EFFECT OF CALCIUM CHLORIDE AND STORAGE CONDITIONS ON THE QUALITY AND STORAGE LIFE OF MANGO (*Mangifera indica* L.) FRUIT

Farzana Fatima[1], Osaidullah[2], Aqeel Ahmad[1], Musa Kaleem Baloch [3], Maleeha Alam[*1]

1. Department of Horticulture, The University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan.
2. NTFP Directorate, Forest Department, Khyber Pakhtunkhwa, Pakistan.
3. Department of Chemistry, Gomal University, and Department of Life Sciences, Qurtuba University of Science and Information Technology, Dera Ismail Khan, Pakistan

ABSTRACT

The mango is one of the most important fruits in the world and is popular both in fresh and processed form; however, it is a climacteric fruit and has a short shelf life. In this study, the mango fruit varieties Langra and Samar Bahisht Chaunsa were harvested at the hard green stage of maturity. The mango fruits were dipped for five minutes in a 1.5% solution of calcium chloride for uniform coating. The coated and uncoated mango fruits were stored at various temperatures for ripening. The storage life was prolonged and quality was improved by coating the fruits with calcium chloride as compared to uncoated fruits, irrespective of storage temperature and variety. The quality was highest for fruits stored at 40 °C while lowest at 20 °C; and storage life was longest for fruits stored at 20 °C while shortest for fruits stored at 40°C, irrespective of the variety. The waste percent was lowest in calcium chloride-coated fruits stored at 30 °C, irrespective of the variety.

Keywords: Quality; Calcium Chloride; Temperature; Storage life; Waste percent.

INTRODUCTION

Mango is a nutritious fruit having an excellent flavor, attractive fragrance, and delicious taste that has made it one of the best fruits (Pal, 1998). An increase in the demand for fresh mango fruit is being observed worldwide, which has increased the prospect for the producing countries (Anwar *et al*., 2008; Amin *et al*., 2008). However, like all other fresh commodities, its market potential is linked with fruit quality and market access (Anwar and Malik, 2007). The non-availability of proper storage conditions contributes toward wastage, as well as reduces the market value of the fruit (Hoa *et al*., 2002; Shafique *et al*., 2006).

The shelf life is considered to be one of the important parameters for the quality of fruit which is very sensitive to temperature and other post-harvest conditions (Simmons *et al*., 1998). One of the major roles of the storage temperature is to control the rate of biochemical reactions and hence monitor the ripening process or the shelf life (Narain *et al*., 1998; Marsh *et al*., 1999; Austin *et al*., 1999; Baloch *et al*., 2011). Mango fruit requires meticulous temperature, moisture and ventilation condition. The importance of temperature management in maintaining the quality of fresh fruits and vegetable is well documented (Kader, 1992).

One of the common techniques used to protect the fruit from micro-organisms is the coating of the fruit. For this purpose, a thin film of material is applied uniformly over the surface of the fruit and can be consumed along with the product (Guilbert, 1986). In addition, they reduced weight loss and delayed ripening (Baldwin, 1994; Cuq *et al*., 1995). The material used can be edible, natural or synthetic (Cuq *et al*., 1995; Dang *et al*., 2008). As a consequence, the number of coatings has been employed and discussed by the scientists and still efforts are going on to find the best one. Therefore, the chitosan, carnauba wax, aloe vera gel, semperfresh, shellac, zein, and polysaccharide-based coatings materials have been used by different scientists and their efficiency and problem associated with them have been highlighted (Carrillo-Lopez *et al*., 2000; Hoa *et al*., 2002; Srinivasa *et al*., 2004; Feygenberg *et al*., 2005; Zhu *et al*., 2008; Abbasi *et al*., 2009).

Postharvest application of calcium chloride on many fruits and vegetables found to delay softening by increasing rigidity (Mehmet et al., 2016; Gao et al., 2020). Several researchers reported the benefits of the edible coating of fruits with natural substances and calcium chloride treatment (Abbasi et al., 2011; Corrales-Garcia and Lakshminarayana, 1991).

The present work aimed to study the effect of various storage conditions and calcium chloride, a postharvest coating on mango fruits to minimize post-harvest losses.

MATERIAL AND METHODS

Sampling

For this research study, the Langra and Samar Bahisht Chaunsa (S.B. Chaunsa) varieties of mango fruit were randomly harvested by hand at hard green stage of maturity from Government Fruit Nursery Farm, Agriculture Extension Department, Dera Ismail Khan, Pakistan. The fruits were washed and cleaned to remove all external materials such as dust, dirt etc. The collected fruits were similar in size and infection free.

Treatments

The mango fruit was dipped for five minutes in 1.5% solution of calcium chloride. For ripening, the coated and uncoated fruits were stored at three different (20, 30 and 40 °C) temperatures. The relative humidity (RH) was kept at 80%, 64% and 58%, respectively till ripening, using Hot Pack incubator (Philadelphia, PA).

Analysis

Two hundred and fifty fruits of mango were collected for every test and variety. Each analysis was carried out three times and the data presented is the average of the repeated analysis over the period of two years. For various parameters, the fruits of mango were analyzed at harvest as well as at the ripened stage. The two factor experiment was laid out in Completely Randomized Design (CRD) with three replications.

Organoleptic evaluation

The skin color, aroma, flavor and taste were measured using the Hedonic scale (Larmond, 1977). A panel of twenty-one experts whose age was 20-45 years was prepared. Twenty one fruits of mango for each sample were randomly selected and cut into six parts. The material obtained was equally divided among the experts. Panelists were sent to various portions which were made for the measurement and had suitable light to judge the real color of the sample. The panelists scored the various samples by assigning the numbers from 0-10 (0-2 means extremely disliked, 2.1-4.0 fair, 4.1-6.0 good 6.1-8.0 very good, and greater than 8 means excellent aroma, taste and flavor). The skin color of mango samples was categorized as 0-2 means green, 2.1-4.0 light green, 4.1-6.0 light yellow, 6.1-8.0 yellow and 8.1-10 full yellow.

The mango fruit firmness was determined with a Bosch penetrometer (model FT 327). The firmness was determined by the force (g- mm^{-2}) necessary for a 2 mm probe to puncture the fruit peel at four different points and taking an average of the values. The values obtained were rescaled according to Hedonic scale for comparison purpose (Larmond, 1977); 2-4.0 means were very soft, 4.1-6.0 soft, 6.1-8.0 slightly soft and 8. 1-10 firm.

Moisture Content, Acidity and pH measurement

The moisture contents were determined by taking 10 g pulp of mango fruit, drying at 76 °C in an oven up to constant weight and calculating the weight loss (AOAC, 2000). The total titratable acidity was measured by titrating 100 mL of juice against sodium hydroxide having concentration as 0.1 N (AOAC, 2000). The finale point in this condition was estimated when the mixture containing juice, phenolphthalein (an indicator) and sodium hydroxide turned pink. The pH was measured using a Microprocessor pH meter supplied by Denver, USA.

Measurements of total sugar and total carotenoids

Total sugar was estimated by evaluating the refractive index using digital Refractometer. The total carotenoid content of flesh was measured subsequent the procedure of Anwar et al., (2008) and was stated as μg/g of β-carotene equivalent from a standard curve of β-carotene.

Total soluble solids and ascorbic acid Measurements

Pulp of five mango fruits was taken and thoroughly mixed and it was used for the evaluation of total soluble solids and ascorbic acid. Ten gram pulp was used for the measurement of total soluble solids (TSS) using digital refractometer (Atago-Palette PR 101, Atago Co. Ltd., Itabashi-Ku, Tokyo, Japan). The content of ascorbic acid were measured by titrating ten gram of mixed pulp sample against the standard 2, 6 dichlorophenol dyes, following the method outlined in (AOAC, 2000).

Measurement of ripened stage and marking of fruit as waste

The fruit ripened stage was noticed through the difference in color, sugar contents and firmness with the passage of time (Shorter and Joyce, 1998). Fruit waste was measured as when its value of firmness was lesser than 4 in Hedonic scale and/or it was either infected by a disease.

Statistical analysis

Each value was expressed as the mean of three independent experiments. Data were assessed by analysis of variance (ANOVA) through Duncan's multiple range tests using SPSS software (SAS Institute Inc., Cary, NC).

RESULTS AND DISCUSSION

The organoleptic parameters and chemical attributes of Langra and Samar Bahisht Chaunsa mango fruit were evaluated at harvest time. The average values of color, firmness, aroma, taste, and flavor were 0.83, 9.51, 0.92, 0.96 and 0.95 for Langra variety; and 0.92, 9.70, 0.97, 1.16 and 1.13 for Samar Bahisht Chaunsa mango fruit. The data showed that the color, aroma, taste and favor were lowest while the fruit firmness was highest in both varieties at harvest time. The average values of total sugar, total carotenoid, acidity, ascorbic acid, pH, moisture content and total soluble solids were 3.95 %, 26.22 µg/g, 3.52 %, 289.64 mg/100g, 3.16, 80.97 % and 7.78 % for Langra variety; and 5.11 %, 58.09 µg/g, 2.45 %, 183.61 mg/100g, 3.39, 77.89 % and 6.65 % for Samar Bahisht Chaunsa variety of mango fruit at harvest time. The data indicated that moisture content, acidity and ascorbic was highest; and total sugar, total carotenoids, pH and total soluble solids were lowest at harvest time, irrespective of the variety.

However, the data showed that organoleptic attributes such as aroma, color, flavor and taste were increased while firmness was decreased at the ripened stage of mango fruit, irrespective of storage temperature and variety (Table 1). The ripening temperature impact on the characteristics of organoleptic was also significant. The maximum values of organoleptic characteristics were noted for fruits ripened at 40°C and the minimum for 20°C, irrespective of the variety. Table 1, showed that the quality score of organoleptic attributes of mango fruit was superior with calcium chloride (1.5%) coating than uncoated fruits at a ripened stage, irrespective of the storing temperature and variety. The reason behind that calcium chloride application on many vegetables and fruits after harvest was found to delay the softening by increasing the rigidity of the middle lamella and act as a binding agent in the cell wall to form calcium pectate, which helps in quality preservation and prolonged the fruits storage life and make them stronger (Gao et al., 2020; Mehmet et al., 2016; Murillo and Adimilson, 1999; Yuen et al., 1993).

Table 1.

Average values of organoleptic parameters measured at the ripened stage for Langra and Samar Bahisht Chaunsa mango fruit stored at different temperatures.

Varieties	Treatments	ST (°C)	Color	Firmness	Aroma	Taste	Flavor
Langra	Uncoated	20	6.01[e†]	6.82[b]	5.91[d]	6.11[c]	6.02[d]
		30	7.41[c]	7.64[a]	7.35[b]	7.56[b]	7.46[c]
		40	7.89[b]	7.79[a]	7.86[b]	8.02[a]	7.95[b]
	Coated	20	6.45[d]	6.93[b]	6.37[c]	6.39[c]	6.37[d]
		30	7.76[b]	7.77[a]	7.71[b]	7.91[b]	7.87[b]
		40	8.31[a]	7.92[a]	8.19[a]	8.45[a]	8.41[a]
	Uncoated	20	6.31[e†]	7.12[b]	6.41[e]	6.45[e]	6.45[e]

Samar Bahisht Chaunsa		30	7.79[c]	7.75[a]	7.65[c]	7.81[c]	7.64[c]
		40	8.12[b]	7.87[a]	8.11[b]	8.36[b]	8.21[b]
	Coated	20	6.73[d]	7.23[b]	6.79[d]	6.96[d]	6.93[d]
		30	8.05[b]	7.88[a]	7.99[c]	8.21[b]	8.18[b]
		40	8.52[a]	7.99[a]	8.51[a]	8.72[a]	8.68[a]

ST stands for storage temperature. The comparison has been made within the variety.

†Values having different superscript in the columns are significantly different under the limit of $P < 0.05$.

The mango fruits were studied for chemical characteristics at the ripened stage and results for various storage temperatures are recorded in Table 2. The results showed that the content of total sugar, total carotenoids, pH, and total soluble solids of mango fruit were increased while moisture content, acidity, and ascorbic acid decreased during ripening, irrespective of the variety. The data indicated that most of the chemical attributes of fruit increased with the increase in temperature. The result showed that the chemical characteristics of mango fruits were improved with calcium chloride-coated fruits as compared to uncoated fruits at the ripened stage, irrespective of the variety and storing temperature. Calcium chloride increases the physical and chemical properties of fruits and preserves the fruits for a longer time as compared to uncoated fruits and retains the overall quality of fruit (Sati and Qubbaj, 2021; Gao et al., 2020; Mehmet et al., 2016). The statistical analysis made in this respect concluded that most of the measured attributes are significantly different under the limit $P < 0.05$ for storage temperature as well as treatments (Table 2).

Table 2.

Average values of chemical constituents measured at the ripened stage for Langra and Samar Bahisht Chaunsa mango fruit stored at different temperatures.

Varieties	T*	ST (°C)	Total sugar (%)	TC (µg/g)	A (%)	AA (mg/100g)	pH	MC (%)	TSS (%)
Langra	Uncoated	20	18.78[e†]	54.64[f]	0.63[a]	89.81[a]	4.79[c]	70.19[d]	19.49[e]
		30	21.41[c]	61.42[d]	0.53[a]	80.19[b]	5.06[b]	71.28[c]	22.36[c]
		40	22.49[b]	63.45[b]	0.45[b]	77.31[c]	5.17[a]	72.39[b]	23.45[b]
	Coated	20	19.54[d]	55.44[e]	0.61[a]	89.55[a]	4.95[b]	71.09[c]	20.45[d]
		30	22.35[b]	62.32[c]	0.50[a]	80.09[b]	5.12[a]	72.11[b]	23.15[b]
		40	23.44[a]	64.51[a]	0.44[b]	77.15[c]	5.26[a]	73.23[a]	24.37[a]
Samar Bahisht Chaunsa	Uncoated	20	20.69[e†]	80.34[f]	0.52[a]	73.41[a]	4.92[c]	69.63[d]	20.59[e]
		30	23.58[c]	86.19[d]	0.42[b]	67.47[b]	5.15[b]	70.51[c]	24.46[c]
		40	24.56[b]	89.36[b]	0.38[b]	65.51[c]	5.25[b]	71.53[b]	25.45[b]
	Coated	20	21.71[d]	81.36[e]	0.51[a]	73.35[a]	5.02[b]	70.55[c]	22.62[d]
		30	24.63[b]	87.21[c]	0.38[b]	67.25[b]	5.28[a]	71.48[b]	25.58[b]
		40	25.67[a]	90.29[a]	0.34[b]	65.18[c]	5.42[a]	72.49[a]	26.61[a]

*T, ST, TC, A, AA, MC, and TSS stand for treatments, storage temperature, total carotenoids, acidity, ascorbic acid, moisture contents, and total soluble solids, respectively. The comparison has been made within the variety.

[†]Values having different superscripts in the columns are significantly different under the limit of $P < 0.05$.

The fruit of mango took a shorter time to ripen at 40°C and longer when stored at 20°C during ripening, irrespective of variety or treatment (Baloch et al., 2013). It was also observed that the rate of ripening was higher for Langra fruit and slower for the variety of Samar Bahisht Chaunsa. On the other hand, the required time for fruit ripening was longer for the mango fruit coated with calcium chloride as compared to uncoated fruit (Figure 1). It can be attributed to the statement that calcium chloride decreases the rate of evaporation and respiration and slows down the process of ripening, which eventually may lead to quality improvement, irrespective of variety or storage temperature (Hmmam et al., 2021; Gao et al., 2020; Abera et al., 2019; Wong et al., 2016; Anjum and Ali, 2004; Santos et al., 2004; Gofure et al., 1997; Suntharalingam, 1996; Yuen et al., 1993).

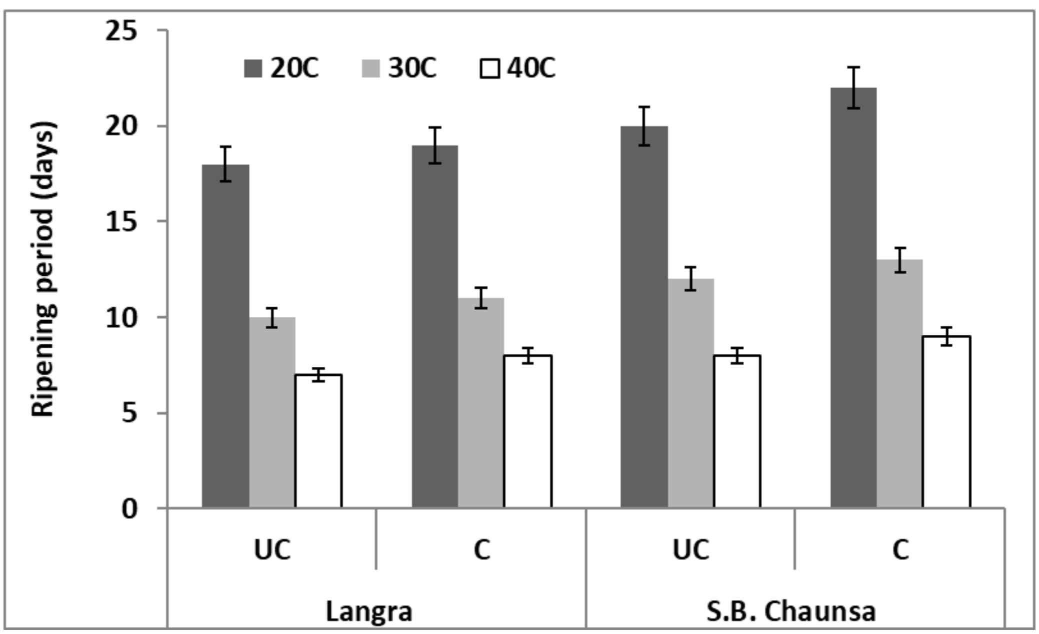

Figure 1: Time required by the Langra and Samar Bahisht Chaunsa fruit to reach at the ripened stage as affected by storage temperature and treatments. UC and C stand for uncoated and coated fruit.

The waste percent was lowest at 30°C as compared to other temperature (Figure 2). It was lowest for Samar Bahisht Chaunsa as compared to Langra mango fruit variety. In coated fruit the waste percent was lower than uncoated mango fruit (Figure 2). The reason for such trend can be that the fruit coated with calcium chloride preserve the fruit and did not allow the bacteria to attack and the fruit remained safe from the diseases (Sati and Qubbaj, 2021; Gao et al., 2020; Jitjak and Sanoamuang, 2021; Bibi and Baloch, 2014).

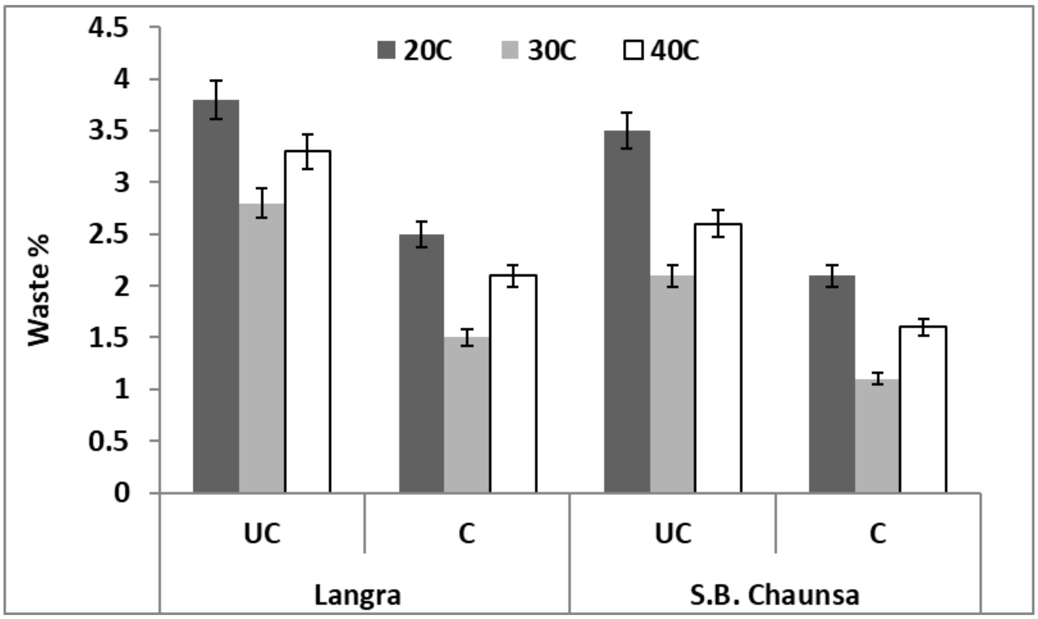

Figure 2: Waste percent of the Langra and Samar Bahisht Chaunsa fruit during the ripening process. UC and C stand for uncoated and coated fruit.

CONCLUSION

It was concluded that coating fruits with calcium chloride improved the quality, slowed down the process of ripening, and decreased the waste percent, irrespective of the storage temperature as well as variety. It was noted that the quality was highest for fruits stored at 40 °C while lowest at 20 °C; and storage life was longest for fruits stored at 20 °C while shortest for fruits stored at 40°C, irrespective of the variety. It was also noted, that the storage life was longest in Samar Bahisht Chaunsa as compared to the Langra variety. The waste percent was lowest for fruits stored at 30 °C, irrespective of the variety.

ACKNOWLEDGMENTS

Provision of lab facilities/support of Gomal University, Pakistan is highly acknowledged. The statistical analysis was performed by Department of Statistics, Gomal University, Pakistan.

REFERENCES

Abbasi, K. S., N. Anjum, S. Sammi, T. Masud and S. Ali. 2011. Effect of coatings and packaging material on the keeping quality of mangoes (*Mangifera indica* L.) stored at low temperature. P. J. Nut. 10 (2): 129-138.

Abbasi, N.A., Iqbal, Z., Mqbool, M., Hafiz, A.I., 2009. Postharvest quality of mango (*Mangifera indica* L.) fruit as affected by chitosan coating. Pakistan Journal of Botany 41, 343-357.

Abera, N.G., Kebede, W., Wassu, M., 2019. Effect of aloe gel and cactus mucilage coating on chemical quality and sensory attributes of mango (*Mangifera indica* L.). Journal of Postharvest Technology 7, 31-43.

Anjum, M. A., Ali, H., 2004. Effect of various calcium salts on ripening of mango Fruits. Journal of Research Science Bahauddin Zakariya University, Multan, Pakistan 15, 45-52.

Anwar, R., Malik, A.U., 2007. Hot water treatment affects ripening quality and storage life of mango (*Mangifera indica* L.). Pakistan Journal of Agricultural Sciences 44, 304-311.

Anwar, R., Malik, A.U., Amin, M., Jabbar, A., Saleem, B. A., 2008. Packaging material and ripening methods affect mango fruit quality. International Journal of Agriculture and Biology 10, 35-41.

AOAC. (2000). Official Methods of Analysis. Association of Official Analytical Chemist. EUA, Gaithersburg, Maryland.

Austin, P.T., A.J. Hall, P.W. Gandar, I.J. Warrington, T.A. Fulton and E.A. Halligan. 1999. Compartment model of the effect of early-season temperatures on potential size and growth of 'Delicious' apple fruits. Ann. Bot. 83:129-143.

Baloch, M. K., F. Bibi and M.S. Jilani. 2011. Quality and shelf life of mango (*Mangifera indica* L.) fruit: As affected by cooling at harvest time. Sci. Hort. 130: 642-646.

Baloch, M.K., Bibi, F., Jilani, M.S., 2013. Effect of coatings over the quality and shelf life of mango (*Mangifera indica* L.) fruit. Journal of Food Processing and Preservation 37, 66-73.

Bibi, F., Baloch, M. K., 2014. Postharvest quality and shelf life of mango (*Mangifera indica* L.) fruit as affected by various coatings. Journal of Food Processing and Preservation 38, 499-507.

Carrillo-Lopez, A., Ramirez-Bushtamant, F., Valdez-Torres, J.B., Rojas-Villages, R., Yahi, E.M., 2000. Ripening and quality changes in mango fruit as affected by coating with an edible film. Journal of Food Quality 23, 479-486.

Corrales-Garcia, J., Lakshminarayana, S., 1991. Response of two cultivars of mango fruits immersed in a calcium solution to cold storage at different times and temperatures. Technical Innovations in Freezing and Refrigeration of Fruits and Vegetables, International Institute of Refrigeration, Paris, pp. 73-77.

Cuq, B., N. Gontard and S. Guilbert. 1995. Edible films and coatings as active layers. In: Rooney, M.L. (Ed.), Active Food Packaging. Chapman & Hall- Glagow-UK, pp. 111–141.

Dang, K.T.H., Singh, Z., Swinny, E.E., 2008. Edible coatings influence fruit ripening, quality and aroma biosynthesis in mango fruit. Journal of Agricultural and Food Chemistry 56, 1361-1370.

Feygenberg, O., V. Hershkovitz, R. Ben-arie, S. Jacob, E. Pesis and T. NIkitenko. 2005. Postharvest use of organic coating for maintaining bio-organic avocado and mango. Acta Hort. 682: 507-512.

Gao, Q., Tan, Q., Song, Z., Chen, W., Li, X and Zhu, X., 2020: Calcium chloride postharvest treatment delays the ripening and softening of papaya fruit. J. Food Proc. Pres. 44(8). DOI: 10.1111/jfpp.14604

Gofure, A., Shafique, M.Z., Helali, M., Ibrahim, M., Rahman, M.M., Alam, M.S., 1997. Studies on extension of post-harvest storage life of mango (*Mangifera indica* L.). *Bangladesh* Journal of Scientific and Industrial Research 32, 148-152.

Guilbert, S. 1986. Technology and application of edible protective films. In Mathlouthi, M. (Ed.), Food packaging and preservation, p. 371-394. London, UK: Elsevier Appl. Sci.

Hmmam, I., Zaid, N., Mamdouh, B., Abdallatif, A., Abd-Elfattah, M., Ali, M., 2021. Storage Behavior of "Seddik" Mango Fruit Coated with CMC and Guar Gum-Based Silver Nanoparticles. Horticulturae 7, 44.

Hoa, T.T., Ducamp, M.N., Lebrun, M., & Baldwin, E.A., 2002. Effect of different coating treatments on the quality of mango fruit. Journal of Food Quality 25, 471- 486.

Jitjak, W., Sanoamuang, N., 2021. Application of cost-effective coating materials supplemented with different types of local essential oil to control *Fusarium verticillioides* (Sacc.) Nerenberg from post-harvest avocado fruits. International Journal of Agricultural Technology 17, 883-898.

Kader, A.A. 1992. Postharvest Technology of Horticultural crops. Second edition, Univ. Calif., Div. Agr. Nat. Resources, Publ. 3311, p. 296.

Larmond, E., 1977. Methods for sensory evaluation of foods. Department of Agriculture, Ottawa, Canada, Publ. No. 1637.

Marsh, K.B., A.C. Richardson and E.A. Macrae. 1999. Early- and mid-season temperature effects on the growth and composition of satsuma mandarins. J. Hort. Sci. Biotechnol. 74: 443-451.

Mehmet, U.K., Rezza n, K., 2016: The effects of calcium chloride and ascorbic acid treatment on ready-to-use carrot shreds. J. Life. Sci. 10(1). DOI: 10.17265/1934-7391/2016.01.002

Murillo, F.J., Adimilson, B.C., 1999. Effect of calcium chloride application on mango fruits cv. Tommy Atkins hydrothermally coated. Pesquisa Agropecuaria Brasileira 34, 761-769.

Narain, N., P.S. Bora, R. Narian and P. Shaw. 1998. Mango. In Tropical and Subtropical Fruits, (Eds.): P.E. Shaw, H.T. Chan and S. Nagy. pp. 1-77. Agrscience, Inc., Auburndale, FL.

Narayana, K., Pal, R.K., Roy, S.K., 1996. Effect of pre-storage treatments and temperature regimes on shelf life and respiratory behaviour of ripe Beneshan mango. Journal of Food Science and Technology Mysore 33, 79-82.

Pal, R.K. 1998. Ripening and rheological properties of mango as influenced by ethrel and calcium carbide. J. Food Sci. Tech. Mysore, 35: 358-360.

Santos, A.F., Silva, S.M., Mendonca, R.M.N., Alves, R.E., Martins, L.P. 2004. Storage of mango fruits cv. Rosa coated with calcium chloride after harvest at different maturity stages. Acta Horticulture 645, 663-670.

Sati, F., and Qubbaj, T., 2021. Effect of calcium chloride postharvest treatment in combination with plant natural substance coating on fruit quality and storability of tomato (*Solanum lycopersicum*) fruits during cold storage. Journal of Applied Botany and Food Quality 94, 100 – 107.

Shafique, M.Z., M. Ibrahim, M.O.H. Helali and S.K. Biswas. 2006. Studies on the physiological and biochemical composition of different mango cultivars at various maturity levels. Bangld. J. Sci. Ind. Res. 41:101-108.

Shorter, A.J., Joyce, D.C., 1998. Effect of partial pressure infiltration of calcium into 'Kensington' mango fruit. Australian Journal of Experimental Agriculture 38, 287-294.

Simmons, S.L., P.J. Hofman, A.W. Whiley and S.E. Hetherington.1998. Effects of pre-harvest calcium sprays and fertilizers, leaf:fruit ratios, and water stress on mango fruit quality. In: Coates LM, Hofman PJ, Johnson GI (eds), International Workshop on Disease Control and Storage Life Extension in Fruit, pp.19-26. Australian Centre for International Agricultural Research, Chiang Mai.

Srinivasa, P. C., N. S. Susheelamma, R. Ravi and R. N. Thnathanara. 2004. Quality of mango fruits during storage: effect of synthetic and eco-friendly films. J. Sci. Food Agric. 84: 818–824.

Suntharalingam, S., 1996. Postharvest treatment of mangoes with calcium. Tropical Science 36, 14-17.

Wong, F.L., Wan Zaliha, W.S., Yusnita, H., 2016. Quality of Chok Anan mango as affected by tapioca-sago starch coating solutions stored at room temperature. Journal Microbiology, Biotechnology and Food Science 6, 737-742.

Yuen, C.M.C., Tan, S.C., Jovce D., P. Chettri., 1993. Effect of postharvest calcium and polymeric film on ripening and peel injury in Kensington Pride mango. Asean Food Journal 8, 110-113.

Zhu, X., Q. Wang, J. Cao and W. Jiang. 2008. Effects of chitosan coating on postharvest quality of mango (*Mangifera indica* L. cv. Tainong) fruits. J. Food Proc. Preserv. 32: 770-784.

AUTHORS

- **First Author**: Farzana Fatima,
- **Second Author**: Osaidullah,
- **Third Author**: Aqeel Ahmad,
- **Forth Author**: Musa Kaleem Baloch,
- **Fifth Author**: Maleeha Alam,