA packaged samples compared to control which has the maximum color change during tenth day of storage (Rana *et al.*, 2018) [27]. Varela *et al*. (2007) [39] stated that the ascorbic acid and calcium chloride treated minimally processed apples were found to maintain the lightness and chroma value during storage which is due to its radical scavenging activity and anti browning property. Chaibrando and Giacalone (2012) [8] also reported that the ascorbic acid, calcium chloride and citric acid were found to inhibit color change in apple cubes during cold storage for 5-10 days. Fresh cut pears treated with calcium chloride, calcium lactate and calcium propionate had maximum color retention than the control (Gomes *et al.*, 2010) [11].

Firmness (N)

Softening is one of the major factors affecting quality of fruits during storage. It is normally due to starch hydrolysis to sugar and by the degaradation of cell wall which is involved in fruit ripening (Guerreiro *et al*., 2015) [12]. Decrease in firmness is directly proportional to moisture loss which results in decreased turgor pressure and crispness of the fresh cut produce (Beaulieu and Gorny, 2002) [3]. During this study, firmness was significantly influenced by the dipping treatment and it was decreased from 44.50N to 35.86N (Table 1). At 15th day of storage, maximum firmness (40.44 N) was retained in T_8 (1.0% of ascorbic acid with 1.0% of calcium chloride) followed by T_6 (1.0% of ascorbic acid with 1.0% of calcium chloride) having 39.76 N whereas, minimum firmness was recorded in control (35.86 N). Saxena *et al.* (2008) [31] stated that the firmness was maximum retained in pre-treated ($CaCl_2$, ascorbic acid, citric acid and sodium benzoate) jackfruit bulbs compared to control. Chantanwarangoon and Kader (2000) [6] also reported that $CaCl_2$ at 1.0% maintained minimum softening in fresh cut mango fruits. Ascorbic acid, calcium chloride and citric acid were retained maximum firmness in fresh cut apples during cold storage (Chiabrando and Giacalone, 2012) [8]. Addition of calcium chloride may be found to preserve the firmness by inhibiting the synthesis of enzymes which is responsible for cell wall degradation and by the formation of calcium pectate which results in the inhibition of pectin solubilization (Rosen and Khader, 1989; Soliva-Fortuny *et al*., 2007) [29, 32].

Shelf life (Days)

Increase in shelf life was due to better cell wall integrity because of calcium infusion had thicken calcium pectate in the cell wall. Shelf life of dipped jackfruit flakes packed in PET jar and stored under refrigerated condition was shown in Table 1**.** Maximum shelf life of 16 days after storage was recorded in T_8 [1.0% ascorbic acid and 1.0% calcium chloride] followed by T_5 [0.5% ascorbic acid and 0.5% calcium chloride], T_6 [0.5% ascorbic acid and 1.0% calcium chloride] and T_7 [1.0% ascorbic acid and 0.5% calcium chloride] having 15 days whereas control samples had only eight days. Prathiba *et al. (*2019a) [25] reported that the jackfruit bulbs treated with 1.0% of $CaCl_2$ and 0.25% of ascorbic acid, packed in vacuum packaging had recorded the maximum shelf life of about 33 days followed by bulbs packed in stand on pouch (32.67 days). Similar findings were reported by Saxena *et al. (*2008) [31] and Prathiba *et al*. (2019b) [26] in jackfruit.

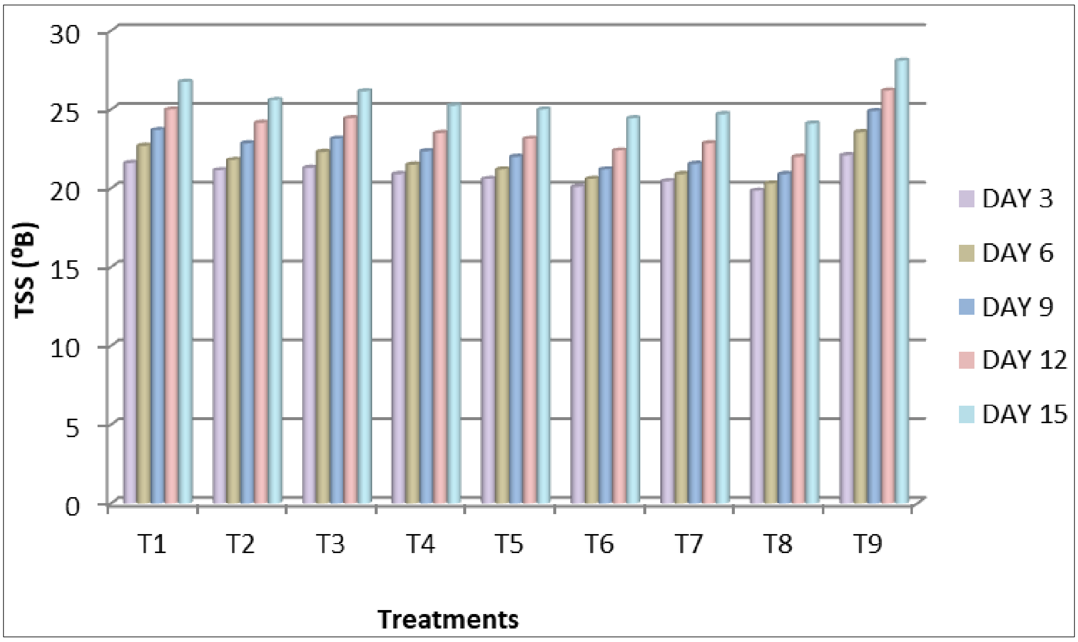

Fig 1: Effect of postharvest treatment on total soluble solids (ºB) of minimally processed jackfruit flakes during storage

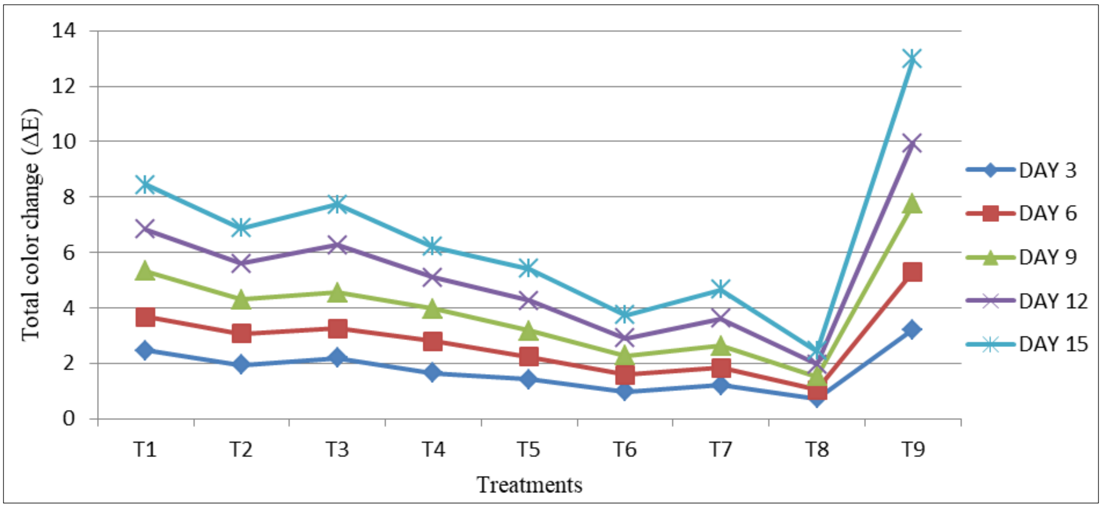

Fig 2: Effect of postharvest treatment on total color change (ΔE) of minimally processed jackfruit flakes during storage

Table 1: Effect of postharvest treatment on Physiological loss in weight (%), Firmness (N) and Shelf life of minimally processed flakes during storage

Treatment	Physiological loss in weight (%)					Firmness (N)					Shelf life (Days)
	3 Days	6 Days	9 Days	12 Days	15 Days	3 Days	6 Days	9 Days	12 Days	15 Days	Mean
T_1	1.24	2.43	3.71	5.30	7.28	42.93	41.94	40.88	39.77	37.98	10.00
T_2	1.07	2.17	3.24	4.73	6.23	43.37	42.41	41.37	40.44	38.58	12.00
T_3	1.16	2.29	3.44	5.05	6.70	43.17	42.17	41.11	40.03	38.33	11.00
T_4	0.99	1.83	3.03	4.46	5.84	43.49	42.72	41.68	40.72	38.97	13.00
T_5	0.91	1.76	2.71	3.87	4.96	43.67	43.14	42.36	41.26	39.24	15.00
T_6	0.74	1.47	2.19	3.24	4.37	44.05	43.86	42.95	41.82	39.76	15.00
T_7	0.82	1.60	2.40	3.65	4.69	43.85	43.48	42.72	41.59	39.56	15.00
T_8	0.65	1.29	1.94	2.99	4.10	44.23	44.01	43.15	42.20	40.44	16.00
T_9	1.52	3.17	5.71	8.25	11.05	42.07	40.59	38.99	37.15	35.86	8.00
SE (d)	0.0180	0.0383	0.0755	0.0549	0.0629	0.5606	0.5466	0.5732	0.4777	0.6022	0.9428
CD (0.05)	0.0378**	0.0805**	0.1586**	0.1153**	0.1321**	1.1778**	1.1484**	1.2043**	1.0035**	1.2652**	1.9808**

*- significant at ($p< 0.05$); **-significant at ($p< 0.01$)

Conclusion

The synergistic effect of postharvest dipping and refrigerated storage condition significantly influenced the physiological loss in weight, firmness, total soluble sugars and shelf life. Compared to all the treatments, jackfruit bulbs treated with ascorbic acid (1.0%) and calcium chloride (1.0%) recorded minimum PLW (4.10%), TSS (24.10ºBrix), color change (ΔE=2.45) and maximum firmness (40.44 N). Maximum shelf life was also observed in 1.0% ascorbic acid and 1.0% calcium chloride (T_8) treated flakes compared to control which had minimum shelf life of about eight days.

References

1. Abound HA. A study of physical and chemical chanes observed in six commercial cultivars of field grown vine ripened tomatoes in the fresh state and after storage. Diss. Abstr 1974;B-34:50-52.
2. Antunes MDC, Dandlen S, Cavaco AM, Miguel G. Effects of postharvest application of 1-MCP and post cutting dip treatment on the quality and nutritional properties of fresh-cut kiwifruit. J Agric Food Chem 2010;58(10):6173–6181
3. Beaulieu JC, Gorny JR. Fresh-cut fruits 2002. <http://www.ba.ars.usda.gov/hb66/146freshcutfruits.pdf>
4. Bico SLS, Raposo MFJ, Morais RMSC, Morais AMMB. Combined effects of chemical dip and/or carrageenan coating and/or controlled atmosphere on quality of fresh-cut banana. Food Control 2009;20(5):508-514. https://doi.org/10.1016/j.foodcont.2008.07.017
5. Caleb OJ, Mahajan PV, Manley M, Opara UL. Evaluation of parameters affecting modified atmosphere packaging engineering design for pomegranate arils. Int. J Food Sci. Technol 2013;48:2315-2323.
6. Chantanawarangoon S, Kader AA. Calcium treatments and modified atmospheres extended post-cutting life of mango cubes. In: Abstracts of IFT Annual Meeting. Dallas 2000. https://doi.org/10.1111/j.1745-4549.2011.00561.x.
7. Chawdhary FA, Raman MA. Distribution of free sugars and fatty acids in jackfruit. Food Chem 1997;60(1):25–28.
8. Chiabrando V, Giacalone G. Effect of antibrowning agents on color and related enzymes in fresh-cut apples during cold storage. Journal of Food Processing and Preservation 2012;36(2):133-140. https://doi.org/10.1111/j.1745-4549.2011.00561.x
9. Cocci E, Rocculi P, Romani S, Dalla Rosa M. Changes in nutritional properties of minimally processed apples during storage. Postharvest Biology and Technology 2006;39:265-271.
10. FAO. In J. B. James and T. Ngarmasak (Eds.), Processing of freshcut tropical fruits and vegetables: a technical guide. Bangkok, Thailand 2010,1–84p. Available from http://www.fao.org/docrep/014/i1909e/i1909e00.htm.
11. Gomes MH, Fundo JF, Santos S, Amaro AL, Almeida DP. Hydrogen ion concentration affects quality retention and modifies the effect of calcium additives on fresh-cut 'Rocha' pear. Postharvest Biology and Technology 2010;58(3):239-246. https://doi.org/10.1080/10408398.2016.1211087

12. Guerreiro AC, Gago CML, Faleiro ML, Miguel MGC, Antunes MDC. The effect of alginate-based edible coatings enriched with essential oilsconstituents on Arbutus unedo L. fresh fruit storage. Postharvest Biol. Technol 2015;100:226–233.
13. Haque MA, Begum R, Shibly AZ, Sultana MM, Khatun A. Influence of jackfruit pulp on the quality and shelf life of jackfruit cake. Journal Environmental Science and Natural Resources 2015;8:59–64. https://doi.org/10.3329/jesnr.v8i1.24672.
14. Hussein Z, Caleb OJ, Jacobs K, Manley M, Opara UL. Effect of perforation mediated modified atmosphere packaging (PM-MAP) and storage duration on physicochemical properties and microbial quality of fresh minimally processed 'Acco' pomegranate arils. LWT-Food Sci. Technol 2015;64:911-918.
15. Jagadeesh SL, Reddy BS, Basavaraj N, Swamy GSK, Gorbal K, Hegde *et al*. Inter tree variability for fruit quality in jackfruit selections of Western Ghats of India. Sci Hortic 2007;112(4):382-387.
16. Johari AM, Rahman NAA, Baharuddin AS, Basha RK, Wakisaka M. Effects of low temperature storage of Mastura (J37) jackfruit bulbs on the physical quality of jackfruit frozen confection. Journal of Agricultural and Food Engineering 2020, http://doi.org/10.37865/jafe.2020.0016
17. Lee L, Arul J, Lencki R, Castaigne F. A review on modified atmosphere packaging and preservation of fresh fruits and vegetables: physiological basis and practical aspects – part-1. Packaging Technology Science 1995;8:15-31.
18. Martinez-Ferrer M, Harper C, Perez-Muntoz F, Chaparro M. Modified Atmosphere Packaging of Minimally Processed Mango and Pineapple Fruits. J Food Sci 2002;67(9):3365-3371. doi:10.1111/j.1365-2621.2002.tb09592.x
19. Mondal C, Remme RN, Mamun AA, Sultana S, Ali MH, Mannan MA. Product development from jackfruit (*Artocarpus heterophyllus*) and analysis of nutritional quality of the processed products. Journal of Agriculture and Veterinary Sciences 2013;4:76–84. https://doi.org/10.9790/2380-0417684.
20. Nanda S, Rao DS, Krishnamurthy S. Effects of shrink film wrapping and storage temperature on the shelf life and quality of pomegranate fruits cv. Ganesh. Postharvest Biol. Technol 2000;22(1):61-69.
21. NHB. National Horticulture Board Database, Ministry of Agriculture. Government of India 2019.
22. Nielsen T, Leufven A. The effect of modified atmosphere packaging on the quality of Honeoye and Korona strawberries. Food Chem 2008;107:1053-1063.
23. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Edn 2, ICAR, New Delhi 381p.
24. Prakash O, Kumar R, Mishra A, Gupta R. *Artocarpus heterophyllus* (Jackfruit): an overview. Pharmacogn Rev 2009;3:353–358.
25. Prathibha SC, Vasudeva KR, Sadananda GK, Suresha GJ. Effect of pretreatment and packaging on quality of fresh cut jackfruit (*Artocarpus heterophyllus* L.) Bulbs. International Journal of Chemical Studies 2019a;7(1):1697-1700.
26. Prathibha SC, Vasudeva KR, Suresha GJ, Sadananda GK. Influence of pretreatment on quality and shelf life of fresh cut jackfruit (*Artocarpus heterophyllus* L.) bulbs. Journal of Pharmacognosy and Phytochemistry 2019b;8(1):2524-2527.
27. Rana SS, Pradhan RC, Mishra S. Optimization of chemical treatment on fresh cut tender jackfruit slices for prevention of browning by using response surface methodology. International Food Research Journal 2018;25(1):196-203.
28. Robertson GL. Food Packaging and Shelf Life—A Practical Guide (CRC Press, Taylor and Francis Group, LLC., Boca Raton 2009,388p.
29. Rosen JC, Kader AA. "Postharvest physiology and quality maintenance of sliced pear and strawberry fruits," J. Food Sci 1989;54:656-659.
30. Sandhya. Modified atmosphere packaging of fresh produce: Current status and future needs. Review. LWT-Food Sci. Technol 2010;43:381–392.
31. Saxena A, Bawa AS, Raju PS. Use of modified atmosphere packaging to extend shelf-life of minimally processed jackfruit (*Artocarpus heterophyllus* L.) bulbs. Journal of Food Engineering, 2008;87:455–466. https://doi.org/10.1016/j.jfoodeng. 2007.12.020.
32. Soliva-Fortuny R, Ricart-Coll M, Elez-Martı´nez P, Martin-Belloso O. Internal atmosphere, quality attributes and sensory evaluation of MAP packaged fresh-cut Conference pears. International Journal of Food Science and Technology 2007;42:208-213.
33. Soliva-Fortuny RC, Grigelmo-Miguel N, Hernando I, Lluch MÁ, Martín-Belloso O. Effect of minimal processing on the textural and structural properties of fresh-cut pears. J Sci. Food Agriculture, Wiley 2002;82(14):1682-8. http://dx.doi.org/10.1002/jsfa.1248.
34. Somboonkaew N, Terry LA. Physiological and biochemical profiles of imported litchi fruit under modified atmosphere packaging. Postharvest Biol. Technol 2010;56:246–253.
35. Somogyi LP, Hui YH, Barret DM. Processing Fruits: Science and Technology. Technomic Publishing Co., Inc., Lancaster, Basel 1996;2:261–271.
36. Srivastava A, Bishnoi SK, Sarkar PK. Advances in value addition in jackfruit (*Artocarpus heterophyllus* Lam.) for food and livelihood security of rural communitie of India. Asian Journa of Horticulture 2017;12(1):160-164.
37. Swami SB, Thakor NJ, Orpe S, Kalse SB. Development of osmo-tray dried ripe jackfruit bulb. Journal of Food Research and Technology 2014;2(2):77–86. http://www.jakraya.com/journal/pdf/4-jfrtArticle_4.pdf.
38. Thakur RJ, Shaikh H, Gat Y, Waghmare RB. Efect of calcium chloride extracted from eggshell in maintaining quality of selected fresh-cut fruits. International Journal of Recycling of Organic Waste in Agriculture 2019;8(Suppl 1):S27–S36
39. Varela P, Salvador A, Fiszman SM. The use of calcium chloride in minimally processed apples: a sensory approach. European Food Research and Technology 2007;224:461-467.
40. Waghmare RB, Annapure US. Combined effect of chemical treatment and/or modified atmosphere packaging (MAP) on quality of fresh-cut papaya. Postharvest Biology and Technology 2013;85:147-153. https://doi.org/10.1016/j.postharvbio.2013.05.010.
41. Yousuf B, Deshi V, Ozturk B, Siddiqui MW. Fresh-cut fruits and vegetables: Quality issues and safety concerns. In Siddiqui MW (Ed.), Fresh-cut fruits and vegetables - technologies and mechanisms for safety control 2020,1–15p. London: Academic Press. https://doi.org/10.1016/B978-0-12-816184-5.00001-X