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Effect of post-harvest coating treatments on apple storage quality

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Apple of 'Royal Delicious' cv. after harvest were coated with rice starch 2%, potato starch 2%, corn starch 2% along with neem oil 0.5, 1, 2% and apricot kernel oil 2%. The treated fruits were stored under low temperature conditions at 2±1°C, 85-90% RH and at ambient storage (18-25°C, 65-75% RH) for 150 and 45 days, respectively. The results suggested that the coating with 2% potato starch +2% apricot kernel oil followed by 2% corn starch +2% apricot kernel oil proved most effective in retaining the overall quality as it caused minimum changes in most of the physical and biochemical quality characteristics. In general, all treatments caused significant (p<0.05) decrease in physiological loss in weight, fruit firmness, pectin content and titratable acidity. Fruits stored at 2±1°C and 85-90% RH exhibited better retention of storage life for 150 days by lowering the incidence of fruit softening, spoilage and better retention of consumer preference compared to ambient storage. Application of 2% neem oil significantly ($p<0.05$) reduced the fruit rot caused by *Penicillium expansum*.

Keywords: Apple, Edible coatings, Neem oil, Apricot oil, Rice starch, Potato starch, Corn starch, Storage quality

Apple (*Malus domestica)* is the most important temperate fruit crop of North Western Indian Himalayan region. Commercial cultivation of apple is largely confined to Jammu and Kashmir, Himachal Pradesh and Uttrakhand which together account for 99% of the total production which is about 2.5% of world apple production (Anon 2005). Depending on the cultivar, apple can be stored for up to 1 year in controlled atmosphere (Varela et al 2008) and it is essential to lengthen the storage period at ambient conditions. From the last few years, the use of various edible bio-materials at the post-harvest stage is becoming popular among growers for the enhancement of shelf-life of fruits. Adoption of environmental and ecologically safe substances, particularly of biological origin, can provide fairly good solution to the synthetic chemical measures which have left sickening effect on the present day consumer (Kohli et al 2007).The objective of this study was to evaluate the effect of various post-harvest coating treatments on storage quality of apple cv. 'Royal Delicious'.

Materials and methods

The study was undertaken in the Department of Post-harvest Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan. Apple (*Malus domestica*) variety 'Royal Delicious' were procured from a well maintained commercial orchard situated at an elevation of 5500 feet above msl in a village Chiathla (Kotkhai), district Shimla, Himachal Pradesh, India. Corn and potato starch were purchased (Sigma-Aldrich Co. USA) and for preparation of rice starch, raw rice was soaked for overnight in water and crushed with excess water to make slurry and sieved. The filtrate was allowed to settle and the settled starch was washed 2-3 times to obtain clean starch. Preliminary study was conducted to detect the suitable starch concentration for preparation of coating materials. The starch solutions were prepared on the percentage weight basis with distilled water and rice, potato and corn starch were used in 1, 2 and 3% concentrations. According to the results of previous studies, 3 different concen-trations of neem oil (0.5, 1.0 and 2%) and 2% apricot kernel oil were selected.

The treatments used for coating of fruits were T_1: rice starch 2% + neem oil 0.5%, T_2: rice starch 2% + neem oil 1%, T_3: rice starch 2% + neem oil 2%, T_4: potato starch 2% + neem oil 0.5%, T_5: potato starch 2% + neem oil 1%, T_6: potato starch 2% + neem oil 2%, T_7: corn starch 2% + neem oil 0.5%, T_8: corn starch 2% + neem oil 1%, T_9: corn starch 2% + neem oil 2%, T_{10}: rice starch 2% + apricot kernel oil 2%, T_{11}: potato starch 2% + apricot kernel oil 2%, T_{12}: corn starch 2% + apricot kernel oil 2% and T_{13}: control (no coating).

Different concentrations of starch and edible oil solutions were prepared on percentage weight basis. For the application of post-harvest coating, uniform, unblemished fruits were selected and washed in tap water. After air drying, the fruits were coated with different edible oil concen-trations which was followed by starch coatings by dipping for 5 min in each solution. Coated fruits were placed on news paper sheets for air drying in shade at room temperature (18-25°C) and packed in corrugated fibre board (CFB) boxes (60 fruits per each treatment) for storage. The quality of treated fruits was monitored at 15 days interval during storage for 45 days under ambient (18-25°C, 65-75% RH) and 30 days interval at cold (2±1°C, 85-90% RH) storage for 150 days.

Fruits were weighed after each storage interval. The loss in weight during storage was expressed as % of initial weight. Fruit firmness was measured with Effigi Penetrometer FT 327 (Effegi Alfonsine, Italy), which recorded the pressure required to force a plunger of 11 mm diameter into pared flesh of fruit. Fruit juice was extracted with an apple juice extractor (B. San Berry and Co, New Delhi) and juice content calculated. The total soluble solids (TSS) content in fruit juice was recorded with Erma hand refractometer. The readings thus obtained were corrected to 20°C as per International Temperature Correction Table (Horwitz 1980). Fruit juice pH was recorded by using a digital pH meter (9157 BN, Witchford, England) after standardizing the pH meter with buffer solutions of pH 4 and 7 (Ranganna 1986). Titratable acidity was determined as per Horwitz (1980) method. A known weight of fruit sample was crushed and taken in 250 ml volumetric flask and the volume was made up. After filtration, 10 ml of filtrate was titrated against 0.1N NaOH by using phenolphthalein as indicator to the end point of faint pink colour. Reducing and total sugar contents were estimated by Lane and Eynon's volumetric method (Horwitz 1980). Pectin content was determined by Carre and Hayne's methods as described by Ranganna (1986) and expressed as % calcium pectate. Polygalacturonase (PG) activity was determined by the method described by Mahadevan and Sridhar (1982). The enzyme action mixture consisted of enzyme extract which was prepared by crushing fruit flesh, 4 ml of pectin in sodium acetate-acetic acid buffer (pH 5.2) and 1 ml of acetate buffer. Using Ostwald-type viscometer the content was mixed by gently drawing air through the large arm of viscometer and suction was applied through the small arm of viscometer and initial efflux time of mixture was determined. After 16 h, again the efflux time of the mixture was measured.

$V, \% = T_0\text{-}T/T_0xT\ H_2O$

where, T_0= initial flow time, T = flow time of reaction mixture after 16 h and, T H_2O = flow time of distilled water, V = loss in viscosity of substrate.

Spoilage of fruits due to fungal rot was calculated by adding up the number of fruits spoiled on successive storage interval and calculating their percentage on the basis of number of fruits stored initially. The sensory evaluation was done by using the 9-point Hedonic scale (Wills et al 1980) with 30 untrained panelists.

Statistical analysis: Three replicates were used in each treatment and the results were assessed by completely randomized design whereas, sensory evaluation was statistically analyzed using randomized complete block design according to Gomez and Gomez (1984).

Results and discussion

During storage an increase in physiological loss in weight was observed in all treatments (Fig. 1) and the most effective treatment was 2% potato starch +2% apricot kernel oil (T_{10}). However, the fruits stored under low temperature conditions recorded slower changes. This might be due to the edible coatings acting as a barrier to moisture loss from fruit surface. The starch based coatings could also be effective due to high amylose content, which helps to decrease water vapour permeability and weight loss and retain fruit firmness for longer periods.

There was a gradual decline in fruit firmness in all treatments during storage (Fig. 1). However, the application of potato starch 2% + apricot kernel oil 2% (T_{10}) proved most effective in retention of higher fruit firmness of 62.2N and 62.8N during ambient and cold storage, respectively. The retention of relatively higher fruit firmness under this treatment could be due to slower metabolic activity leading to slower ripening changes and delayed senescence.

There was a gradual increase in juice yield up to 120 days of storage at 2±1°C and 85-90% RH and, thereafter, it declined considerably, whereas, the fruits stored at ambient conditions showed continuous decline in its juice content (Fig. 1). At low temperature, higher juice yield during the initial storage period may be due to the occurrence and completion of ripening and other associated changes, as a result of certain macro molecules that might have been broken down into smaller molecules during this period. Among treatments, 2% neem oil +2% corn starch (T_9) coating was most effective in retaining maximum juice content during storage. The reason may be the regulation of ethylene biosynthesis and cellular disintegration (Gakhukar 1996), which might have enabled the tissue to remain in better physiological condition for a longer time and resulted in more juice production during storage (Hardenburg et al 1990). Higher moisture losses may be the reason for reduction of juice content of fruits at ambient storage. Fruit coatings are capable of retaining higher juice content in different fruits (Ozdemir et al 1996).

The TSS (Table 1), total sugars (Table 2), and reducing sugar (Table 3) contents in general increased during storage up to 120 days and thereafter showed a declining trend at the cold storage, whereas, at ambient conditions, increase of these constituents was only up to 30 days followed by decline during remaining storage period. Maximum TSS content (13.4°B) was recorded in T_5 and T_{12}, whereas, reducing sugar content (8.4%) was with potato starch 2% + apricot kernel oil 2% (T_{10}) at cold storage. The increase in TSS and sugar contents during the earlier part of storage may be due to the hydrolysis of insoluble polysaccharides into simple sugars. TSS and total sugars which were fairly low at harvest increased during storage due to hydrolysis of starch into sugars and after the completion of hydrolysis of starch, further increase in TSS and/or in sugar content did not occur and hence a decline in these attributes are predictable (Smith et al 1979). These findings are further supported by the observations of Singh and Mohammed (1997).

During storage, increased respiration is responsible for the decline of malic acid content which is the principle metabolic substance together with sugars in apple (Ackermann et al 1992). With the decrease in acid content, the fruit juice pH decreased (Table 4) and maximum titratable acidity (0.3%) was recorded (Table 5) in response to coating with potato starch 2% + apricot kernel oil 2% (T_{10}), potato starch 2% + neem oil 2% (T_6) and corn starch 2% + apricot kernel oil 2% (T_{12}) at cold storage. This may be attributed to the presence of an active principle compound azadirchtin in neem oil and tocopherol in apricot kernel oil, which help to maintain the stability and cellular integrity and thereby, delaying changes which are associated with ripening and senescence (Kleeberg 1996). Singh and Mohammed (1997) have reported that rice starch with or without gum helped in higher retention of acidity in guava fruits. Similar observations with acidity and pH have also been reported by others (Mahajan and Chopra 1994, Patricia et al 2005).

Gradual increase in PG activity (Table 6) was observed up to 120 days except in T_1, T_2 and T_{13} which reflected a definite increase up to 90 days and thereafter a progressive decline which was comparatively slower as a result of application of different extracts and as such the maximum PG activity (17.8%) was with T_{10} after 150 days in cold storage, whereas, it recorded the higher level of PG activity (11.8%) with T_{12} under ambient storage. Rapid reduction in fruit temperature at cold storage and slowing down of the metabolites of fruits by temperature at cold storage and slowing down of the metabolites of fruits by

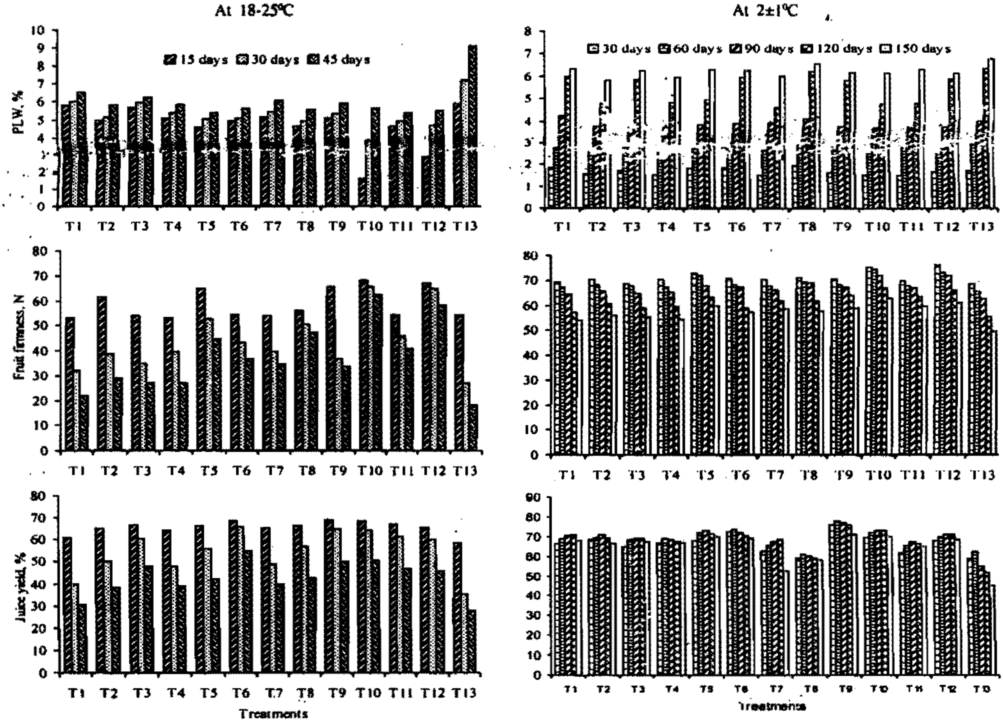

Fig. 1. Effect of post-harvest coating treatments on physical quality of apples during storage at different temperatures (n=3). T_1-T_{13}: As in text. PLW=Physiological loss in weight

Table 1. Effect of various post-harvest coating treatments on total soluble solids (°B) of 'Royal Delicious' apple during storage

Treat-ments	Storage (S), temp. and days							
	18-25°C			2±1°C				
(T)	15	30	45	30	60	90	120	150
T_1	14.0	12.1	10.5	10.3	11.0	12.5	12.6	11.7
T_2	16.2	14.1	9.8	11.2	11.4	12.2	13.8	12.5
T_3	15.0	13.2	12.0	10.5	11.6	13.0	13.2	11.6
T_4	15.1	14.4	11.0	11.4	12.4	12.5	13.6	12.7
T_5	14.1	15.9	15.3	11.0	12.4	13.4	14.3	13.4
T_6	14.3	15.6	14.8	12.2	12.6	12.7	14.2	12.6
T_7	16.2	14.3	10.1	11.3	12.5	12.7	13.5	12.5
T_8	14.0	12.1	10.5	10.3	11.0	12.5	12.6	11.7
T_9	16.2	14.1	9.8	11.2	11.4	12.2	13.8	12.5
T_{10}	15.0	13.2	12.0	10.5	11.6	13.0	13.2	11.6
T_{11}	15.1	14.4	11.0	11.4	12.4	12.5	13.6	12.7
T_{12}	14.1	15.9	15.3	11.0	12.4	13.4	14.3	13.4
T_{13}	14.3	15.6	14.8	12.2	12.6	12.7	14.2	12.6

$CD_{0.05}$ T = 0.27, S = 0.02, T x S = 0.06 T = 0.02, S = 0.01, T x S = 0.05, (n=3), T_1-T_{13} As in text, Initial value=10.2

Table 2. Effect of various post-harvest coating treatments on total sugar contents (%) of 'Royal Delicious' apple during storage

Treat-ments	Storage (S), temp. and days							
	18-25 °C			2±1 °C				
(T)	15	30	45	30	60	90	120	150
T_1	8.2	7.7	7.2	7.8	9.0	10.6	11.2	10.4
T_2	8.4	10.2	9.3	8.2	9.3	10.3	11.8	10.9
T_3	8.3	9.0	8.7	7.8	9.0	10.2	11.2	10.4
T_4	8.3	10.2	9.2	7.7	9.1	10.2	11.7	10.7
T_5	8.7	10.4	10.5	8.5	10.1	10.8	12.3	11.3
T_6	7.9	10.2	9.9	8.3	9.5	10.5	11.8	11.1
T_7	8.4	9.6	9.1	8.2	9.2	10.3	11.2	10.2
T_8	8.5	10.3	10.0	8.6	9.7	10.8	12.0	11.2
T_9	7.6	10.3	10.1	8.3	9.3	10.6	12.0	10.9
T_{10}	7.8	10.4	11.5	8.5	9.5	10.7	12.2	11.7
T_{11}	9.2	9.3	10.2	8.7	9.5	10.7	12.4	11.2
T_{12}	9.1	9.4	10.8	8.7	9.9	10.9	12.3	11.4
T_{13}	9.9	7.8	6.3	8.4	10.5	10.4	8.2	7.0

$CD_{0.05}$ T = 0.02, S = 0.01, T x S = 0.04 T = 0.02, S = 0.01, T x S = 0.03. (n=3), T_1-T_{13} As in text, Initial value=7.4

Table 3. Effect of various post-harvest coating treatments on reducing sugar contents (%) of 'Royal Delicious' apple during storage

Treatments	Storage (S), temp. and days							
(T)	18-25°C			2±1°C				
	15	30	45	30	60	90	120	150
T_1	7.9	7.3	6.1	6.4	7.0	7.6	8.4	7.2
T_2	8.1	8.5	7.2	6.5	5.7	7.9	8.5	7.1
T_3	7.6	8.5	7.2	6.1	6.5	7.7	8.4	7.3
T_4	8.0	8.3	7.3	6.4	7.4	8.2	8.1	7.2
T_5	7.4	8.6	8.5	6.4	7.4	8.7	8.7	7.5
T_6	7.4	8.1	8.4	6.5	7.6	8.3	8.6	7.4
T_7	7.5	8.4	7.5	7.1	7.5	7.9	8.5	6.7
T_8	7.6	8.4	8.6	6.5	7.3	8.3	9.0	7.8
T_9	7.0	8.4	8.3	6.4	7.2	8.3	8.7	7.4
T_{10}	7.1	8.2	9.4	6.5	7.4	8.8	9.2	8.4
T_{11}	7.4	8.4	8.4	6.6	7.5	8.5	8.8	7.3
T_{12}	7.4	8.7	8.5	6.6	7.5	8.4	9.0	7.9
T_{13}	8.6	8.0	5.5	7.5	8.4	6.9	5.7	5.1

$CD_{0.05}$ T = 0.02, S = 0.01, T x S = 0.03T = 0.02, S = 0.01, T x S = 0.05, (n=3), T_1-T_{13} As in text. Initial value=10.2

Table 4. Effect of various post-harvest coating treatments on pH of 'Royal Delicious' apple during storage

Treatments	Storage (S), temp. and days							
(T)	18-25°C			2±1°C				
	15	30	45	30	60	90	120	150
T_1	3.8	4.4	4.7	3.8	3.9	4.0	4.3	4.4
T_2	3.7	4.1	4.6	3.7	3.8	3.8	3.9	4.1
T_3	3.8	4.3	4.7	3.8	3.8	3.9	4.0	4.1
T_4	3.8	4.3	4.6	3.8	3.9	3.9	4.0	4.2
T_5	3.5	3.8	4.3	3.6	3.7	3.8	3.9	4.0
T_6	3.7	3.9	4.5	3.7	3.7	3.8	3.9	4.1
T_7	3.8	4.3	4.6	3.8	3.9	3.9	4.0	4.2
T_8	3.5	3.8	4.4	3.6	3.8	3.8	3.9	4.1
T_9	3.7	4.0	4.6	3.8	3.8	3.8	4.0	4.1
T_{10}	3.4	3.8	4.2	3.4	3.6	3.7	3.7	4.0
T_{11}	3.5	3.9	4.4	3.7	3.8	3.8	3.9	4.1
T_{12}	3.5	3.9	4.3	3.6	3.6	3.8	3.9	4.1
T_{13}	3.9	4.4	4.7	4.0	4.2	4.3	4.4	4.6

$CD_{0.05}$ T = 0.02, S = 0.01, T x S = 0.03 T = 0.02, S = 0.01, T x S = 0.05, (n=3), T_1-T_{13} As in text. Initial value=3.2

Table 5. Effect of various post-harvest coating treatments on titratable acidity (as % malic acid) of 'Royal Delicious' apple during storage

Treatments	Storage (S), temp. and days							
(T)	18-25°C			2±1°C				
	15	30	45	30	60	90	120	150
T_1	0.2	0.1	0.1	0.3	0.3	0.3	0.2	0.2
T_2	0.2	0.1	0.1	0.3	0.3	0.3	0.2	0.2
T_3	0.3	0.2	0.2	0.4	0.3	0.3	0.2	0.2
T_4	0.2	0.2	0.1	0.3	0.3	0.2	0.2	0.2
T_5	0.2	0.2	0.1	0.3	0.3	0.2	0.2	0.2
T_6	0.3	0.3	0.2	0.4	0.3	0.3	0.3	0.3
T_7	0.2	0.2	0.1	0.3	0.3	0.3	0.2	0.2
T_8	0.2	0.2	0.1	0.3	0.3	0.2	0.2	0.2
T_9	0.3	0.2	0.2	0.4	0.3	0.3	0.3	0.2
T_{10}	0.3	0.2	0.2	0.4	0.4	0.3	0.3	0.3
T_{11}	0.3	0.2	0.2	0.3	0.3	0.3	0.2	0.2
T_{12}	0.3	0.2	0.2	0.4	0.3	0.3	0.3	0.3
T_{13}	0.2	0.1	0.1	0.3	0.3	0.3	0.2	0.2

$CD_{0.05}$ T = 0.02, S = 0.01, T x S = 0.03 T = 0. 02, S = 0.01, T x S = 0.05, (n=3), T_1-T_{13} As in text, Initial value=0.4

Table 6. Effect of various post-harvest coating treatments on polygalacturonase (PG) activity (%) loss in viscosity of substrate of 'Royal Delicious' apple during storage

Treatments	Storage (S), temp. and days							
(T)	18-25°C			2±1°C				
	15	30	45	30	60	90	120	150
T_1	15.2	18.6	8.5	12.6	17.5	19.6	15.3	13.2
T_2	15.1	18.3	9.9	11.4	16.3	18.5	16.2	14.7
T_3	15.2	18.4	8.6	11.7	15.6	18.4	18.9	14.4
T_4	15.2	18.3	9.6	11.8	15.6	17.9	18.8	14.3
T_5	15.1	17.6	11.7	11.7	15.4	17.9	18.7	14.9
T_6	15.2	18.2	10.4	11.2	15.5	17.7	18.6	15.6
T_7	15.2	18.3	9.6	11.9	15.7	17.9	18.8	14.3
T_8	15.1	17.6	10.7	11.2	15.4	19.0	18.5	14.3
T_9	15.2	18.2	10.3	11.4	15.8	16.8	18.7	16.5
T_{10}	15.1	17.3	11.7	11.3	15.3	16.4	18.4	17.8
T_{11}	15.1	18.2	10.5	11.2	15.4	16.7	18.4	17.3
T_{12}	15.2	17.5	11.8	10.8	15.4	16.4	18.5	17.7
T_{13}	15.2	18.6	8.5	12.6	17.5	19.6	15.3	13.2

$CD_{0.05}$ T = 0.19, S = 0.01, T x S = 0.03 T = 0.04, S = 0.02, T x S = 0.08, (n=3), T_1-T_{13} As in text, Initial value=10.6

modified atmospheres created by the application of kernel oil and starches might have lowered the activity of various enzymes including PG and pectin methyl esterase. Coating significantly decreased the rate of pectin degradation and therefore, enabled the fruits to retain higher pectin content during storage and the most effective treatment was T_6 with maximum pectin content of 1.7% after 45 days at ambient storage and T_{12} recorded maximum pectin content of 1.3% at the end of cold storage. Lowest pectin contents of 0.4 and 0.5% were in control fruits at ambient and cold storage, respectively. However, the retention of higher firmness and pectin content (Table 7) under these treatments during the present investigation is a direct evidence for the reduction of activities of these enzymes as reported by Ben Yehoshua (1978) and Kader et al (1989).

Fruit spoilage was not noticed in all the treatments up to 15 and 120 days during storage at ambient and cold temperature, respectively. Spoilage in the treated fruits was 0-2.2% on 30 days and 1.4-2.8% on 45 days storage at ambient temperature as compared to 2.3 and 3.2%, respectively in control samples. In treated fruits stored at low temperature, the spoilage was 0-1.3% as against 1.7% for control on 150 days of storage (results not shown). Singh et al (2000) reported that post-harvest application of neem oil 10% showed minimum decay losses followed by castor oil 10% and also, antiseptic and antifungal action of neem oil might have prevented the infection by

Table 7. Effect of various post-harvest coating treatments on pectin content (as % calcium pectate) of 'Royal Delicious' apple during storage

Treatments (T)	Storage (S), temp. and days							
	18-25°C			2±1°C				
	15	30	45	30	60	90	120	150
T_1	1.2	0.9	0.7	1.4	0.7	0.7	0.5	0.4
T_2	1.4	1.1	0.5	1.3	1.3	1.2	1.1	0.9
T_3	1.2	1.0	0.7	0.9	0.8	0.8	0.6	0.6
T_4	1.1	1.0	0.6	1.3	1.2	1.1	0.8	0.7
T_5	1.4	1.2	0.9	1.4	1.4	1.3	1.2	1.0
T_6	1.3	1.2	1.7	1.3	1.3	1.2	1.1	0.9
T_7	1.2	1.0	0.6	1.0	0.8	0.8	0.7	0.6
T_8	1.4	1.2	0.8	1.3	1.3	1.2	1.1	0.9
T_9	1.2	1.0	0.6	1.3	1.2	1.2	1.0	0.8
T_{10}	1.4	1.3	1.0	1.9	1.8	1.7	1.6	1.1
T_{11}	1.4	1.3	0.7	1.4	1.3	1.3	1.1	1.0
T_{12}	1.5	1.3	0.9	1.7	1.6	1.5	1.4	1.3
T_{13}	1.1	0.6	0.4	0.9	0.8	0.7	0.5	0.5

$CD_{0.05}$ T = 0.02, S = 0.01, T x S = 0.03 T = 0.02, S = 0.02, T x S = 0.05, (n=3), T_1-T_{13} As in text. Initial value=1.9

Table 8. Effect of various post-harvest treatments on sensory overall acceptability of 'Royal Delicious' apple during storage

Treatments (T)	Storage (S), days (I) at					
	18-25°C			2±1°C		
	15	30	45	30	90	150
T_1	6.1	5.2	4.2	6.4	6.2	6.0
T_2	6.6	5.8	4.8	7.3	6.8	6.5
T_3	6.5	5.4	4.9	6.6	5.9	5.0
T_4	[illegible]	5.6	4.7	7.1	6.9	6.2
T_5	7.0	6.0	5.5	7.6	6.9	6.7
T_6	7.1	6.1	5.1	6.7	6.3	6.2
T_7	6.6	5.7	4.7	7.4	6.6	5.5
T_8	6.7	5.8	5.2	6.9	6.5	6.1
T_9	6.6	5.6	4.5	6.6	6.2	6.0
T_{10}	7.2	6.2	5.2	7.5	7.0	6.8
T_{11}	6.6	5.9	4.6	7.3	6.7	6.5
T_{12}	7.0	6.1	5.0	7.8	7.4	7.2
T_{13}	4.9	3.9	3.5	6.1	5.4	4.3

$CD_{0.05}$ T = 0.02, S = 0.01, TxS = 0.03 T = 0.02, S = 0.02, T x S = 0.05, (n=3), T_1-T_{13}: As in text. *Sensory evaluation was done by using 9 point Hedonic scale

microorganisms responsible for spoilage (Bhowmick and Vardhan 1981).

The overall sensory acceptability (Table 8) of fruits on the basis of rating for appearance, colour, texture, and flavour showed a gradual decline during storage in response to coating with different extracts. The treatments, corn starch 2% + apricot kernel oil 2% (T_{12}) followed by potato starch 2% + apricot kernel oil 2% (T_{10}) recorded maximum score for overall acceptability at the end of storage.

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