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Shelf-life extension of pear with coatings under ambient and super market conditions

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ABSTRACT

Pear fruits of cv. Punjab Beauty were harvested at firm mature stage. The fruits were coated with different food grade Nipro Fresh SS-40T™ and SS-50™ coatings. After coating, the fruits were packed in corrugated fibre board cartons and stored under two different temperature conditions, *i.e.* under super-market conditions (20-22°C and 80-85% RH), and under ambient conditions (30-32°C and 70-80% RH). The fruits were evaluated for various quality attributes periodically. The data revealed that both the coatings proved effective in minimizing weight and firmness loss and maintained quality attributes as evident from higher total soluble solids (TSS), minimum microbial decay and optimum organoleptic quality. These coatings helped in delaying the ripening process of fruits and the one coated with Nipro Fresh SS-40™ and SS-50™ can be stored for 12 days under ambient conditions and 15 days under super market conditions. On the other hand, the control fruits maintained their storage life for 6 and 9 days under both the conditions, respectively.

Key words: Fruit coatings, pear, quality, storage conditions.

INTRODUCTION

Pear is an important fruit of sub-tropical India growing primarily in north-west parts. The important pear cultivars grown are Patharnakh, Punjab Nakh, Punjab Gold, Punjab Nectar, Punjab Beauty, Punjab Soft, Nijisseiki *etc*. Punjab Beauty is a semi-soft cultivar, preferred by the farmers, traders and consumers due to its juicy pulp and crisp texture. The harvesting of fruits of this cultivar start in the third week of July that continues up to the mid of August. Generally, this period coincides with high rainfall and high temperature, which interferes with post-harvest quality and marketability of fruits. Therefore, the farmers are forced to sell their produce during this period sometimes at a throw away price due to lack of knowledge about post-harvest handling practices that leads to glut in the market, resulting in huge post-harvest losses. The fruits have a natural wax coating, which develops during the maturation and ripening processes. However, during handling of the fruits the natural wax gets destroyed, as a result, bruising occurs during packing and transport operation. Therefore, the application of commercial food grade waxes is important to replace this loss during post-harvest period. Coating or waxing reduce shriveling, wilting and respiration rate of fruits and enhances the gloss and cosmetic appearance of fruits (El-Anany *et al.*, 5). The use of food grade wax coating on fruits is safe, and approved for application on fresh fruits and vegetables (PFA, 11).

The concept of super market is coming up in the country and many leading corporate sectors have opened their outlets in various cities, where different types of fruits and vegetables are displayed after coatings and packaging that has an added advantage of maintaining freshness and produce quality. Therefore, the present investigation was planned to study the effect of coatings on the shelf-life and quality of pear fruits under ambient (30-32°C; 70-80% RH) as well as super-market (20-22°C; 80-85% RH) conditions.

MATERIALS AND METHODS

The 'Punjab Beauty' pear fruits of uniform size, disease and bruise-free were picked randomly from all the four directions of the plants at physiological mature stage and shifted to laboratory. The fruits were then sorted, graded and washed in chlorine solution (100 ppm). Thereafter, fruits were divided into requisite lots for further handling. In the present studies, two commercial formulations, *viz*. Nipro Fresh SS-40 T™ and SS-50™ were used for application on pear fruits. These coatings were procured from Nipro Technologies Limited, Panchkula, Haryana. The coatings were applied on fruit surface manually with a piece of foam pad. The coated and control fruits were then stored under two temperature conditions, *i.e.*, under super-market (20-22°C; 80-85% RH) and under ambient (30-32°C; 70-80% RH). The various physico-chemical parameters of fruits were recorded at three day intervals up to 15 day for

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ambient conditions and up to 18 day for super market conditions. The physiological loss in weight (PLW) was calculated on initial weight basis and expressed in per cent. The fruit firmness was measured with the help of a penetrometer (Model FT-327, USA) using 8 mm stainless steel probe and expressed in terms of pounds force pressure (lb force). The overall organoleptic rating of the fruits was done by a panel of ten judges on the basis of external appearance of fruits; texture, taste, and flavour by making use of a 9-point hedonic scale (Amerine *et al.*, 1).

The total soluble solids (TSS) of the fruit juice were determined using a hand refractometer. The titratable acidity was estimated by titrating the known volume of juice against N/10 NaOH using phenolphthalein as an indicator. The decay percentage of treated and untreated fruits was calculated as the number of decayed fruit divided by initial number of all fruits multiplied by hundred (El-Anany *et al.*, 5). Pectin methyl esterase activity was determined as per method described by Mahadevan and Sridhar (8). There were four replications for each treatment and each replication comprised of 25 fruits. The experiment was laid-out in completely randomized design and analyzed for variance by using SAS (V9.3, SAS Institute INC, and Cary NC, USA) package.

RESULTS AND DISCUSSION

It was noticed that SS-40 T coated fruits registered the lowest average PLW (3.07%) followed by SS-50 coated fruits (3.14%) under ambient conditions (Table 1). The PLW in SS-40 T™ and SS-50™ coated fruits, ranged between 0.45 to 6.95 and 0.52 to 7.10 per cent from 3 to 15 days of storage as compared to control where PLW was found to be the highest (9.31%) and ranged between 3.88 to 14.22 per cent. However, under super market conditions, the lowest mean PLW (3.37%) was observed in fruits coated with SS-40T closely followed by SS-50™ coated fruits (3.55%) (Table 2). On the other hand, the highest mean PLW (6.60%) was observed in control fruits. In pear fruits, permissible limit of weight loss is 6% to maintain the market acceptability (Singh *et al.*, 13). Keeping in view the acceptable level of PLW, it can be visualized from the data that under ambient conditions (28-30°C), the SS-40T™ and SS-50™ coated fruits can be stored for 12 days. On the other hand under super market conditions (18-20°C), the desirable weight loss was noticed up to 15 days in SS-40T™ and SS-50™ coated fruits. The control fruits maintained acceptable weight loss for market acceptability only up to 6 and 9 days, respectively under both the storage conditions. The application of coatings have been reported to play an important role in lowering the weight loss of mango (Baloch and Bibi, 2).

The fruit firmness followed a declining trend commensurate with advancement in storage period. The fruits coated with SS-40™ T maintained the highest average firmness (13.1 lb force), followed by SS-50™ (12.9 lb force) under ambient conditions (Table 1). The control fruits registered the lowest mean firmness (10.62 lb force). In case of super market conditions, the highest average firmness was recorded with SS-40T (13.4 lb force), closely followed by SS-50 (13.1 lb force). The control fruits registered firmness of 11.4 lb force (Table 2). The soft pear fruits attain best eating quality at 10 lb force firmness. Considering this value as cut off limit for firmness, it was observed that SS-40T™ and SS-50™ coated fruits could be stored for 12 and 15 days, respectively at ambient and super market conditions, however for control fruits it was only up to 6 and 9 days of storage, respectively. Softening of fruits is caused either by breakdown of insoluble proto-pectins into soluble pectin or by hydrolysis of starch. The loss of pectin substances in the middle lamella of the cell wall is perhaps the key steps in the ripening process that leads to the loss of cell wall integrity thus cause loss of firmness and softening (Solomos and Laties, 14). The coating of fruits with SS-40T™ and SS-50™ resulted in higher fruit firmness, under both the storage conditions, which might be due to reduction in moisture loss and respiratory activity, thus maintained the turgidity of the cells. Applications of coatings have been reported to play an important role in maintaining the fruit firmness in apple (Bishnoi *et al.*, 3) and Kinnow (Mahajan *et al.*, 9).

The decay of pear fruits increased with storage period under both the storage conditions. However, coated fruits recorded minimum rotting (3%) under ambient conditions after 12 days of storage (Table 1) and 2-3% decay under super market conditions after 15 days of storage (Table 2). The control fruits registered high decay (18 and 9%) after 12 and 15 days under ambient and super market conditions, respectively. The coatings play an important role in the reducing water loss of produce and thereby responsible for lowering the spoilage of fruits. The present study confirms the results of Bishnoi *et al.* (3 & 4) who noticed that terpenoidal oligomer coating retarded the growth of microorganisms in case of stored apple and sweet lime fruits.

The maximum sensory score was shown by fruits coated with SS-40T (7.0) followed by SS-50 (6.9) under ambient conditions (Table 1). However, control fruits registered the minimum sensory score (6.1). The sensory score of coated fruits increased gradually up to 12 days in case of SS-40T and SS-50

Table 1. Effect of coatings on physico-chemical quality and enzymatic changes of pear under ambient conditions.

Treatment	Storage period (days)					Mean
	3	6	9	12	15	
PLW (%)						
Nipro Fresh SS 40-T	0.45	1.35	1.80	4.80	6.95	3.07
Nipro Fresh SS 50	0.52	1.40	1.92	4.78	7.10	3.14
Control	3.88	5.62	10.34	12.50	14.22	9.31
Mean	1.62	2.79	4.69	7.36	9.42	
$CD_{0.05}$	Treatment (T) = 0.87 Storage (S) = 0.60 T × S = 1.80					
Firmness (lb force)						
Nipro Fresh SS 40-T	17.00	14.90	13.45	11.00	9.20	13.11
Nipro Fresh SS 50	16.80	14.60	13.20	10.90	9.00	12.90
Control	15.60	11.60	10.20	9.00	6.70	10.62
Mean	16.47	13.70	12.28	10.30	8.30	
$CD_{0.05}$	Treatment (T) = 0.70 Storage (S) = 0.90 T × S = 1.50					
Decay (%)						
Nipro Fresh SS 40-T	0	0	0	3	5	2
Nipro Fresh SS 50	0	0	0	3	7	2
Control	0	5	12	18	25	12
Mean	0	2	4	8	12	
$CD_{0.05}$	Treatment (T) = 0.50 Storage (S) = 0.62 T × S = 0.90					
TSS (%)						
Nipro Fresh SS 40-T	11.57	12.00	12.77	13.40	11.57	12.26
Nipro Fresh SS 50	11.60	12.00	12.60	13.30	11.40	12.18
Control	11.90	12.73	13.03	10.03	9.00	11.34
Mean	11.69	12.24	12.80	12.24	10.66	
$CD_{0.05}$	Treatment (T) = 0.2 Storage (S) = 0.4 T × S = 0.5					
Acidity (%)						
Nipro Fresh SS 40-T	0.35	0.30	0.27	0.24	0.22	0.28
Nipro Fresh SS 50	0.33	0.31	0.29	0.25	0.20	0.28
Control	0.32	0.28	0.27	0.25	0.23	0.27
Mean	0.33	0.30	0.28	0.25	0.22	
$CD_{0.05}$	Treatment (T) = NS Storage (S) = 0. 02 T × S = NS					
Sensory quality						
Nipro Fresh SS 40-T	6.7	7.0	7.2	7.5	6.8	7.0
Nipro Fresh SS 50	6.7	7.0	7.0	7.2	6.5	6.9
Control	6.2	7.0	6.5	6.0	5.0	6.1
Mean	6.5	7.0	6.9	6.9	6.1	
$CD_{0.05}$	Treatment (T) = 0.3 Storage (S) = 0.2 T × S = 0.6					

(7.5 and 7.2) and thereafter decreased. In contrast, for control fruits, the sensory score increased up to 6 days of storage (7.0) and thereafter declined at faster rate. Under super market conditions, the sensory quality gradually increased in SS-40T and SS-50 coated fruits up to 15 days (7.5 and 7.3) and then declined. However, the control fruits recorded the highest sensory score of 7.0 after 9 days of storage but thereafter a sudden decline in sensory quality was noticed and fruits registered a score of 5.7 after 18 days of storage (Table 2). In the present investigation, it was noticed that pear fruits coated

Table 2. Effect of coatings on physico-chemical quality and enzymatic changes of pear under super-market conditions.

Treatment	Storage period (days)						Mean
	3	6	9	12	15	18	
PLW (%)							
Nipro Fresh SS 40-T	0.35	1.20	1.65	4.35	5.50	7.18	3.37
Nipro Fresh SS 50	0.42	1.36	1.80	4.60	5.78	7.35	3.55
Control	3.70	4.20	5.40	7.50	9.00	9.80	6.60
Mean	1.49	2.25	2.95	5.48	6.76	8.11	
$CD_{0.05}$	Treatment (T) = 0.65 Storage (S) = 0.52 T × S = 1.20						
Firmness (lb force)							
Nipro Fresh SS 40-T	17.8	16.2	14.4	12.0	10.8	9.2	13.4
Nipro Fresh SS 50	17.4	15.7	14.0	11.8	10.4	9.0	13.1
Control	16.6	14.0	11.2	9.6	8.9	8.0	11.4
Mean	17.3	15.3	13.2	11.1	10.0	8.7	
$CD_{0.05}$	Treatment (T) = 0.50 Storage (S) = 0.46 T × S = 1.12						
Decay (%)							
Nipro Fresh SS 40-T	0	0	0	0	2	3	1
Nipro Fresh SS 50	0	0	0	0	3	3	1
Control	0	0	0	5	9	15	5
Mean	0	0	0	2	5	7	
$CD_{0.05}$	Treatment (T) = 0.3 Storage (S) = 0.2 T × S = 0.8						
TSS (%)							
Nipro Fresh SS 40-T	11.30	12.20	12.80	13.15	13.30	11.00	12.29
Nipro Fresh SS 50	11.20	12.00	12.70	13.00	13.20	10.80	12.15
Control	11.70	12.45	13.10	11.90	11.40	10.00	11.76
Mean	11.40	12.22	12.87	12.68	12.63	10.60	
$CD_{0.05}$	Treatment (T) = 0.3 Storage (S) = 0.5 T × S = 0.6						
Acidity (%)							
Nipro Fresh SS 40-T	0.38	0.35	0.33	0.30	0.28	0.25	0.32
Nipro Fresh SS 50	0.40	0.36	0.32	0.30	0.26	0.22	0.31
Control	0.35	0.31	0.29	0.26	0.22	0.20	0.27
Mean	0.38	0.34	0.31	0.29	0.25	0.22	
$CD_{0.05}$	Treatment (T) = NS Storage (S) = 0.04 T × S = NS						
Sensory quality							
Nipro Fresh SS 40-T	6.8	7.0	7.0	7.2	7.5	6.7	7.0
Nipro Fresh SS 50	6.5	7.0	7.0	7.0	7.3	6.5	6.9
Control	6.0	6.8	7.0	6.5	6.0	5.7	6.3
Mean	6.4	6.9	7.0	6.9	6.9	6.3	
$CD_{0.05}$	Treatment (T) = 0.2 Storage (S) = 0.4 T × S = 0.5						

with SS-40T and SS-50 under both the storage conditions developed better sensory quality, which might be due to partial modifications as result of coatings, which also resulted in development of the acceptable flavour. Earlier, Gol *et al.* (7) noticed that carambola fruits coated with edible coating improved the organoleptic quality and consumer acceptability without the development of off-flavour.

The fruits coated with SS-40T registered the maximum average TSS content (12.26%), followed by SS-50 coated fruits (12.18%) under ambient conditions (Table 1). The control fruits recorded the lowest average TSS (11.34%). It was further observed that in SS-40 T and SS-50 coated fruits, the TSS content increased slowly and steadily up to 12 days and thereafter declined. On the other hand, control fruits recorded a rise in TSS content up to 6 days and then started to decline at a faster rate. Under super market conditions, SS-40T and SS-50 coated fruits registered an increase in TSS (13.30%) content up to 15 days (Table 2). In control fruits, the TSS content increased up to 9 days (13.10%) and then a sudden decline was noticed. The increase in TSS during storage may possibly be due to breakdown of complex organic metabolites into simple molecules or due to hydrolysis of starch into sugars. The delayed increase in TSS over a longer period of time in coated pear fruits under both the storage conditions might be attributed that coating retard ripening and senescence processes and simultaneously delayed the conversion of starch into sugars. A delayed and smaller increase in TSS as seen in the present study has also been reported in *Aloe vera* gel coated sweet cherry (Martinez *et al.*, 10). The acidity of pear fruits showed a linear decline irrespective of different treatments as the storage period advanced under both the storage conditions (Tables 1 & 2). However, non-significant differences were observed between coated and non-coated (control) fruits. The decrease in titratable acids during storage might be attributed to utilization of organic acid in pyruvate decarboxylation reaction occurring during the ripening process of fruits (Pool *et al.*, 12).

The coatings significantly influenced the PME activity in pear fruits. It was observed that both the coatings minimized the enzyme activity in pear fruits under both the storage conditions as compared to control. Under ambient conditions, the PME activity in fruits coated with SS-40T and SS-50 increased up to 12 days of storage and declined thereafter. On the other hand control fruits recorded maximum activity up to 6 days of storage and afterwards a sharp decline was noticed (Fig. 1). Under SMC, the SS-40 T and SS-50 coated fruits recorded increase in PME activity upto 15 days of storage and thereafter declined. The control fruits recorded an increase in PME activity up to 9 days of storage and after that declined at a much faster rate (Fig. 2). The lower and delayed increase in PME activity in coated fruits, *viz.* 12th day under ambient conditions and 15th day under SMC as against 6th and 9th day in control fruits under both the storage conditions, respectively. This effect might be related to slower respiratory activity due to the creation of modified atmospheric conditions by the coatings. Edible coatings are presented as an excellent way to preserve the quality of fruits by maintaining the firmness and consumer acceptability of fruits which is probably due to suppressing the fruit softening enzyme activities (Wijewardane and Gularea, 15). Gol and Rao (6) reported that zein or

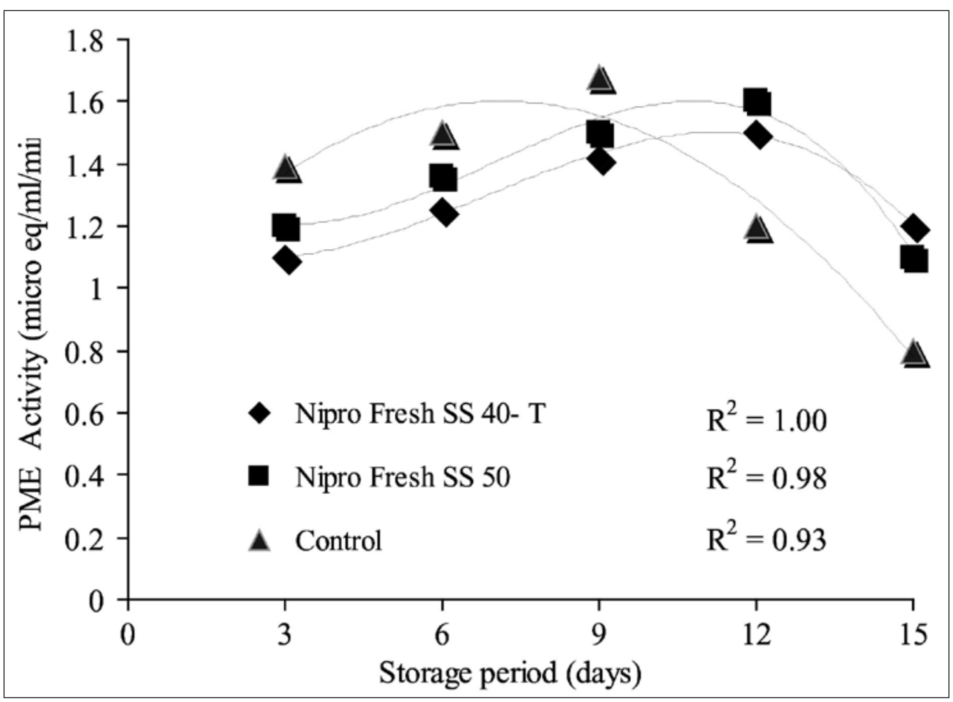

Fig. 1. Effect of coatings on PME activity of pear during storage under ambient conditions.

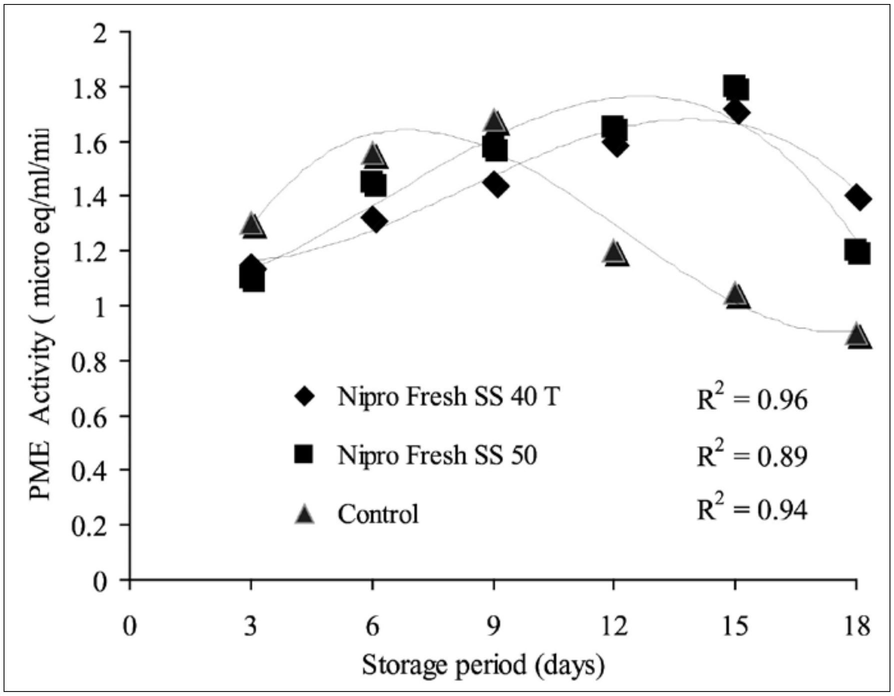

Fig. 2. Effect of coatings on PME activity of pear during storage under super market conditions.

gelatin coatings delayed the ripening of mango fruits by suppressing the activity of softening enzymes such as polygalacturonase, pectin methyl esterase, cellulase and β-galactosidase.

It can be concluded from the present studies that both the coatings, *i.e.*, Nipro Fresh SS-40T and SS-50 were equally effective in extending the storage-life of pear fruits for 12 days under ambient conditions and 15 days under super market conditions. On the other hand, the control fruits maintained their storage-life for 6 and 9 days under the two marketing conditions, respectively.

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