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Innovative Approach of Active Packaging in Cardboard Carton and its Effect on Overall Quality Attributes Such as Weight Loss, Total Soluble Solids, pH, Acidity and Ascorbic Acid Contents of Chaunsa White Variety of Mango at Ambient Temperature During Storage

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Abstract: Significant effect ($p<0.05$) of Innovative approach of Active packaging in Cardboard Carton (APCC) on overall quality attributes such as weight loss, Total Soluble Solids (TSS), pH, Titrate-able Acidity (TA) and Ascorbic Acid (AA) contents of Chaunsa white variety of Mango was investigated at ambient temperature (28-33°C and 56.7-69.7% relative humidity) during storage. It was observed that the uncoated fruit packed in carton had comparatively higher percent weight loss (10.96%) than control (9.39%); however, after application of APCC system same packaging had significantly reduced the percent weight loss up to (6.89%). It was also noted that mango fruit undergone through APCC system showed a slower increase of TSS (16.44-20.76%), pH (3.98-4.83), slower decrease in TA (0.51-0.92%), or slower increased of AA (23.06-40.83 mg/100 g) during ripening with an average mean of 8.10%, 17.73%, 4.28, 0.75%, 25.47 mg/100 g respectively at later stage of storage as compared to control sample (T_1) had higher weight loss (9.39%), TSS (20.83%), highest pH value (4.91), lowest acidity (0.44%), highest AA (42.06 mg/100 g), respectively at much earlier during storage. It is clear from these studies that Innovative approach of APCC with other protective chemicals such as coating emulsions having fungicide, ethylene absorbent and anti-ripening agent had extended storage life up to 25 days and played a very effective and vital role to control compositional changes by delaying the ripening process and with a minimum quality loss, as compared to control sample had greater compositional changes with maximum quality loss during storage at ambient temperature. Due to unattractive skin, brown pulp color and poor taste the control fruit was unacceptable within two weeks of their storage.

Key words: Fruit, Chaunsa mango, active packaging, ascorbic acid, organoleptic, physico-chemical composition, quality characteristics

INTRODUCTION

Active Packaging (AP) is a modern development consisting of a group of techniques in which the package is self-motivated and is actively involved with food products or act together with internal atmosphere to extend the shelf life while maintaining quality and safety. Active packaging is some time referred to as interactive or smart packaging which is planned to sense internal or external environmental changes and to take action by changing its own properties or attributes. Potential techniques used in active packaging are the use of oxygen scavenging/carbon dioxide, ethylene and moisture absorbing systems by placing sachets, incorporation of antimicrobial agents into polymer surface coatings or in plastics films, sheets or on materials and into the pads for fresh produce (John, 2008). Atmosphere in packaging is actively established by replacing the packaging atmosphere with desirable atmosphere through the use of absorbing substances in the package to scavenge O_2, CO_2, H_2O and C_2H_4 and for this purpose $CaCl_2$, sorbitole and Xylitol in package is used to absorb H_2O, molecular sieves and hydrated lime is used to absorb CO_2 while $KMnO_4$ is used to scavenge the ethylene to adjust and maintain the proper atmosphere (Kumar *et al.*, 2009). The ripening process of mango fruit involves a series of biochemical reactions or metabolic activities that cause chemical changes, increased respiration, ethylene production, change in structural polysaccharides causing softening, degradation of chlorophyll develops pigments by carotenoids biosynthesis, changes in carbohydrates or starch conversion into sugars, organic acids, lipids, phenolics, volatile compounds, etc thus leading to ripening of fruit with softening of texture to acceptable quality (Herianus *et al.*, 2003). Mango is packaged from very simple baskets of bamboo, pigeon pea (*Cajanus*) or mulberry with paddy straw as cushioning material because of their easy availability and low cost. This type of packaging was found to be unsatisfactory because of uneven ripening of fruit, excessive shrinkage, bruising

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and stacking was also a problem with the use of baskets. However, ventilated Low-Density Polyethylene (LDPE) linings have also being found to be beneficial, as this material maintains humidity, which results in less shrinkage during storage (Tharanathan *et al.*, 2006). The recent studies showed that coated fruit having other protective chemicals when packaged in polyethylene had played a very effective role to control compositional changes by delaying the ripening process and with a minimum quality loss during 30 days of storage at ambient temperature, as compared to the control sample that had greater compositional changes with maximum quality loss during storage at ambient temperature (Rathore *et al.*, 2009). Polyethylene wrapping of $CaCl_2$ treated apple proved very useful for reducing weight loss and shriveling and retained consumer acceptability even after 60 days of storage (Hayat *et al.*, 2005). In Israel MAP technique of polyethylene perforated and non-perforated sealed packaged coupled with low temperature at 14°C for 3 weeks and then at 20°C for 4 days when applied to Tommy Atkins during storage showed no decay until opening in non-perforated pack, and then rotted rapidly. Data obtained on shelf life, weight loss, spoilage and retention of Vitamin C indicated that cool chamber was an ideal storage technique (Pal, 1998). The removal of ethylene with ethysord adsorbent, from CFB carton packaged alphonso mango had extended life up to 16 days as compared to its 8 days normal life and controlled black spots completely by washing with 0.01% $KMnO_4$ (Raje *et al.*, 1997). In Israel the A. *alternata*, *Phomopsis* sp. or *Lasiodiplodia* sp. attacking at the stem-end of the fruit were controlled recently on commercial level by a combined hot water (55°C) spray with 225 ug/ml prochloraz and fruit brushing, followed by 900 ug/ml prochloraz sprays before waxing for 15-20 sec. The normal life of Baneshan mango is 4 days at ambient temperature, was extended from 6-9 days by low temperature and further extended 8, 12 and 23 days at room temperature, cool chamber and cold storage when treated with bavistin fungicide, parafin wax and wrapping with HM-film that provide modified atmosphere coupled with low temperature (Narayana *et al.*, 1996). The previous studies revealed that different techniques have been applied for improvement or maintenance of the quality of fruit during storage. However the innovative approach of Active Packaging in Cardboard Carton (APCC) and its effect on overall quality attributes such as weight loss, total soluble solids, pH, acidity and ascorbic acid of Chaunsa white variety of mango at ambient temperature during storage is not available in the literature. Therefore the present study was designed for the determination of the effect of innovative approach of APCC on the quality parameters such as weight loss, TSS, pH, Titrate-able Acidity and Ascorbic Acid of chaunca white during storage.

MATERIALS AND METHODS

Collection of sample: For present research studies Chaunsa white very important commercial varieties of mango was selected and for this purpose unripened, matured, hard green and uniform size of fresh arrival fruit were purchased from wholesale fruit market in Islamabad.

Hot water treatment: Chaunsa white variety of mango were immediately transferred from wholesale market to post harvest laboratory of Department of Food Technology in University of Arid Agriculture Rawalpindi and after careful sorting, fruits in cotton bags were subjected to hot water treatment at 53°C for three minutes and immediately cooled by dipping in cold water at 20°C and were dried in air. Coatings were prepared according to the concentrations as described by Rathore *et al.* (2009).

Grading, coating, packaging and storage: Chaunsa white late commercial variety of mango fruit was graded according to their size and total 180 selected fruit were divided into 6 groups having 30 mangoes in each group respectively. These groups were under gone into following 6 treatments viz; Control (T_1), Carton (T_2), Wax-CMC having NaOCl coated fruit packed in Carton (T_3), Wax-CMC Coated fruit with $KMnO_4$ package in Carton (T_4), Wax-CMC Coating having 2,4,5-T in Carton (T_5), H_3BO_3 and 2,4,5-T having oil treated fruit packed in Carton (T_6) and then were stored at ambient temperature (28-33°C and 56.7-69.7% relative humidity) for a storage period of 30 days.

Physico-chemical and sensory evaluations: Physico-Chemical parameters such as weight loss, total soluble solids, pH by using HANAS pH meter no. 210, titratable acidity according to standard procedures as mentioned in AOAC (1990). Ascorbic acid was determined by standard method as described by Awan and Rehman (1999). The data obtained were statistically analyzed for Analysis of Variance (ANOVA) by using 2-Factorial Complete Randomized Design (CRD) and Duncan's Multiple Range Test (DMRT) was applied to compare the mean values obtained according to the method described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

It was investigated that Chaunsa white variety of mango under gone through innovative approach of active packaging in cardboard carton had affected the overall quality attributes such as weight loss, total soluble solids, ph, acidity and ascorbic acid contents of chaunsa white variety of mango at ambient temperature during storage.

Weight loss: Table 1 illustrates that statistically, treatments and their interactions had significant difference on percent weight loss during 30 days of their storage. The uncoated fruit packaged in Carton T_2 (10.96%) had comparatively more weight loss than control T_1 (9.39 %) might be due to decreased in the relative humidity or more temperature in side the pack and comparatively dried atmosphere created by lower percent relative humidity increased loss, however this loss was much reduced to 8.10% when coated fruit was packaged in same packaging after 30 days of storage as compared to first day of their storage having 0.00% weight loss. The present investigations showed that Chaunsa white mango coated with Wax-CMC with $KMnO_4$ package in carton (T_4) had minimum weight loss (6.89%), followed by 2,4,5-T and H_3BO_3 having oil treated fruit packaged in carton T_6 (8.01%), Wax-CMC having Sodium Hypochlorite packaged in Carton T_3 (8.37%), Wax-CMC having 2,4,5-T coated fruit packaged in carton T_5 (9.15%) as compared to controlled T_1 (9.39%) had more weight loss whereas, Carton T_2 (10.96%) had the maximum weight loss at ambient temperature during 18 days of storage (Table 1). The effectiveness of carton packaging with the combination of coating, ethylene absorbent used, fungicide or antiripening agent to minimize the loss was varied, may be due to the difference in created Modified Atmosphere in Packaging (MAP), CO_2 levels and decreased O_2 levels which reduce respiration rates, maintained mango quality, slowed down the transpiration as result prevented water loss and decay was effectively controlled by fungicide. These results are generally in agreement with those reported by Ladaniya and Sonkar (1997). It is evident from our studies that combination of wax coating with $KMnO_4$ had reduced the weight loss, might be due to creation of modified atmosphere by removing ethylene with ethylene absorbent and decreased rate of respiration by degrading ethylene produced by the fruits into carbon dioxide and water. These results are agreed with the findings of Yuniarti and Suhardi (1992) they used calcium chloride, wax emulsion, wrapping mangoes in perforated polyethylene bags containing $KMnO_4$ and reported that lower weight loss was observed in case of treated mangoes as compare to control. The increasing trend of weight loss in treated fruit is also reported by other scientists (Carrillo *et al*., 2000; Chitarra *et al*., 2001; Hayat *et al*., 2005). Therefore, it is understandable that Chaunsa white after coating having ethylene absorbent or antiripening agent or antiripening agent with oil and disinfectant packaged in carton played a vital role in delaying of ripening with minimum percent weight loss during storage.

Total soluble solids (TSS): It is obvious from Table 1 that treatments and their interactions had highly significant effect on percent total soluble solids contents of mango except T_2 and T_3 (20.76%, 19.18%) with insignificant effect, however a significant difference in total soluble solids of these treatments to others were found during 18 days of their storage. The TSS of coated fruit packaged in carton ranged from 16.44-20.76% with an average means of 17.73% as compared to first day of their storage having minimum percent of total soluble solids (10.0%). The increasing trend of the percent total soluble solids contents of fruit during storage that could be attributed mainly due to breakdown of starch into simple sugars during ripening along with a proportional increase in TSS and further hydrolysis decreased the TSS during storage. The maximum percent total soluble solids contents of late Chaunsa white mango were observed in T_2 (20.76%), followed by T_3 (19.18%), T_4 (18.54%), T_6 (16.78 %) and T_5 (16.44%) however, all of the treatments showed a slower increasing rates or the more retaining trend in percent total soluble solids contents for longer period as compared to control T_1 (20.83%). The effectiveness to minimize or the retained the percent total soluble solids contents was varied may be due the difference in the modified atmosphere created by coating-carton packaging, having ethylene absorbent, fungicide or antiripening agent used had slowed down the metabolic activities and delay ripening with reduced TSS contents during storage (Table 1). These results are in line with earlier findings (Kittur *et al*., 2001; Raje *et al*., 1997; Rosa *et al*., 2001; Ladaniya and Sonkar, 1997). Therefore, coating-carton combination could be more effective in delaying ripening of mango by slower increase of TSS contents during storage.

pH value: The Table 1 reveals that the pH value of coated fruit packaged in carton was 3.98-4.83 with an average means of 4.28 as compared to control having higher pH (4.91) after 18 days of storage at ambient temperature. The treatments and their interactions had highly significant effect on pH value of mango during storage except T_5 and T_6 (4.03 3.98) with insignificant effect, however a significant difference of pH value of these treatments to others were found during 18 days of their storage. The fluctuations of pH might be due to the variations in titratable acidity or temperature of storage and decline of acidity is attributed due to increased activity of citric acid glyoxylase during ripening or reduction in acid content may be due to their convertion into sugars and further utilization in metabolic process during storage. These results are correspond with Srinivasa *et al*. (2002) who described that pH values of Alphonso mango had an increasing trend from 4.06-6.73 on 12^{th} day in control fruit at ambient temperature 27±1°C at 65% RH. Doreyappy-Gowda and Huddar (2001) also observed that Green mature Alphaso and other 7 varieties of mango fruit stored at 18-34°C under gone a series of physico-chemical changes during

Table 1: Effect of coating having fungicide, ethylene absorbent and antiripening agent packaged in cardboard carton on the physico-chemical composition of chaunsa white variety during storage

	Treatments						
Parameters	T_1	T_2	T_3	T_4	T_5	T_6	Overall effect of Carton-coat
Weight loss (%)	9.39b	10.96a	8.37d	6.89f	9.15c	8.01e	8.10
Total soluble solids (%)	20.83a	20.76b	19.18b	18.54c	16.44f	16.78e	17.73
pH	4.91a	4.83b	4.47d	4.66c	4.03fg	3.98g	4.28
Titratable acidity (%)	0.44l	0.51k	0.67i	0.61j	0.92bc	0.80gh	0.75
Ascorbic acid (mg/100 mg)	44.06a	40.83b	23.06i	26.11g	26.3f	26.41e	25.47

Mean values with different letters in same row are significantly different to each other at ($p<0.05$).

T_1 = Control; T_2 = Carton; T_3 = Coat + NaOCl + Carton; T_4 = Coat + $KMnO_4$ + Carton; T_5 = Coat+2,4,5-T + Carton; T_6 = Coat+2,4,5-T having oil + H_3BO_3-$CaCl_2$ + Carton

ripening and the major changes were considerably increased in pH from 2.85-4.38 during ripening. These results are comparable with those of Hayat *et al.* (2005) who reported that there was a gradual increased of pH from 4.22-4.78 in Banky apple during storage at ambient temperature. These results are not agreed with those of Manzano *et al.* (1997) who reported that pH value showed decreasing trend from 4.82-3.82 during 20 days of their storage, however there was an agreement with their 2nd part of statement that temperature of storage also affected pH value and lower pH value 4.21 at 12°C as compared to higher pH value 4.67 at 25°C was observed during 20 days of storage. These results are in line with the findings of Kudachikar *et al.* (2001) who described that the pH value of Neelum mango was decreased (3.0) and acidity increased (1.9%) upto 90 days after the fruit set. Later, pH slightly increased (3.1) and acidity slightly decreased (1.5%) at 110 days after fruit set which is optimum stage of maturity after the fruit set. The maximum pH value of coated late Chaunsa white mango were observed in T_2 (4.83), followed by T_4 (4.66), T_3 (4.47), T_5 (4.03) and T_6 (3.98) as compared to first day with very low pH value (3.85, however, these treatments having comparatively lower pH as compared to control with highest pH value T_1 (4.91), after 18 days of storage at ambient temperature. The control had significantly higher pH value than other treatments after 18 days of their storage might be due to free atmospheric conditions of temperature, O_2 and relative humidity that caused more oxidation and degradations of acids as compared to coated fruit. The treated fruit with CMC-Bee-wax polysaccharide based coating having NaOCl (T_3), $KMnO_4$ (T_4) or 2,4,5-T (T_5) packed in carton respectively had lower pH value might be due to the slower metabolic process of conversion of sugar or degradation of acids compared to other treatments that might be due to a difference in the modified atmosphere created by different types of coatings or might be due to formation of carboxylic acid by dark fixation of CO_2 or due to high internal CO_2 levels. The ripening process was more effectively controlled in those treatments having NaOCl fungicide as compared to H_3BO_3. Similar pattern was observed by Carrillo *et al.* (2000) who reported that Haden mangoes coated with different concentrations of Semperfresh had lower pH (4.75) as compared to noncoated fruit (5.66) at the end of storage at 13°C during 32 days of storage and coating was more effective in maintaining a lower pH during storage. These results are confirmed by (Manzano *et al.*, 1997) who reported that pH value of Hadden mango treated with waxes coating were depending on types of coating and had no significant effect on pH content in between Prolong and control (4.60, 4.54) or Fomesa and Primafresh (4.23, 4.25), however a significant difference in between three groups Fomesa and Prolong (4.23, 4.54) or Fomesa and control (4.23, 4.60) or Primafresh and control (4.25, 4.60) was noted during storage. These results are in line with those Baldwin *et al.* (1999) who observed that pH value depends on type of coating and showed significantly lower pH (4.6, 4.7) in Natural-Seal (NA) a polysaccharide-based edible coated fruit or Tropical Fruit Coating (TPC) respectively compared to control (5.5) at 10 or 15°C with 90-95% RH for 19 days, followed simulated marketing conditions at 20°C with 56% RH for 4 days. These results are comparable with Hayat *et al.* (2005) who reported that apple had higher pH (4.60) in control than paraffin wax coating (4.47) or polyethylene (4.42) during storage. This might be due to less oxidation of the fruits and calcium decrease in the degradation of acids thus maintaining the integrity of cells and polyethylene to delay the metabolic changes in fruits. Similarly polyethylene bags were sealed so air was not available for various chemical reactions resulting in less increase in PH. These investigations are similar to those (Srinivasa *et al.*, 2002) Who described that pH values of Alphonso mango was higher in control (4.06-6.73) as compared to chitosan (5.04) coating or LDPE film (5.79) treated with 500 ppm Carbendazim fungicide in carton boxes on 12th day at ambient temperature 27±1°C at 65% RH during ripening. The results of the present studies shows that Chaunsa white packaged in carton had higher pH value, however coating with anti-ripening agent (T_5) and anti-ripening agent with oil and disinfectant (T_6) respectively when packaged in carton had maintained lower pH value very near to first day pH value (3.85) shows that these treatments might be controlled the ripening process due to that pH value was maintain at lower level.

Titratable acidity: It is obvious from Table 1 that all of the of treatments had a significant difference in overall percent of titratable acidity ranged from 0.51-0.92%, with an average means of 0.75% after 25 days of storage as compared to first day with very high percent acidity (1.28%). The maximum percent acidity of late Chaunsa white mango were observed in T_5 (0.92%), followed by T_6 (0.80%), T_3 (0.67%), T_4 (0.61%) and T_2 (0.51%) however, these treatments maintained comparatively higher percent acidity compared to control T_1 (0.44%) had very low percent acidity after 25 days of storage at ambient temperature or first day with very high percent acidity (1.28%) that might be due to higher CO_2 and lower levels of O_2 in the internal atmosphere, an aerobic respiration produced carbonic acid and as result increased in acidity. These results are in lined with those (Baldwin *et al*., 1999) who observed that Tomy Atkins mango treated with Natural Seal (NA) a polysaccharide-based edible coating had higher TA (0.28) than TFC (0.21) or uncoated (0.16) fruit at 10 or 15°C with 90-95% RH for 19 days, followed simulated marketing conditions at 20°C with 56% RH for 4 days. These results are confirmed by (Manzano *et al*., 1997) who reported that Hadden mango treated with waxes coating stored at different temperatures had no significant effect on titratable acidity percent in between Prolong and control (0.33%) or Fomesa and Primafresh (0.40%), however a significant difference in between three groups Fomesa and Prolong (0.40, 0.33%) or Fomesa and control (0.40, 0.27%) or Primafresh and control (0.40, 0.27%) was noted during storage. However our research studies disagree with this statement that titratable acidity percent showed increasing trend from 0.18-0.57% during 20 days of their storage. These results are in correspond with (Srinivasa *et al*., 2002) who found that Titratable acidity values also showed a decreasing trend, the initial value of 2.17% being reduced to 0.08% in control fruit on 12th day in desapped, washed with tap water then dipped Alphonso mango in 500 ppm Carbendazim fungicide for 15 min and after drying fruit were kept in carton boxes whose top was covered with Chitosan (100 gauge) or with low-density polyethylene(100 gauge) or kept as such as control at ambient temperature 27±1°C at 65% RH. Similar changes were noted by (Kudachikar *et al*., 2001) in Neelum mango which had optimum stage of maturity 110 days after the fruit set and pH value decreased (3.0) and acidity increased (1.9%) upto 90 days after the fruit set . Later, pH slightly increased (3.1) and acidity slightly decreased (1.5%) at 110 days after fruit set. It is obvious from the results of the present studies that cardboard corten with combination of coating, antiripening agent with or without fungicide, or ethylene absorbent is very effective to maintain the maximum percent acidity and delay ripening process.

Ascorbic acid: It is evident from Table 1 that treatments and their interactions had highly significant effect on ascorbic acid contents of mango during storage and the ascorbic acid content in coated fruit packaged in carton was ranged from 23.06-40.83 mg/100 g with an average means of 25.47 mg/100 g during 25 days of storage at ambient temperature compared to very low ascorbic acid contents at first day (13.49 mg/100 g). The treated fruit showed a slower increasing trend of ascorbic acid contents during ripening might be due to the slower changes in the atmospheric conditions of modified packaging and the un-ripened fruit was going to optimum ripening stage that caused an increase in AA contents and after that the contents was reduced with passage of time might be due to degradation of AA by oxidation. These results are confirmed by Kudachikar *et al*. (2001) who reported that the ascorbic acid content of Neelum mango fruit increased from 42 mg/100 g at 30th days after the fruit set to a maximum of 74 mg /100 g on fresh weight bases at 70th days, there after it decreased to 70.5 mg/100 g at 110th days that was the optimum stage of maturity of Neelum mango after the fruit set. It is apparent from Table 1 that statistically there was a significant difference of ascorbic acid contents among treatments was found during 25 days of their storage at ambient temperature. The maximum ascorbic acid contents of late Chaunsa white mango in coated fruit packaged in polyethylene were observed in T_2 (40.83 mg/100 g), followed by T_6 (26.41 mg/100 g), T_4 (26.11 mg/100 g), T_5 (26.30 mg/100 g) and T_3 (23.06 mg/100 g) as compared to control with maximum ascorbic acid contents T_1 (44.06 mg/100 g) or having very low ascorbic acid contents at first day (13.49 mg/100 g) during storage that might be due to free atmospheric conditions, oxidation of AA was higher in control that caused rapid reduction in AA content compared to others coated fruit retained more AA might be due to slower decrease of AA in the higher concentration of CO_2 inside the fruit package after 18 days of storage at ambient temperature. These results are in line with the findings of Rana *et al*. (1992) who reported that decrease in ascorbic acid content was observed when sweet oranges were treated with oil emulsion stored in wooden box with a polyethylene bag. These results are comparable with (Carrillo *et al*., 2000) Who examined that ascorbic acid had decreasing trend in Haden mangoes coated with different concentrations of Semperfresh at 13°C during 32 days of storage but decrease was slower in coated fruit as compared to noncoated fruit. These results further support the findings of Raje *et al*. (1997) in India who prescribed that the ascorbic acid content of alphonso mangoes in CFB carton depends on type of absorbent used and was higher in Halogen releaser 66.62-93.98 mg/100 g, followed by control 88.49 mg/100 g and in $KMnO_4$ dipped 75.42 mg/100 g after 8th day at 32-36°C and RH of 70-75% during storage. There was a gradual decline in the ascorbic acid content during storage, however, the maximum retention of ascorbic acid was noted in $KmnO_4$ treated fruit (9.53 mg/100 g), followed by ethysord (8.49 mg /100 g) after 16th day of storage period as compared to the combination of ethysord and SO_2 releaser (1.90 mg/100 g), Oxidizer (1.85 mg/100 g) and halogen releaser (1.49 mg/100 g) having less retention of ascorbic acid during storage as compared to control that was spoiled after 8th day of their storage. It is obvious from the results that Chaunsa white packaged only in cardboard carton packaged was higher in ascorbic acid contents might be due to earlier ripening as compared to coated fruit packaged with ethylene absorbent, antiripening agent or antiripening agent with or without disinfectant were very effective in delay ripening as a result lower contents of ascorbic acid during storage.

Conclusion: Keeping in view the results of the present studies, it is concluded that innovative approach of Active Packaging in Cardboard Carton (APCC) is successful approach in which Chaunsa white either packaged in cardboard carton alone or with combination of coating, antiripening agent with or without fungicide, or ethylene absorbent or antiripening agent with oil and disinfectants had played a vital role in delaying of ripening process and increased the shelf life, with minimum percent weight loss, slower increase of TSS contents, maintained lower pH or maximum percent acidity and ascorbic acid at later stage during storage. Further development in this packaging system is possible by including the wrapping of coated fruit in polyethylene and then packing in carton combination may be more effective in delaying ripening and maintenance of freshness or quality of the fruit. Therefore further research studies for new innovations in this packaging system are required in near future.

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