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Effect of Postharvest Treatments with Some Coating Materials on the Shelf Life and Quality of Banana

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Abstract: An experiment on the effect of some coating materials on the storage and quality of banana var. Amrita sagar was carried out at Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during September 1997 to January 1998. The five materials viz., $CaCl_2$ @ 1%, waxol, Benlate 500 ppm, surfactant (Jet powder) @ 6% , thickener (corn starch) @ 6% and their combinations were considered as coating materials. The longest shelf life was found in wax coated fruits (21 days) with the lowest weight loss per finger (6.89%) while the shortest shelf life was recorded in Benlate treated fruits (9.33 days). The highest weight loss was obtained in $CaCl_2$ treated fruits (25.07%). The highest percentage of total sugars was recorded in control fruits (21.63) and the lowest in wax coated fruits (18.8) at full ripe condition. A moderate high TSS was obtained in wax coated fruits (29 %) as compared to the highest TSS in Benlate treated fruits (30.5%) at full ripe stage. The lowest titrable acidity was also recorded in wax coated fruits (0.47%).

Key words: Post harvest treatment, shelf life, banana, coating materials, quality

Introduction

Banana is one of the popular fruits in Bangladesh and comprises nearly 42% of the total fruit production of the country (Hoque, 1988). Its importance in the world fruit trade is second only next to that of citrus (Samson, 1980). Banana is the only fruit, available throughout the year, relatively inexpensive and is within the reach of all classes of buyers. Banana contains nutrients in a more balanced proportion than many other fruits. It has nearly all the essential nutrients including minerals and vitamins. It is also a rich source of energy. The per head per day availability of fruits in Bangladesh is 54 g which is rather low as compared to the advanced countries. This is mainly due to a vast population against low yield and total production of fruits. This situation is further aggravated by high level of postharvest loss ranged from 25-50% (Amiruzzaman, 1990).

Banana is a climacteric fruit and its rate of respiration is minimum at maturity and the rate rises up to the peak during ripening. A high rate of respiration is usually associated with a short storage life. Soft texture and high moisture content makes banana with a high chance to be wounded and contaminated during handling and transportation and this may be worsened by high temperature and relative humidity. Hence care should be taken to reduce respiration rate during storage especially in tropical and subtropical countries like Bangladesh. Thus prolonging storage life of a fruit consists of slowing down the processes leading to ripening and senescence after ripening. Improvement of shelf life may be done with the application of a good skin coating as it reduces respiration rate and with some physical and chemical measures (Pantastico, 1975). Skin coating to prolong the shelf life of fruits is being practiced in the world. Hence the physico-chemical processes during and after ripening of fruits need to be studied extensively for the development of proper storage methods. Desai *et al.* (1989) reported that banana treated with wax emulsion and thickener (Tal prolong) gave the best results with regard to shelf life. Satyan (1992) reported that bunches of banana cv. Williams were treated with Benomyl to reduce the postharvest rotting. El-Hammady *et al.* (1985) stated that banana fruits were treated with $CaCl_2$ solution before and after storage reduced decay with regard to storability and fruit quality. But information regarding the effect of different coating materials on shelf life of banana in our local context is scanty. Thus the experiment was undertaken to investigate the effect of some coating materials on the storage life of banana and also to determine the bio-chemical changes occurring during storage when the fruits are coated by these materials.

Materials and Methods

The experiment was carried out at the laboratory of Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during September 1997 to January 1998. Nine different coating materials were considered for storage of banana which were: (1) $CaCl_2$ @ 1%, (2) waxol, (3) Benlate @ 500 ppm, (4) surfactant (Jet powder) @ 6%, (5) $CaCl_2$ with surfactant, (6) thickener (corn starch) @ 6%, (7) $CaCl_2$ with thickener, (8) $CaCl_2$ with surfactant and thickener, and (9) control. The experiment was conducted in completely randomized design with three replications.

Fully matured banana bunches of uniform size, shape and colour were carefully harvested from the BSMRAU farm. Twenty seven hands with 10 fingers per hand of about uniform size and weight were selected for treatment application. At first solutions were prepared for all the coating materials as per above mentioned concentrations. Then the selected banana hands for each treatment were dipped in their respective solutions for 5 minutes except waxol and air dried for 15 minutes and kept in the polyethylene bags. In case of wax, it was made liquid by melting in an aluminum pot and the banana hands were dipped for one minute and then air dried for 15 minutes. All the treated fruits including control ones were stored in polyethylene bags (0.05 mm thickness) with 5 g $KMnO_4$ (5g of $KMnO_4$ crystals were tied by a piece of cotton) as ethylene absorbent and the top of the bags were tied with James clip and placed on the laboratory floor at ambient temperature (20-24 °C) and at 60 -70% RH.

The period from harvesting to the onset of senescence during storage was divided into 6 stages (Harris and Poland, 1937), each stage being defined by the skin colour as followed: stage 1 (S1) - finger mature but green at harvest, stage 2 (S2) - finger green with trace of yellow, stage 3 (S3) - finger medium ripe with nearly half the skin yellow and the rest greenish,

stage 4 (S4) - finger yellow but tip green, stage 5 (S5) - finger completely yellow i.e. full ripe, and stage 6 (S6) - nearly half the skin of the finger black i.e. over ripe.

The fruits were observed regularly at an interval of two days during storage and the data on the following characters were collected: (1) days to attain different stages of ripening recorded by observing skin colour and physical appearance of fruits from harvesting till rotting; (2) physical qualities e.g., shelf life, weight loss, and pulp/peel ratio; (3) chemical qualities e.g., reducing sugar and total sugar were estimated following Somogyi (1952) method, titrable acid content was estimated following Shiraishi (1980), starch content was estimated following Ranganna (1979), and total soluble solid (TSS).

The collected data were analyzed statistically and the means were compared by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Days to attain different stages of ripening: A wide variation was found among the treatments in respect of days to attain different stages of ripening of banana from stage 1 (Table 1). At the initial stages of ripening relatively more number of days were required to attain the next stage from pervious stage but gradually it took less number of days with the progress of ripening stage. The waxol treated fruits had taken the maximum number of days to attain different stages of ripening from stage 1, which was statistically higher than all the treatments. The minimum number of days required in Benlate treated fruits which was similar with other treatments except waxol.

Shelf life: The effect of treatments on shelf life of banana was found statistically different (Table 1). The waxol treated fruits had the longest shelf life (21 days) which was statistically higher than other treatments. The shortest shelf life was found in Benlate treated fruits (9.33 days) which was identical with other treatments except waxol treated fruits. Wax act as a physical barrier on banana skin, which might reduce water loss from banana by transpiration and other means. Due to that wax coated banana gave the highest self life.

The shelf life of banana observed in present study are supported by finding of Rao and Chundawat (1988), Desai *et al.* (1989). All of them found increased shelf life with waxol coated fruits.

Percentage weight loss: It was observed that weight loss of fruits in all the treatments increased gradually with the progress of ripening during storage (Fig. 1). Significant difference in total weight loss per finger was found among the treatments (Table 1). The highest weight loss was observed in $CaCl_2$ treated fruits (25.07%) which was comparable with other treatments except the lowest weight loss in waxol (6.89%) which was identical with Benlate (15.63%) and $CaCl_2$ + thickener + surfactant treated fruits (16.79%).

The weight loss in banana during ripening might be due to substrate loss by respiration and loss of water through various physiological mechanisms. Minimization of weight loss in wax coated fruit might be due to action of coating as a physical barrier to gas diffusion from fruit stomata through which the gas exchange takes place between tissue and external atmosphere.

Pulp/peel ratio: The effect of different treatments on pulp/peel ratio of banana at full ripe stage (stage 5) was found highly significant (Table 1). The highest pulp/peel ratio was observed in $CaCl_2$ + thickener + surfactant treated fruits (2.79) which was identical with that of $CaCl_2$ (2.68), control (2.64), surfactant (2.57), $CaCl_2$ + thickener (2.44) and Benlate treated fruits (2.28). Waxol treated fruits had the lowest pulp/peel ratio (1.67) which was comparable with that of thickener (2.09) and $CaCl_2$ + surfactant treated fruits (2.17). The highest peel weight of waxol coated banana might be due to that, wax coating acts as a physical barrier to the loss of water from peel through transpiration.

The increase in pulp/peel ratio observed in present study are supported by findings of Tripathi *et al.* (1981) and Palmer (1971).

Percentage total sugar: Marked increase in total sugar content of banana was observed in all the treatments up to ripening stage 5 and then decrease during ripening. The effect of treatments on the percentage of total sugar of banana was found highly significant in all the ripening stages (Table 2a). At the ripening stage 3, thickener treated fruits had the highest percentage total sugar (20.32%) and differed significantly with other treatments. The lowest percentage of total sugar was observed in $CaCl_2$ + thickener treated fruits (16.83) which was identical with $CaCl_2$ + surfactant (16.94), waxol (17.52), $CaCl_2$ + thickener + surfactant (17.60) and $CaCl_2$ treated fruits (17.66%). The highest total sugar was obtained in control fruits (21.63 and 20.77) at stage 5 and 6 respectively and was comparable with thickener treated fruits (21.11 and 20.26) at both stages and with $CaCl_2$ + surfactant treated fruits (20.19) at stage 6 only. The lowest percentages of total sugar were obtained in waxol treated fruits (18.80 and 16.81) at stages 5 and 6 respectively and differed significantly with other treatments at both the stages.

The increase in total sugar of fruits might be attributed to the conversion of starch to sugar.

Percentage reducing sugar: A highly significant difference in percentage reducing sugar was observed among the treated banana during storage (Table 2a). At the ripening stage 3, the highest percentage of reducing sugar was obtained in Benlate treated fruits (6.28) and differed significantly with other treatments. The lowest percentage reducing sugar was recorded in surfactant treated fruits (2.47) which was identical with $CaCl_2$ treated fruits (3.27). The highest percentages of reducing sugar was found in $CaCl_2$ + thickener + surfactant treated fruits (11.22 and 14.39) at stages 5 and 6 respectively which were identical with $CaCl_2$ + thickener treated fruits (10.06) at stage 5 and at 6. It was comparable with Benlate treated fruits (13.24). The lowest percentages reducing sugar obtained in waxol coated fruits (6.09 and 8.44) at stages 5 and 6 respectively and was comparable with $CaCl_2$ (6.2) and $CaCl_2$ + surfactant treated fruits (6.36) at stage 5 but was significantly lower than other treatments at stage 6.

A steady increase in reducing sugar content of banana occurred during storage. Tripathi *et al.* (1981) also found an increase in reducing sugar of banana during ripening. Increase in reducing sugar might be attributed to enzymic conversion of starch to reducing sugar and also to conversion of some non-reducing sugar to reducing sugar through the process of inversion.

Percentage starch: Significant variation was found in respect of percentage starch in the treated fruits at different ripening stages during storage (Table 2a). At the ripening stage 3, the highest percentage starch was obtained in surfactant treated

Table 1: Influence of coating materials on the number of days required to attain different stages of ripening of banana from stage 1

Coating materials	Days to attain different stages of ripening					Weight loss (%)	Pulp to peel ratio
	S2	S3	S4	S5	S6		
$CaCl_2$	8.00 b	9.00 b	10.00 b	11.33 b	13.33 b	25.06 a	2.68 ab
Waxol	13.33 a	15.67 a	17.33 a	19.00 a	21.00 a	6.89 b	1.67 d
Benlate	4.00 b	5.00 b	6.00 b	7.33 b	9.33 b	15.63 ab	2.28 abc
Surfactant	5.33 b	7.00 b	8.00 b	9.33 b	10.67 b	22.62 a	2.57 abc
$CaCl_2$ + surfactant	7.33 b	8.67 b	9.67 b	10.67 b	11.67 b	24.70 a	2.17 bcd
Thickener	5.00 b	6.67 b	7.67 b	9.00 b	10.33 b	17.36 a	2.09 cd
$CaCl_2$ + Thickener	5.67 b	6.67 b	7.67 b	9.33 b	10.33 b	18.69 a	2.44 abc
$CaCl_2$ + Thickener + surfactant	6.00 b	7.33 b	8.67 b	9.67 b	11.00 b	16.79 ab	2.79 a
Control	7.00 b	8.00 b	9.00 b	10.67 b	12.00 b	19.39 a	2.64 abc

Means in a column followed by same letter(s) are not significantly different at 5% level DMRT

Table 2a: Effect of coating materials on chemical parameters of banana during storage

Coating materials	Total sugars(%)			Reducing sugar(%)			Starch content(%)		
	Ripening stage			Ripening stage			Ripening stage		
	S3	S5	S6	S3	S5	S6	S3	S5	S6
$CaCl_2$	17.67 bcd	20.35 c	18.10 d	3.27 de	6.20 e	9.54 d	14.26 a	6.67 ab	3.39 ab
Waxol	17.52 bcd	18.80 e	16.81 e	4.90 b	6.09 e	8.44 e	13.21 b	6.12 bc	3.92 a
Benlate	18.30 b	20.01 cd	18.22 d	6.28 a	8.33 bc	13.24 ab	12.26 c	4.92 de	2.52 b
Surfactant	17.91 bc	20.09 cd	19.38 bc	2.47 e	7.39 cd	9.79 d	14.92 a	5.76 c	3.26 ab
$CaCl_2$ + surfactant	16.94 cd	20.67 bc	20.19 ab	3.49 d	6.36 de	10.44 cd	14.24 a	7.02 a	3.01 ab
Thickener	20.32 a	21.11 ab	20.26 ab	4.74 bc	8.75 b	11.15 c	12.38 c	4.50 ef	2.92 ab
$CaCl_2$ + Thickener	16.83 d	20.18 cd	18.77 cd	4.35 bcd	10.06 a	12.68 b	14.23 a	4.35 ef	2.67 b
$CaCl_2$ + thickener + surfactant	17.60 bcd	19.47 d	19.21 c	4.74 bc	11.22 a	14.39 a	12.45 c	4.02 f	1.56 c
Control	17.77 bcd	21.63 a	20.77 a	3.63 cd	7.95 bc	10.18 cd	14.78 a	5.55 cd	3.79 a

Means in a column followed by same letter(s) are not significantly different at 5% level DMRT

Table 2b: Effect of coating materials on some chemical parameters of banana during storage

Coating materials	Titrable acid content (%)			Total soluble solids (%)		
	Ripening stage			Ripening stage		
	S3	S5	S6	S3	S5	S6
$CaCl_2$	0.41	0.47 c	0.32 b	23.00 de	28.00 bc	28.50 c
Waxol	0.43	0.47 c	0.36 ab	24.70 bc	29.00 b	30.00 b
Benlate	0.42	0.53 abc	0.35 ab	25.90 ab	30.50 a	31.00 a
Surfactant	0.45	0.50 bc	0.45 a	22.00 e	27.40 cd	30.00 b
$CaCl_2$ + surfactant	0.42	0.55 abc	0.46 a	26.50 a	27.40 cd	28.90 c
Thickener	0.44	0.59 a	0.42 ab	23.80 cd	27.60 cd	28.60 c
$CaCl_2$ + thickener	0.45	0.57 ab	0.37 ab	21.90 e	27.40 cd	28.90 c
$CaCl_2$ + thickener + surfactant	0.39	0.57 ab	0.40 ab	22.00 e	27.10 cd	27.60 d
Control	0.46	0.49 bc	0.37 ab	23.00 de	26.40 d	29.80 b

Means in a column having same letter(s) are not significantly different at 5% level DMRT

fruits (14.92) which was identical with control (14.78), $CaCl_2$ (14.26), $CaCl_2$ + surfactant (14.24) and $CaCl_2$ + thickener treated fruits (14.23) while the lowest obtained in Benlate treated fruits (12.26) which was comparable with thickener (12.38) and $CaCl_2$ + thickener + surfactant treated fruits (12.45). At the full ripe conditions (stage 5), the highest percentage starch fell to 7.02 in $Cacl_2$ + surfactant treated fruits which was identical with $CaCl_2$ treated fruits (6.67). At the over ripe condition (stage 6), waxol treated fruits had the highest percentage of starch (3.92) followed by control (3.79) which were identical with $CaCl_2$ (3.39), surfactant (3.26), $CaCl_2$ + surfactant (3.01) and thickener treated fruits (2.92%). The lowest percentages of starch were recorded in $CaCl_2$ + thickener + surfactant treated fruits (4.02 and 1.56) at stages 5 and 6 respectively which were comparable with $CaCl_2$ + thickener (4.35) and thickener treated fruits (4.5%) at stage 5 but was statistically lower than other treatments at stage 6.

Decrease in starch content during ripening was also observed by Lal *et al.* (1974) and Abdullah *et al.* (1985). Chacon *et al.* (1987) found 17.1% starch in green bananas.

Percentage titrable acidity: Titrable acid of banana pulp was increased rapidly during storage period up to stage 5 and then decreased. The pattern of changes in all the treated and untreated fruits were not similar. Significant differences were found among the treatments in respect of percentage titrable acidity of pulp at different ripening stages (Table 2b). At the full ripe condition (S5), thickener treated fruits had the highest titrable acidity (0.59), which was identical with $CaCl_2$ + thickener + surfactant (0.57), $CaCl_2$ + thickener (0.57), $CaCl_2$ + surfactant (0.55) and Benlate treated fruits (0.53). The lowest percentage titrable acidity was observed in both $CaCl_2$ and waxol treated fruits (0.47) which were identical with control (0.49), surfactant (0.50), Benlate (0.53) and $CaCl_2$ + surfactant treated fruits (0.55). At the over ripe condition (S6), the highest titrable acidity was observed in $CaCl_2$ + surfactant treated fruits (0.46%), followed by surfactant treated fruits (0.45%), which were similar with other treatments except $CaCl_2$ treated fruits which had the lowest titrable acidity (0.32).

The decrease in titrable acidity of banana pulp between stage 5 and stage 6 agrees with the report by Loesecke (1950).

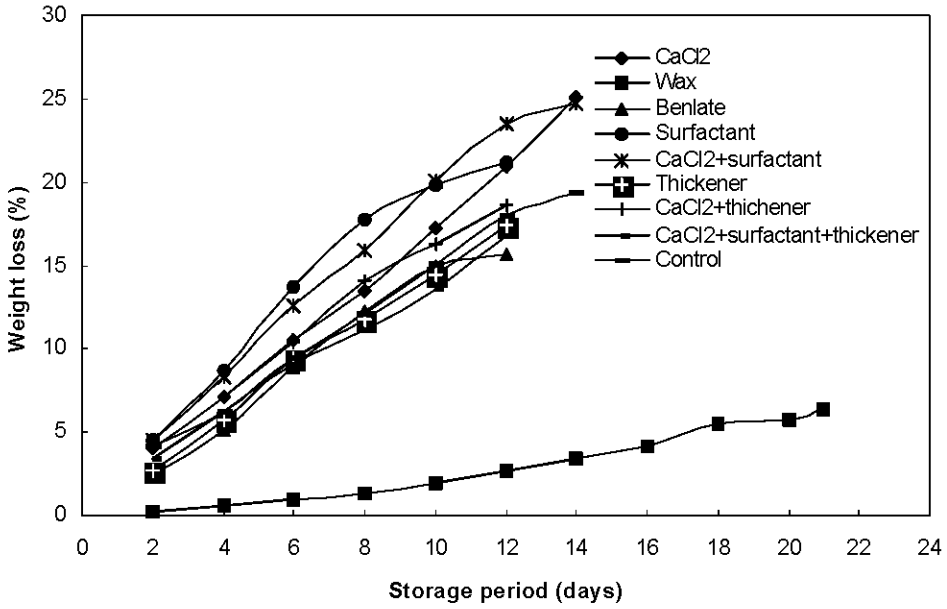

Fig. 1: Effect of coating materials on the weight loss of banana at 2 days interval during storage

Percentage total soluble solid: The percentage TSS of banana increased during ripening. Significant differences were found among the treatments in respect of TSS in pulp of banana at different ripening stages (Table 2b). At the ripening stage 3, the highest percentage TSS was found in $CaCl_2$ + surfactant treated fruits (26.5) which was similar with Benlate treated fruits (25.9) and the lowest in $CaCl_2$ + thickener treated fruits (21.90), which was identical with $CaCl_2$ + thickener + surfactant (22.0), surfactant (22.0), control (23.0) and $CaCl_2$ treated fruits (23.0%). The highest percentages TSS were recorded in Benlate treated fruits (30.5 and 31.0) at stage 5 and 6 respectively and differed significantly from other treatments at both stages. The lowest percentage TSS was found in control fruits (26.5) at stage 5 which was comparable with all other treatments except waxol (29.0) and Benlate treated fruits (30.5) while at stage 6, the lowest percentage TSS was obtained in $CaCl_2$ + thickener + surfactant treated fruits (27.6), which was significantly lower than others.

Increase in TSS of fruit might be attributed due to increase in soluble sugars, soluble pectin, soluble organic acids etc. Increase in TSS of fruit observed in present study agrees with the report by Tripathi *et al.* (1981) and Abdullah *et al.* (1985). It may be concluded that treating banana with melted waxol for one minute and packing it in polyethylene bags containing 0.5 g $KMnO_4$ were useful in checking the weight loss, maintaining fruit quality and thereby prolonging the shelf life of fruits by 7-11 days more than control ones (12 days).

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