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Effect of Various Coating Materials on Keeping Quality of Mangoes (*Mangifera indica*) Stored at Low Temperature

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Abstract: Mango fruits (cv. Chausa) were treated with different concentrations of CMC, calcium chloride and beeswax. The mangoes were then placed in boxes, each with a sponge soaked in $KMnO_4$.The mangoes were then stored at refrigerated temperature (8-10°C). The physico-chemical analysis were repeated after seven days interval. Fruits treated with 2% CMC, showed best behaviour through out storage period with minimum loss of weight, increased ascorbic acid content and was able to conserve better sensory characteristics through entire period of storage.

Key words: *Mangifera indica,* keeping quality, low temperature, storage

Introduction

Mango is one the most popular and best loved fruit worldwide. Its popularity is because of its excellent flavour, attractive fragrance, beautiful colour, delicious taste and health giving properties. Ripe pulp of mangoes provides 74 kcal of energy per 100 g of edible portion (Salunkhe and Desai, 1984). It is second major fruit crop in Pakistan with the production of 1036 thousand tons (GoP, 2003) during the year 2002-2003 and contributing 5.86% of total worlds production of mangoes (Anonymous, 2001).

According to an estimate, about 35% of fruits and vegetables are wasted in Pakistan (Anonymous, 2001). Due to this wastage, mango growers are not in a position to supply high quality produce to market. It is important to reduce these losses, to maintain the freshness of fruit for distant local markets, export and to regulate fruit supply in the off-season.

Kent' mango is one of the main mango cultivar commercialized in the world. Nevertheless its perishable character reduces its life of shelf. The objective of this research was to study the effect of different calcium applications, wax and combinations of both by the immersion method. The fruit were stored at 10°C for 30 days and soon transferred to 20°C for 12 days. Commercial-grade mangoes were treated hydrothermally and the following treatments were applied: control (T_1); wax (T_2); 0.5% $CaCl_2$ (T_3); 0.5% $CaCl_2$+wax (T_4); 1% $CaCl_2$ (T_5); 1% $CaCl_2$+wax (T_6). Respiration rate, general appearance and weight loss were evaluated daily, while firmness, pulp color, total soluble solids, pH, titratable acidity, calcium content in the peel and the pulp were determined at 3-day intervals. T_3, T_4, T_5 and T_6 increased the calcium content in the peel of the fruit, with values proportional to concentrations applied. In the pulp, the increase of the calcium content was smaller than ones in the peel. Treatment T6 fruit, compared with the other treatments, had significant differences in respiratory rate and weight loss, and had a good appearance, without spots and rots at the 12 days of the evaluation to 20°C (Bringas-Taddei *et al*., 2002).

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Angeleno' plums were coated with edible Hydroxypropyl Methylcellulose (HPMC)-beeswax (BW) composite coatings. The coatings consisted of beeswax at 4 lipid content levels (0, 20, 40 and 60% dry basis). One group remained uncoated as control and another group was dipped in water. Plums were stored 2, 4 and 6 weeks at 1°C and transferred to 20°C for 1 to 3 weeks. Weight loss, deterioration index and texture of plums were measured during storage. Sensory quality was also evaluated. No differences in weight loss were observed between uncoated and 0% BW-coated plums. Weight loss decreased as lipid content increased from 20 to 40%, but above 40% BW content, weight loss was not further reduced. Coatings improved texture compared with uncoated plums after prolonged storage at 1 and 20°C. No differences were observed in the deterioration index during treatments as storage time at 20°C increased for samples initially stored 2 weeks at 1°C. However, the deterioration index of coated samples stored 4 or 6 weeks at 1°C decreased compared with uncoated plums as storage time at 20°C increased. Flavor was not affected by coating application. Results indicate that HPMC-BW coatings have the potential to extend shelf-life of 'Angeleno' plums held at 20°C (Navarro *et al*., 2004).

With the expansion of fruit processing industry, storage is becoming an important factor in the operation of the processing plant at uniform rate. To minimize wastage of fruits, remedy is to delay their ripening by storage (Nazri, 1981). Mango is a type of tropical fruit which is very perishable and it is necessary to keep it cool after harvest. Cold storage and application of skin coatings control the ripening process and reduce aging and water loss (Sundararaj *et al*., 1972) and have no doubt in increasing the shelf life of fruit.

Materials and Methods

Mango (Mangifera indica L.)

Fresh, unripe, hard and green mangoes (*Mangifera indica* L.) of variety chausa were harvested from Multan (PUNJAB) orchards. Care should be taken that all the mangoes were of same maturity level.

Hot Water Treatment

Mangoes after harvesting from orchards were immediately given hot water treatment at 50°C for 3 min (Subramanyam *et al*., 1975) and then mangoes were air dried to drain off any excess water.

Treatments

The mangoes were given different treatments including CMC (1, 2 and 3 %), calcium chloride (1, 2 and 3%), beeswax (2%), polyethylene sheet and control treatment.

Storage of Mangoes

The mangoes were then placed in boxes having holes at the front and both sides. Also sponges soaked in saturated $KMnO_4$ solution were placed in boxes and mangoes were then stored at refrigerated temperature (8°C) for 3 months (September to November) during the year 2003.

Evaluation of Mangoes

Mangoes were evaluated for different physico-chemical analysis after regular interval of seven days for 3 months (September to November) during the year 2003.

Physical Analysis

Physical analysis includes weight loss, which was determined by using triple beam balance. TSS were determined by using hand refractometer according to AOAC method no. 932.12. pH was determined by using pH meter according to AOAC method No. 981.12. (1990).

Chemical Analysis

Different chemical analysis includes titratable acidity, which was determined according to AOAC method No. 942.15. Ascorbic acid was determined according to AOAC method No. 967.21. (1990).

Sensory Evaluation

Samples were evaluated for colour, flavour, taste and texture by a panel of five judges, using nine point hedonic scale as described by Larmond (1977).

Statistical Studies

Finally the data obtained for each parameter were subjected to statistical analysis using the techniques of Steel and Torrie (1980).

Results and Discussion

Physical Analysis

Weight Loss

Data pertaining to weight loss indicated highly significant results and showed a general trend of decrease in weight during storage. This was observed for all the fruits, coated and the control ones. However, the rate of decrease in weight was comparatively slower in coated fruits than in the control ones.

From the Table 1, it is evident that maximum score was recorded for control T_0 (control) on 49th day of storage whereas minimum weight loss was recorded for T_2 (CMC 2%) throughout storage period of 77 days, due to the presence of coating that act as semi permeable membrane and help in lesser loss of moisture (Lim *et al*., 1998).

Table 1: Effect of different treatments and storage intervals on weight loss (%)

	Mean				Mean		
Treatments	Wt. loss	TSS	pH	Storage intervals	Wt. loss	TSS	pH
Control	15.06a	12.79cd	3.16f	0 day	0.00j	10.00h	3.85f
CMC 1%	5.62f	13.71ab	3.92b	7 days	1.21i	14.74f	4.95b
CMC 2%	4.43g	14.22a	4.60a	14 days	3.39h	17.07e	4.94b
CMC 3%	6.77e	13.33bc	3.53d	21 days	6.04g	18.44d	4.88c
Polyethylene sheet	10.06c	12.63d	3.17f	28 days	8.80f	20.22b	4.79d
Bees wax 2%	11.72b	13.97a	3.42e	35 days	11.48d	21.50a	5.01a
$CaCl_2$ 1%	8.78d	13.79ab	3.41e	42 days	13.27c	20.78b	4.53e
$CaCl_2$ 2%	7.06e	14.00a	3.50d	49 days	16.16b	19.44c	3.85f
$CaCl_2$ 3%	10.13c	13.67ab	3.66c	56 days	17.53a	13.56g	3.56g
				63 days	11.48d	3.77i	1.04h
				70 days	10.08e	1.66j	0.54i
				77 days	11.65d	1.61j	0.53i

Total Soluble Solids (° brix) and pH of mango fruit during storage at refrigerated temperature

Total Soluble Solids

Data regarding total soluble solids revealed highly significant results and there was a general trend of increase in TSS with time and then gradual decrease for both coated and control fruits.

Table 1 showed that T_4 (polyethylene sheet) have lowest value in terms of TSS and proved to be poor in terms of TSS. Decrease in TSS might be the result of activities of microorganisms causing the consumption of sugars. T_2 (CMC 2%) retained maximum TSS followed by T_7 (calcium chloride 2%).

pH

The results regarding pH, as described in Table 1 were highly significant and showed mixed pattern of increase and decrease in pH but on the whole there was an increase in pH. Minimum value of pH was recorded for T_0 (control), followed by T_4 (polyethylene sheet). Maximum pH was recorded for treatment T_2 (CMC 2%).

Chemical Analysis

Titratable Acidity

Titratable acidity initially decreased and then increased during storage but the net result is decrease in acidity. Table 2 indicates that minimum acidity was observed in T_0 (control), also in T_4 (polyethylene sheet) probably due to the fact that as fruit ripens it diminished its malic and citric acid contents, due to microbial activity (Martinez *et al*., 1997). Maximum acidity was observed in T_2 (CMC 2%).

Ascorbic Acid

The results regarding ascorbic acid generally showed a gradual decline of ascorbic acid with time. From Table 2 it is clear that minimum ascorbic acid content were recorded for T_0 (control) followed by T_4 (polyethylene sheet) probably due to increased respiration, causing loss of ascorbic acid. Maximum ascorbic acid content was observed for T_2 (CMC 2%) due to lesser loss of acid.

Sensory Evaluation

Skin Colour

The data regarding mean values of scores for skin colour of fruits stored at refrigerated temperature indicated that there was a significant difference among skin colour scores of different treatments. Generally increasing trend in colour scores was observed and then at the end there was a decrease in the scores. An experienced panel of judges carried out the evaluation of skin colour.

Table 2: Effect of different treatments and storage intervals on titratable acidity

	Mean			Mean	
Treatments	Titratable acidity	Ascorbic acid	Storage intervals	Titratable acidity	Ascorbic acid
Control	0.30f	7.16f	0 day	1.28a	14.04a
CMC 1%	0.43b	9.87b	7 days	0.75b	13.12b
CMC 2%	0.55a	12.07a	14 days	0.56c	12.45c
CMC 3%	0.40d	8.88c	21 days	0.47d	11.85d
Polyethylene sheet	0.30f	7.20f	28 days	0.43e	11.26e
Beeswax 2%	0.36e	7.86e	35 days	0.36f	10.46f
$CaCl_2$ 1%	0.41c	8.11de	42 days	0.33g	9.73g
$CaCl_2$ 2%	0.44b	8.46d	49 days	0.32g	9.12h
$CaCl_2$ 3%	0.42c	8.00e	56 days	0.19h	7.01i
			63 days	0.06i	2.22j
			70 days	0.03j	1.13k
			77 days	0.02j	1.10k

(Citric acid) (%) and Ascorbic Acid (mg/100 gm) of mango fruit during storage at refrigerated temperature

Table 3: Effect of different treatments and storage intervals on skin colour, pulp colour and taste (scores) of mango fruit during storage at refrigerated temperature

	Mean				Mean		
Treatments	Skin colour	Pulp colour	Taste	Storage intervals	Skin colour	Pulp colour	Taste
Control	2.92g	3.20g	3.18f	0 day	2.00i	2.50g	2.00e
CMC 1%	5.08b	5.46b	4.77b	7 days	4.45g	4.66e	5.05d
CMC 2%	6.83a	6.71a	6.36a	14 days	5.31f	5.44d	5.92c
CMC 3%	4.33c	4.66c	4.76b	21 days	5.97d	6.39c	6.39b
Polyethylene sheet	3.18f	3.45f	3.15f	28 days	6.60b	6.99a	6.89a
Bees wax 2%	3.03fg	3.70e	2.94g	35 days	6.84a	7.13a	6.97a
$CaCl_2$ 1%	4.20cd	4.08d	3.89d	42 days	6.37c	6.65b	6.09c
$CaCl_2$ 2%	4.15d	3.81e	4.06c	49 days	5.52e	5.60d	5.22d
$CaCl_2$ 3%	3.78e	3.86e	3.49e	56 days	4.02h	3.83f	2.00e
				63 days	1.46j	1.36h	1.61f
				70 days	0.76k	0.68i	0.62g
				77 days	0.72k	0.66i	0.50g

Table 4: Effect of different treatments and storage intervals on flavour and texture (scores) of mango fruit during storage at refrigerated temperature

	Mean			Mean	
Treatments	Flavour	Texture	Storage intervals	Flavour	Texture
Control	3.27f	3.29g	0 day	2.00g	2.50g
CMC 1%	5.46b	5.21b	7 days	4.96e	5.07e
CMC 2%	5.90a	6.28a	14 days	5.73d	5.81c
CMC 3%	4.65c	4.73c	21 days	6.17c	6.31b
Polyethylene sheet	3.28f	3.14g	28 days	6.68b	6.93a
Beeswax 2%	3.47f	3.70f	35 days	7.23a	7.01a
$CaCl_2$ 1%	4.07e	4.03e	42 days	6.66b	6.40b
$CaCl_2$ 2%	4.34d	4.48d	49 days	5.63d	5.31d
$CaCl_2$ 3%	4.15de	3.77f	56 days	4.44f	3.88f
			63 days	0.68h	1.22h
			70 days	0.66h	0.55i
			77 days	0.58h	0.52i

From Table 3 it is clear that T_2 (CMC 2%) had best score for skin colour and it differed significantly with all other treatments. The appearance of skin colour is related to skin chlorophyll degradation. While control treatment in the absence of coatings was unable to give significant results.

Pulp Colour

Table 3 presents mean values of scores for pulp colour of fruits stored at refrigeration temperature. The general trend was an increase and then decrease in scores. Overall coated fruits produced significant results.

Comparison of the means of different treatments showed that maximum value for pulp colour of mangoes was recorded in T_2 (CMC 2%), as ripening is up to the mark with appearance of more number of carotenoids (John *et al*., 1970; Katayama *et al*., 1971).

Taste

The data containing mean values of scores for taste of fruits stored at refrigeration temperature is depicted in the Table 3, with a general trend of an increase and then decrease in scores. From Table 3, it is evident that T_5 (beeswax 2%) had minimum values for taste scores, might be due to improper sugar to acid ratio. T_2 (CMC 2%) had produced appreciable results for taste scores, due to increased sweetness.

Flavour

Data pertaining flavour, generally showed a gradual increase in flavour scores followed by a gradual decline with the passage of time. The best ranking was observed for T_2 (CMC 2%), while lowest score for flavour was recorded in T_0 (control), T_4 (polyethylene sheet) and T_5 (beeswax 2%), as it is clear from the Table 4.

Texture

Table 4 shows mean values of scores for textures of fruits stored at refrigeration temperature with a general trend of an increase and then decrease in the scores. Table 4 clearly indicates that T_2 (CMC 2%) had the most score for texture while control (T_0) had least score, due to the absence of coatings that help to maintain texture of fruits by reducing the movement of water molecules into the cell and out of the cell.

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