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Effect of different coating material and packaging materials on quality and shelf life of Kinnow (*Citrus nobilis x Citrus deliciosa*) fruit

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Abstract
The present study entitiled "Effect of different coating material and packaging materials on quality and shelf life of Kinnow (*Citrus nobilis X Citrus deliciosa*) fruit." was conducted at department of horticulture, Post-Harvest laboratory, Naini agriculture college SHUATS, Prayagraj, U.P during the academic year 2022-24.Packaging and coating treatment includes T0 (Control/No coating & packaging), T_1 (Bee wax coated fruit packed in newspaper), T_2 (Bee wax coated fruit packed in brown paper), T_3 (Bee wax coated fruit packed in HDPE), T_4 (Acacia gum coated fruit packed in newspaper), T_5 (Acacia gum coated fruit packed in brown paper), T_6 (Acacia gum coated fruit packed in HDPE), T_7 (Guar gum coated fruit packed in newspaper), T_8 (Guar gum coated fruit packed in brown paper) T_9 (Guar gum coated fruit packed in HDPE). The physical, biochemical and organoleptic assessment of each treatment result was conducted up to 21 days and at every 7 days interval, all observation were recorded. The PLW (%) and Volume loss (%) were recorded lowest in the fruits packed in T_5 during storage which were (3.45%) and (0.74%) respectively. Total soluble solids and total sugar contents had increasing trend during storage period and found highest (11.89) and (10.69) in T_5 treatment respectively at 21 days while ascorbic acid and titrable acidity had decreasing trend and mean value was found highest (16.31) and (0.81) in T_5 treatment respectively during storage. On the basic of organoleptic evaluation nine-point hedonic rating scale, it was concluded that Kinnow fruits packed under Acacia Gum Coating+ Brown Paper Wrapping scored highest overall acceptability at 21 days of storage, and it can be recommended to farmers for prolonging the storability of the fruits at ambient conditions.

Key words: HDPE, Kinnow, acacia gum, guar gum, Beewax, brown paper, newspaper

Introduction
Growing citrus is a lucrative business that boosts the economies of nations like the United States, Brazil, Mexico, China, Iran, India, Spain, and Greece. India ranks fifth in the world for citrus fruit output, encompassing the cultivation of mandarins, grapefruits, limes, lemons, oranges, tangerines, and so forth. The Mandarin category of citrus fruits includes kinnow, which is widely farmed in Pakistan and India. The University of California Citrus Experiment Station is where Kinnow was first developed in 1935, and it was first introduced to India in the early 1940s.

It is a cross between the citrus cultivars Willow Leaf mandarin (*Citrus deliciosa*) and King' (Citrus nobilis). Kinnow fruit has an oblate shape, with a flattened apex and base, and a bright orange-yellow color. The fruit is made up of two main parts: the pericarp, or peel, and the endocarp, which branches into the epicarp and mesocarp (albedo) respectively. This type is mid-season, with few seeds clinging to 9-10 segments. The silky peel ripens to a deep orange color. juice with taste. Soils that range from sandy to clay loam to acidic (pH 5.5–7.5) can be used to cultivate Kinnow. The month of December to January is when the small to medium-sized, cadmium yellow-colored Kinnow fruits are ready for harvesting.

Gujarat, Maharashtra, Andhra Pradesh, Punjab, Karnataka, Uttaranchal, Bihar, Orissa, and Assam are the main growing regions for citrus fruits in India. Currently, the total area under cultivation for citrus fruit production in India is 1042.0 thousand hectares (13.3% of the total area under fruits), with a production of 10090.0 thousand MT (12.4% of the total production under fruits) and a productivity of 9.87 MT/HA.

The total area under cultivation for sweet oranges in India is 323.2 thousand hectares (4.6% of the total area under fruits), with a production of 3520.0 thousand MT (4.3% of the total production under fruits) and productivity of 10.9 MT/hectare during the 2012–2013 season. (NHB 2020-21).

Guar gum: The guar plant's (Cyamopsis tetragonoloba) seed contains guar gum, a fiber that gels. The food industry uses this gel-forming galactomannan, which is produced by grinding the endosperm of Cyamopsis tetragonolobus, as thickening, gelling, emulsifying, and stabilizing agents. It is also utilized as a binding ingredient in other industrial adhesives.

Acacia gum: Gum arabic or gum acacia, other names for Acacia gum (AG), is a soluble, non-viscous fiber derived from the powdered, dried tree sap of Acacia tree species. Senegalia Senegal and Vachellia Seyal, two species of Acacia trees, are the source of this natural gum, also known by the names gum arabic, gum Sudani, and Senegal gum. It is edible, water soluble, and mostly used in the food sector. Which oppose the pace of ethylene synthesis and respiration.

Beeswax: Cera Alba, or beeswax, is a naturally occurring wax that is made by Apis honey bees. Foods coated with beeswax create a barrier against light, air, and vapor, which can help stop water loss and the oxidation of fat and pigments.

Materials and Methods

The present investigation entitled "Effect of different coating material and packaging materials on quality and shelf life of Kinnow (*Citrus nobilis X Citrus deliciosa*) fruit" was carried at PHT, Department of horticulture, Naini Agriculture College, SHUATS, Prayagraj (U.P.) during the academic year 2022-24. Kinnow fruit were gathered from local navin fruit mandi of district prayagraj. For research purpose the fruit with uniform were selected. Apart, other traits of healthiness for fruits free from that of disease and bruising on skin were also taken in consideration for selection of fruits for harvest. The packed fruits were stored at (18-20 °C & 90-95% RH) in PG laboratory of PHT, Department of horticulture, Naini agriculture college, SHUATS, Prayagraj (U.P.). All the packaging & coating materials via; T0 (Control or no packaging), T_1 (Bee wax coating+ newspaper packaging), T_2 (Bee wax coating+ brown paper packaging), T_3 (Bee wax coating+ HDPE packaging), T_4 (Acacia gum coating+ newspaper packaging), T_5 (Acacia gum coating+ brown paper packaging), T_6 (Acacia gum coating+ HDPE packaging), T_7 (Guar gum coating+ newspaper packaging), T_8 (Guar gum coating +brown paper packaging) T_9 (Guar gum coating+ HDPE packaging). The data were recorded at 0, 7, 14 and 21 days of storage period. With 3 replications in Complete Randomized Design (CRD).

Results and Discussion

Fruit weight: The maximum fruit weight during the course of experiment. T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (181.30, 165.60, 152.70 and 114.20) g have highest fruit weight followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (177.20, 161.50, 148.60 and 110.10) g which were significantly superior than T_0 (Control) with (146.50, 130.80, 117.9 and 79.40) g. Fruit length and width were found to be highly impacted by the storage period and the packaging material, with fruit length and width steadily decreasing as the storage period extended. Fruits may shrink as a result of increased moisture loss through transpiration and respiration, which also influenced the fruit's weight and shape. This could explain why fruit length and width decreased as the storage period rose. When compared to all other packaging options, the control fruits showed the greatest drop in length and width since they were not wrapped and were exposed to the environment, which resulted in the absence of a barrier that would have prevented moisture loss. The results are in close agreement with the findings of Bhatnagar (2012) [12], Manisha and Gandhi *et al.* (2012) [12] in Kinnow fruits.

Physiological weight loss: The minimum physiological weight loss was found in T_5. There was significant differences between the treatments at Initial, 7, 14 and 21 days, among the treatment used T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (0.00 and 0.27 and 2.16 and 3.45) g have lowest Physiological weight loss followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (0.00, 0.36, 2.25 and 3.63) g which were significantly superior than T_0 (Control) with (0.00, 0.83, 2.72 and 4.20) g. The percentage of physiological weight loss (PLW) in kinnow fruits varied depending on the type of packing used. As the storage period goes on, there is a noticeable rise in the physiological loss of weight because of the fruits' increased respiration and moisture loss. Thakur *et al.* (2002) [4] reported comparable outcomes in Kinnow. The results are in conformity with findings of Ali *et al.* (2015) [4].

Volume (cm^3): The maximum volume of the fruit was found in tratment T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (191.3, 173.2, 169.2 and 157.12) cm^3 have highest volume followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (186.7, 168.66, 164.66 and 152.58) cm^3 which were significantly superior than T_0 (Control) with (170.10, 152.05, 148.05 and 135.97) cm^3. Fruit volume was highly influenced by the type of packaging and length of storage.

The volume value peaked at 0 days and peaked at 45 days during the storage period. This is the cause of the increased transpiration and respiration. The same pattern was noted by Sharifi *et al.* (2007) [32] in orange peels.

Specific gravity (g/cm^3): Among the treatment used T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (0.97, 0.99, 1.02 and 1.10) g/cm^3 have lowest Specific gravity followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (0.92, 0,97, 1.00 and 1.08) g/cm^3 which were significantly superior than T_0 (Control) with (0.84, 0.89, 0.92 and 1.00) g/cm^3. The type of packaging & coating material and length of storage have a substantial impact on specific gravity. The alterations result from fruits shrinking over an extended period of time during storage. The outcomes are consistent with studies conducted on Ponkan tangarine by Abdel Aziz-Atiat *et al.* (2002) [1], According to Egwim *et al.* (2013) [24], fruit density drops as storability increases. Degradation of structural polysaccharides led to a drop in pulp content, which in turn caused a fall in specific gravity with an increase in storage time.

Peel thickness (mm)

There was significant differences between the treatments at Initial, 7, 14 and 21 days, among the treatment used T_5

(Acacia gum Coating + Brown Paper Wrapping) with (7.50, 7.20, 6.40 and 6.20) mm have highest Peel thickness followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (6.80, 6.50, 5.70 and 5.50) mm which were significantly superior than T_0 (Control) with (4.10, 3.80, 3.00 and 2.80) mm. Peel thickness have a decline trend and highest mean value of peel thickness was notice in T_5 at zero day and lowest in T0 at 21 days. that the peel thickness decreased up to maturity and increased again after ripening. Similar findings reported by Verma *et al*. (2012) [35]. Dharampal and Saini (1994) [20] reported that peel thickness of Kinnow fruit ranged from 0.21 to 0.30 cm.

Peel weight (gram): Among the treatment used T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (50.1, 39.9, 30.95 and 22.41) gram have highest Peel weight followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (49.2, 38.5, 29.55 and 21.01) gram which were significantly superior than T_0 (Control) with (39.5, 29.3, 20.35 and 11.81) gram. The peel weight of Kinnow fruit steadily decreases as storage time increases. It might be because moisture loss from peel tissue causes the majority of water to be lost, which essentially changes how the fruit looks. Fruit shrivelling, softening, shrinking, and distortion result from peel moisture loss. This might be due to the fact that shrinks packaging acted as a barrier, which had checked the losses of the moisture from the fruit surface. These results are in close agreement with the findings of Sonkar *et al*. (2009) [34], Kinnow fruit.

Juice content (%): Among the treatment used T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (82.80, 72.65, 63.13 and 46.05) % have highest Juice content followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (80.93, 70.85, 61.43 and 44.39) % which were significantly superior than T_0 (Control) with (66.91, 57.38, 48.74 and 32.01) %. In every treatment, the amount of juice was reduced with the type of packaging & coating used and the amount of time spent storing the product. One possible explanation for this could be the fruits' surface losing moisture. The outcomes follow the findings of Paudel *et al*. (2019) [30].

Total Soluble Solid (Brix^0): Among the treatment used T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (9.54, 10.67, 10.97 and 11.89) Brix^0 have highest T.S.S followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (9.63, 10.13, 11.08 and 12.12) Brix^0 which were significantly superior than T_0 (Control) with (8.36, 9.21, 11.42 and 13.14) Brix$^{0.}$ As the duration of storage increased, the TSS of fruits rose in all packing materials (T_1 to T_9). Increased polysaccharide hydrolysis and juice concentration from dehydration may be the cause of the rise in total soluble solids with longer storage times. In control fruits, the maximum TSS was noted at the conclusion of storage. It might be because these fruits lose the most water. Jawandha *et al*. (2012) [30].

Titrable Acidity (%): Among the treatment used T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (1.04, 0.93, 0.87 and 0.81) % have highest titrable acidity followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (1.06, 0.94, 0.84 and 0.79) % which were significantly superior than T_0 (Control) with (1.11, 0.99, 0.76 and 0.67) %. The acidity of Kinnow fruit exhibited a consistent linear decline as the storage period progressed. This decrease in acidity could be attributed to the heightened catabolism of organic acids within the fruit, facilitated by the process of respiration. The reduction in titratable acids throughout storage might stem from the utilization of organic acids in the pyruvate decarboxylation reaction, which occurs during the ripening process of fruits. These findings align with previous studies such as Mahajan *et al.* (2016) [28] in Kinnow.

Ascorbic Acidity (mg/100g): Among the treatment used T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (18.77, 18.27, 17.24 and 16.31) mg/100g have highest Ascorbic Acidity followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (18.96, 18.46, 17.43 and 16.22) mg/100g which were significantly superior than T_0 (Control) with (18.91, 17.81, 16.77 and 14.76) mg/100g. The ascorbic acid content demonstrated a consistent decline across all treatments throughout the storage period, with a more noticeable reduction observed under ambient conditions. This pronounced decrease could be attributed to the slower degradation rate facilitated by the reduced metabolic activity at lower temperatures. The higher levels of ascorbic acid observed under low temperatures might be a result of the diminished rate of fruit metabolic activities, particularly respiration. These findings are consistent with the conclusions drawn by Worawaran *et al.* (2013) [37].

Reducing sugar (%): Among the treatment used T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (4.23, 4.58, 5.18 and 5.39) % have highest Reducing sugar followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (4.19, 4.54, 5.14 and 5.35) % which were significantly superior than T_0 (Control) with (3.87, 4.22, 5.02 and 5.23) %. All of the treatments were successful in changing the reducing sugar content, however the amount of reducing sugar increased with longer storage times. The non-climacteric character of kinnow fruit may be the cause of the increase in reducing sugars during storage as no new reducing sugar synthesis occurs. An increase in water loss during storage may potentially be the cause of the decrease in sugar content. Increase in reducing sugars with increasing period of storage has also been reported in strawberry (Moing and Renaud, 2001) [17].

Total sugar (%): Among the treatment used T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (8.31, 9.55, 10.33 and 10.69) % have highest Total sugar followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (8.39, 9.44, 10.22 and 10.58) % which were significantly superior than T_0 (Control) with (7.90, 9.06, 9.90 and 10.40) %. This peak in total sugars could be attributed to several factors, including the conversion of polysaccharides into soluble sugars, dehydration, transformation of certain cell wall materials such as hemicelluloses and pectins, and a decrease in ascorbic acid content. These outcomes align with the findings of Kumar and Chauhan (1990) [27] in mandarins. observed that unwrapped mango fruit registered the higher soluble solids and sugars percentage in contrast to fruits wrapped in brown paper.

Organoleptic evaluation: Appraisal of data revealed that the organoleptic quality of Kinnow during storage significantly differed with the different packaging & coating material. The Acacia gum coated and brown paper packed Kinnow fruits

showed a gradual and steady increase in the organoleptic quality attributes up to 21 days, after which a gradual decline was observed; whereas in control fruits, the sensory score increased up to 5 days of storage and thereafter declined at a faster pace. The maximum Colour & appearance score of Kinnow during storage was recorded in T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (8.8) followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (8.3) and the minimum was recorded in T_0 (Control) with (4.2). The maximum score of Overall acceptability of Kinnow during storage was recorded in T_5 (Acacia gum Coating+ Brown Paper Wrapping) with (7.85) followed by T_4 (Acacia gum Coating+ Newspaper Wrapping) with (7.73) and the minimum was recorded in T_0 (Control) with (3.63). The recording of higher sensory score in Acacia gum coated with brown paper wrapped fruit might be due to the ability to retain the desirable gaseous atmosphere inside the package, which is responsible for maintaining the texture and flavor of the fruit (Nanda *et al.*, 2009) [29]. Wrapping of banana and kiwi fruits in heat-shrinkable film have been reported to maintain an acceptable appearance, flavor, and overall eating quality (Sharma *et al.*, 2012) [33].

Table 1: Effect of different packaging and coating material on physical parameters of Kinnow during storage at 21days

Notion	Initial fruit Weight (g)	Physiological loss in weight (%)	Diameter Radial (cm)	Diameter Longitudinal (cm)	Volume (cc/cm)	Specific gravity (g/cm3)	Peel weight (g)	Peel Thickness (mm)	Juice Content (%)
T_0	79.4	4.20	46.90	36.91	135.97	1.00	11.81	2.80	32.01
T_1	88.4	4.08	55.40	43.71	144.17	1.04	16.01	4.50	35.64
T_2	100.4	4.11	58.20	45.51	147.57	1.06	13.21	4.90	40.48
T_3	102.8	4.17	56.95	46.71	145.37	1.01	19.01	4.20	41.45
T_4	110.1	3.63	61.00	48.11	152.58	1.08	21.01	5.50	44.39
T_5	114.2	3.45	67.10	51.61	157.12	1.10	22.41	6.20	46.05
T_6	94.1	3.79	60.42	47.61	150.80	1.07	17.11	5.00	37.94
T_7	87.1	4.00	59.62	44.51	149.68	1.03	14.91	4.70	35.12
T_8	96.4	4.06	59.47	42.41	148.75	1.05	20.11	5.30	38.87
T_9	85.4	4.15	54.39	41.51	143.76	1.02	18.11	4.60	34.43
S.Ed(±)	2.52	0.013	0.45	0.75	0.018	0.016	0.82	0.006	0.97
$CD_{5\%}$	5.05	0.028	1.05	1.65	0.045	0.038	1.968	0.014	2.134
CV	10.1	0.055	3.02	4.27	0.082	0.092	4.428	0.034	5.529

Table 2: Effect of different packaging and coating material on biochemical parameters of Kinnow during storage at 21days

Notion	Total soluble solids (Brix)	Titratable acidity (%)	Reducing Sugars (%)	Total Sugars (%)	Non-Reducing Sugars (%)	Ascorbic acid (mg/100 g of pulp)
T_0	13.14	0.67	5.23	10.40	5.17	14.76
T_1	12.37	0.72	5.27	10.39	5.12	15.65
T_2	12.56	0.70	5.09	10.29	5.2	15.82
T_3	12.69	0.72	5.20	10.38	5.18	15.54
T_4	12.12	0.79	5.35	10.58	5.23	16.22
T_5	11.89	0.81	5.39	10.69	5.30	16.31
T_6	13.41	0.78	5.31	10.56	5.25	16.12
T_7	12.89	0.76	5.25	10.40	5.15	16.16
T_8	12.77	0.77	5.33	10.60	5.27	15.82
T_9	12.96	0.75	5.29	10.43	5.14	16.01
S.Ed(±)	0.013	1.14	1.57	0.89	1.74	1.22
$CD_{5\%}$	0.029	2.50	3.45	2.047	4.87	3.43
CV	0.075	6.38	8.94	4.806	10.09	9.61

Conclusion

On the basis of organoleptic evaluation, Kinnow fruits packed in (Acacia gum Coating+ Brown Paper Wrapping) had highest score at 21 days of storage in comparison to all other packaging materials. These fruits had minimum physiological loss in weight (%), Volume loss (%), and retained maximum juice weight with highest overall acceptability during storage, therefore packaging of kinnow fruits in Acacia gum Coating+ Brown Paper Wrapping can be recommended to farmers for prolonging the storability of the fruits at ambient conditions.

References.

1. Abdel Aziz-Atiat SI. Effect of some post-harvest treatments and packaging types on Ponkan tangerine fruit quality during and after cold storage. Zagazig J Agric Res. 2002;29(3):845-875.
2. Adeola AA, Aworh OC. Development and sensory evaluation of an improved beverage from Nigeria's tamarind (*Tamarindus indica* L.) fruit. J Food Agric Nutr Dev. 2010;10(9):4079-4093.
3. Ahmad M, Chaudry MA, Khan I. Some post-harvest shelf life extension studies on citrus fruits. NIFA Annual Report; c1979. p. 55-71.
4. Ali AM, Zulfiqar A, Atta M, Khan RA, Iqbal Z, Khan AM. Effect of natural and synthetic fruit coatings on the postharvest quality of Kinnow mandarins. Agric. EngInt: CIGR Journal. 2015;17(1):197-206.
5. Ali and Khorram Postharvest treatments for preserving quality of 'Kinnow' fruit under different storage conditions. Adv. Hort. Sci. 2015;27(4):152-158.
6. Amerine MA, Roessler EB, Ough CS. The effect of pH and titratable acidity. Am J Enol. Vitic. 1965;16(1):29-37.

7. Baldwin EA, Nisperos-Carriedo MO, Moshonas MG. Quantitative analysis of flavor and other volatiles and for certain constituents of two tomato cultivars during ripening. J Am Soc Hortic Sci. 1991;(6):265-269.
8. Bangulzai AM, Leghari HM, Wahocho AN, Baloch BQ, Talpur HK, Gola QA, *et al*. Effect of different packing materials and storage periods on physico-chemical characteristics of citrus fruits. Pure Appl. Biol. 2020;9(1):565-575.
9. Baviskar MR, Waskar DP, Kaulgud SN. Effect of various post-harvest treatments on shelf life and quality of ber fruit. Indian J Hort. 1995;(52):37-45.
10. Bhardwaj LR, Mukherjee S. Factors affecting physic-chemical, sensory and microbiological quality of Kinnow juice blends. J Nutr Food Sci. 2012;(2):6. DOI: 10.4172/2155-9600.1000148.
11. Bhat A, Sharma RM, Kher R. Effect of various post harvest treatments on storage behaviour of Kinnow in relation to different storage conditions. Progr. Hortic. 2004;36(1):35-39.
12. Bhatnagar, Singh, Manisha. Gandhi Studies on preparation of ready to serve mandarin (*Citrus reticulata*) diet drink. Pak J Agri Sci. 2012;45(4):470-476.
13. Bhattarai BP, Shah R. Effect of different packaging materials on post-harvest status of mandarin (*Citrus reticulata* Blanco). J Hortic; c2017. DOI: 10.4172/2376-0354.1000218.
14. Chavan RF, Jadhao VG, Sakhale BK. Studies on preparation of mango-sapota, mixed fruit bar. J Food Technol Environ. 2016;2(2):361-365.
15. Choudhary S, Ray DP, Das BK, Sahu GS. Effect of pre and post-harvest treatment on ripening quality and storage life of Sapota cv. Pala. Orissa J Hort. 2003;31(2):55-61.
16. Cohen E, Ben-Yehushua S, Rosenberger I, Shalom Y, Shaprio B. Quality of lemons sealed in high density polyethylene film during long term storage at different temperatures with intermittent warming (I.M.). J Hortic Sci. 1990;(65):603-610.
17. D'Aquino S, Angioni M, Schirru S, Agabbio M. Quality and physiological changes of film packed 'Malvasio' Mandarins during long term storage. Food Sci. Technol. 2001;34(4):206-214.
18. Das RC, Dash J. The effect of wax emulsion 2, 4-D and 2, 4, 5-T on the storage behavior of mosambi (*Citrus sinensis* Osbeck). Proc. Int. Symp Subtrop Trop Hortic; c1967. p. 104-107.
19. Deka BC, Sharma S, Borah SC. Postharvest management practices for shelf life extension of Khasi mandarin. Indian J Hort. 2006;(63):251-255.
20. Dharampal and Saini, Kaushal M, Sharma R. Development and storage stability of papaya (*Carica papaya* L.) toffee and leather. Int. J Farm Sci. 1994;4(3):117-125.
21. Echeverría G, Graell J, Lara I, Lopez ML. Physicochemical measurements in 'Mondial Gala' apples stored at different atmospheres, Influence on consumer acceptability. Postharvest Biol. Technol. 1989;50(3):135-144.
22. Egwim EC, Ogudoro AC, Folashade G. The effect of pectinase on the yield and organoleptic evaluation of juice and wine from banana and paw-paw. Ann Food Sci. Technol. 2013;14(2):206-211.
23. Faasema J, Abu JO, Alakali JS. Effect of packaging and storage condition on the quality of sweet orange (*Citrus cinesis*). Int. J Agric Technol. 2011;7(3):797-804.
24. Goldenberg M. Genetic diversity among mandarins in fruit-quality traits. J Agr. Food Chem. 2014;62(21). DOI: 10.1021/jf5002414.
25. Jawandha SK, Tiwan PS, Randhawa JS. Effect of low density polyethylene (LDPE) packaging and chemicals on ambient storage of Kinnow. J Hort. Flora Res Spectr. 2012;1(1):55-59.
26. Kaur H, Randhawa JS, Dhatt AS. Effectivity of wax and fungicides on the storage behaviour of seal packaged Kinnow mandarins. J Res. 2004;41(1):47-52.
27. Kumar and Chauhan. Effect of wax-coating on the physiological and bio-chemical aspects of Kinnow fruit. Pak J Sci. Ind. Res. 1990;(3):142-145.
28. Mahajan Influences of ambient and evaporative cool chamber storage conditions on the quality of polyethylene-packed Kinnow fruits. Adv. Hortic. Sci. 2016;10(4):179-184.
29. Nanda, Effect of pre-harvest application on shelf-life of ber (*Zizyphus mauritiana* Lamk.) fruits cv. Gola. Haryana J Hort. Sci. 2009;17(3-4):183-189.
30. Paudel, The flavor of mandarin hybrids with different coatings. Postharvest Biol Technol. 2019;(24):79-87.
31. Pongener A, Mahajan BVC, Singh H. Effect of different packaging films on storage life and quality of peach fruits under cold storage conditions. Indian J Hort. 2011;68(2):240-24.
32. Sharifi Effect of debittering techniques on the chemical characteristics of stored Kinnow juice. J Hill Agric. 2007;8(4):490-494.
33. Sharma., Helali MOH, Ibrahim M, Hassan P. Physico-chemical composition of four papaya varieties grown at Rajshahi. J Bio-Sci. 2012;14:83-86.
34. Sonkar Singh S, Mahalle B. Sub-optimum low temperature of "Nagpur" mandarin as influenced by wax coating and intermittent waxing. Indian J Hortic. 2009;62(1):1-7.
35. Verma, Wijerathna SR, Kreischer NR, La Macchia J, Helmbrecht E, *et al*. The structural basis for peptidomimetic inhibition of eukaryotic ribonucleotide reductase: a conformationally flexible pharmacophore. J Med Chem. 2012;51(15):4653-4659.
36. Vikram B, Prasad VM. Studies on value added Kinnow - Aonla blended ready to serve beverage. J Food Process Technol; c2014. DOI: 10.4172/2157-7110.1000288.
37. Worawaran, Singh DB, Singh GK. Effect of postharvest treatments on shelf life and quality of Kinnow mandarin. Indian J Hortic. 2013;67(2):243-248.