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Short communication

Postharvest application of $CaCl_2$ and wrapping materials on shelf-life of banana cv. Robusta

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ABSTRACT

Present experiment was conducted to evaluate the effect of $CaCl_2$ and wrapping materials on improving shelf-life of banana. Twelve treatment combinations comprising of $CaCl_2$ (2 or 4%), polyethylene bag, banana dried leaves, news paper, $CaCl_2$ (2%) + polyethylene bag, $CaCl_2$ (4%) + polyethylene bag, $CaCl_2$ (2%) + banana dried leaves, $CaCl_2$ (4%) + banana dried leaves, $CaCl_2$ (2%) + news paper, $CaCl_2$ (4%) + newspaper with control were taken. $CaCl_2$ (4%) + polyethylene bag treatment resulted in minimum spoilage (19.65%), highest marketability (80.35%), fair organoleptic score, maximum total sugars (20.10%), ascorbic acid (2.96 mg/ 100 g of fresh weight) with increased shelf-life (16 days) of banana cv. Robusta fruits.

Key words: Banana, $CaCl_2$, post-harvest storage, shelf-life, wrapping material.

Bihar is an important banana growing state which produces 4.8% of total banana production in the country (Anon, 1). Robusta is the prime choicest cultivar of this state, which predominantly grown in Bhagalpur, Koshi in Purnea and Gandak in Vaishali districts with its high yield prospective and excellent fruit quality. As far as postharvest losses of banana fruits are concerned it is approximately 30-40 per cent. It happens due to the perishable nature of this fruit, wretched handling practices as well as inadequate storage facilities. Wrapping revealed immense role in lengthening the shelf-life as well as reducing the wastage by inhibiting undesirable physiological events, bruising and pathological deterioration during storage, transportation and marketing (Sahay *et al*., 7). The appropriate wrapping materials afford congenial surroundings which decreases the ethylene synthesis, unwanted bio-chemical changes, ripening, slows down the rate of respiration, desiccation and pathological deterioration of fruits (Singh *et al.*, 8).

Polyethylene bags are used broadly to prolong shipment and storage life of banana and other fruits. Singh *et al.* (8) found that the shelf-life of strawberry was maintained up to six days when they were packed in high-density polyethylene pouches. A number of chemicals were also reported to have role in postharvest management of banana fruits by delaying the ripening process. The use of calcium salts itself as well as combined action of chemical dip with 1% (w/v) calcium chloride, 0.75% (w/v) ascorbic acid and 0.75% (w/v) cysteine help to maintain firmness of fresh cut banana (Vilas-Boas and Kader, 9) and improve quality of many fruits during storage by minimizing the respiration rate, disease incidence and weight loss.

The present experiment was carried out at the Department of Horticulture (Fruit & Fruit Technology), BAU, Sabour, Bhagalpur. The bunches of banana cv. Robusta were dehanded, washed and treated with $CaCl_2$ (2 or 4%) solution. The surface moisture was dried under shade. The treated or untreated (control) bunches were packed in newspaper, dried banana leaves and LDPE polythene bags of 150 gauge thickness of pouch size (120 × 60 cm). The total surface area of each polythene bag was 7,200 cm^2 with perforation (8 holes /bag) and each whole having 0.50 cm^2 surface areas (Sahay *et al.*, 7).

The fruits were handpicked to avoid any injury and carried to the experimental laboratory in bamboo basket. Only firm healthy fruits of uniform size and maturity, free from pest, disease, injuries, bruises and blemishes were selected for the experiment. Banana hands were selected from mature uniform bunches. One hand with 12 fingers was considered as one experimental unit. Aqueous solution of $CaCl_2$ (2 or 4%) solutions were used in which the fruits were dipped (10 min.). The treated fruits were air-dried. There were 12 treatment combinations replicated thrice under completely randomized design (CRD). Each treatment had two sets. First set was used for estimation of spoilage and marketability, while the second set was used for bio-chemical analysis as well as organoleptic evaluation. Marketability of the fruits was characterized on the account of their firmness, colour and appearance at alternate day interval on the strength of initial fruit weight. For storage studies, the maximum temperature ranged from 27.4° to

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32.4°C and minimum temperature varied from 9.5° to 16.8°C, while, the relative humidity varied from 25.0 to 88.0% during the storage period. The total sugars and ascorbic acid contents were estimated following standard methods. Sensory evaluations were conducted to assess the consumer acceptability of the stored fruits by the score and corel system with the panel of five judges (Larmond, 4).

The spoilage of fruits increased with successive increment in the storage period irrespective of treatments (Table 1). The highest spoilage of banana fruits during storage was recorded under control to the tune of 79.35% (T_{12}), while significantly lower spoilage (19.65%) was found in $CaCl_2$ (4%) + fruits packaged in polyethylene bag (T_7) followed by $CaCl_2$ (4%) + fruits wrapped in newspaper (21.04%) on the 16th day of experiment. This might be due to existing pathogens on the fruit surface, which easily invaded and increased decaying of banana fruits with storage period (Emerald and Sreenarayanan, 2). The unpacked fruits were exposed openly with the direct contact of air and temperature of contiguous situation, so that control might have respired faster and transpired rapidly that causes loss of water and enhanced the microbial infection. At this time, ethylene evolution, degradative metabolism and pectin hydrolysis were also at higher rate resulting in more decay. The polyethylene bag acted as an effective barrier to surrounding atmosphere and reduced exposure of fruits to micro-floras. Ventilated polyethylene bags slowed down the rate of respiration, ethylene evolution, oxidative metabolism and pectin hydrolysis resulting in retention of firmness. It might have imparted some resistance against the growth of the pathogens on fruits.

The marketability of banana fruits was evaluated on the basis of shrinkage, softness, appearance and taste of fruits. In all treatments marketability declined gradually and successively with the prolongation of storage period (Table 2). The highest marketability were noticed with $CaCl_2$ (4%) + polyethylene bag (90.41%) followed by $CaCl_2$ (2%) + polyethylene bag (90.17%) at the end of storage period as compared to control (69.22%). Improvement in marketability percentage of fruits treated with $CaCl_2$ along with different wrapping materials is due to good texture, better edible quality, less physiological and spoilage losses.

Total sugars increased gradually with the advancement of storage period and after attaining its peak, the value reduced slightly (Fig. 1). The fruits packed with $CaCl_2$ (2%) + polyethylene bag or $CaCl_2$ (4%) + polyethylene bag (20%) exhibited continuous enhancement in total sugars content till the end of the experiment, whereas in remaining treatments, it declined after 14th day of storage. At the end of experiment, the highest total sugars were obtained in fruits packaged with $CaCl_2$ (4%) + polyethylene bag (20%), which showed statistical parity with $CaCl_2$ (2%) + polyethylene bag and minimum value was recorded under control (16%). The increase in total sugars content may be due to loss of moisture and hydrolysis of polysaccharides and transformation of organic acids into soluble sugars. The declined

Table 1. Effect of $CaCl_2$ and wrapping material on spoilage of banana fruits during storage.

Treatment	Period of storage (days)									Mean
	00	02	04	06	08	10	12	14	16	
T_1- $CaCl_2$ 2%	0.00	0.00	2.12	3.02	4.35	6.85	11.59	19.95	28.60	10.93
T_2- $CaCl_2$ 4%	0.00	0.00	2.02	2.89	4.15	6.73	11.45	19.71	28.02	10.71
T_3- Polyethylene bag	0.00	0.00	3.40	4.16	10.12	13.62	32.57	61.12	68.35	27.62
T_4- Banana dried leaves	0.00	0.00	4.36	5.28	10.86	18.65	35.95	64.24	73.46	30.40
T_5- Newspaper	0.00	0.00	5.93	6.58	12.16	19.25	40.35	67.35	75.20	32.40
T_6- $CaCl_2$ 2% + polyethylene bag	0.00	0.00	1.80	2.50	5.35	8.20	11.34	15.20	20.05	9.21
T_7- $CaCl_2$ 4% + polyethylene bag	0.00	0.00	1.60	2.42	5.10	8.01	11.04	15.04	19.65	8.98
T_8- $CaCl_2$ 2% + Banana dried leaves	0.00	0.00	1.80	2.95	6.02	8.82	11.59	20.02	23.45	10.66
T_9- $CaCl_2$ 4% + Banana dried leaves	0.00	0.00	1.90	2.89	5.68	8.69	11.04	17.79	23.04	10.15
T_{10}- $CaCl_2$ 2% + Newspaper	0.00	0.00	2.60	3.49	7.35	10.21	13.34	17.24	21.20	10.78
T_{11}- $CaCl_2$ 4% + News paper	0.00	0.00	2.50	3.30	9.20	12.17	15.15	17.04	21.04	11.49
T_{12}- Control	0.00	0.00	6.59	7.63	12.95	20.65	42.35	69.35	79.35	34.12
Mean	0.00	0.00	3.05	3.93	7.77	11.82	20.65	33.67	40.12	
CD at 5%	T = 0.55; D = 0.46; T × D = 1.65									

Table 2. Effect of $CaCl_2$ and wrapping material on marketability of banana fruits.

Treatment	Period of storage (days)									Mean
	00	02	04	06	08	10	12	14	16	
T_1- $CaCl_2$ 2%	100.00	100.00	97.88	96.98	95.65	93.15	88.41	76.13	71.40	88.51
T_2- $CaCl_2$ 4%	100.00	100.00	97.98	97.11	95.85	93.27	88.55	76.35	71.96	88.72
T_3 -Polyethylene bag	100.00	100.00	96.60	95.84	89.88	86.38	67.43	36.56	31.65	72.05
T_4- Banana dried leaves	100.00	100.00	95.60	85.72	89.14	83.62	67.13	42.60	26.75	70.09
T_5- Newspaper	100.00	100.00	96.07	95.14	88.95	81.80	82.31	35.90	24.80	72.14
T_6- $CaCl_2$ 2% + polyethylene bag	100.00	100.00	98.02	97.50	94.65	91.80	88.60	80.64	79.95	90.17
T_7- $CaCl_2$ 4% + polyethylene bag	100.00	100.00	98.40	97.50	94.90	91.99	88.96	80.80	80.35	90.41
T_8- $CaCl_2$ 2% + Banana dried leaves	100.00	100.00	97.40	95.07	92.65	89.79	86.66	78.80	78.76	88.43
T_9- $CaCl_2$ 4% + Banana dried leaves	100.00	100.00	97.50	95.29	93.50	89.04	87.40	78.89	78.96	88.65
T_{10}- $CaCl_2$ 2% + Newspaper	100.00	100.00	98.20	95.34	93.88	91.18	88.41	76.06	75.10	88.31
T_{11}- $CaCl_2$ 4% + Newspaper	100.00	100.00	98.10	97.11	94.32	91.32	88.96	76.28	75.95	88.86
T_{12}- Control	100.00	100.00	95.01	94.18	89.37	87.68	87.21	49.74	23.35	69.22
Mean	100.00	100.00	97.23	95.23	92.73	89.25	84.17	65.72	59.92	
CD at 5%	T= 2.46; D = 2.13; T x D = 7.37									

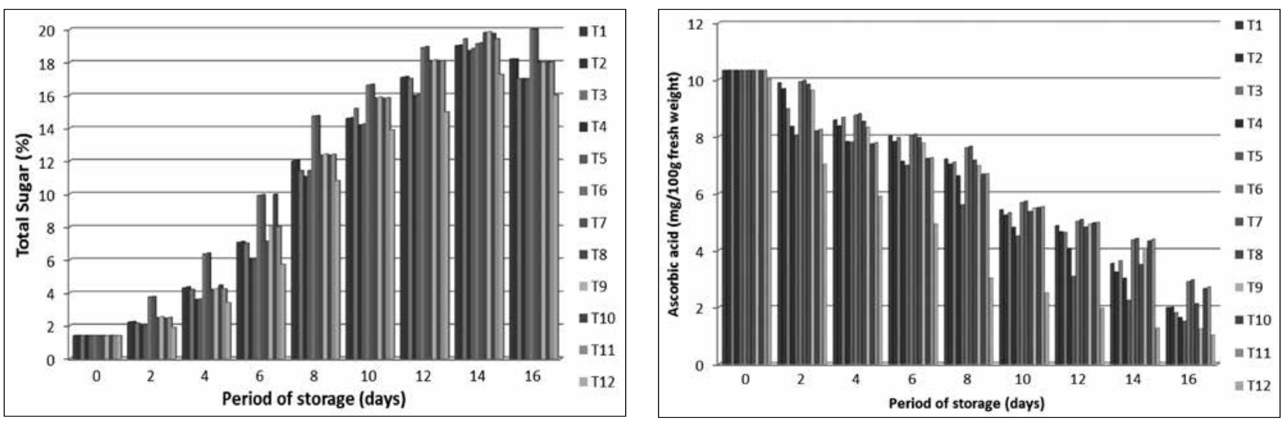

Fig. 1. (a) Total sugars (%) and (b) ascorbic acid contests in banana fruits during storage under various packaging treatments.

rate of physiological changes and slow conversion of starch and polysaccharides into simple sugars and less utilization in respiration and other catabolic process might be the reasons of estimation of the highest content of total sugars in fruits dipped in solutions of calcium salts. Similar findings have also been reported by Prasad *et al.* (6) and Jagadeesha *et al.* (3) in banana.

The ascorbic acid content in fruits reduced gradually and progressively with the prolongation of storage period, irrespective of treatments (Fig. 1a, b). The minimum depletion on termination of experiment was observed in fruits treated with $CaCl_2$ (4%) + polyethylene bag (2.96 mg/100 g of fresh weight) and $CaCl_2$ (2%) + polyethylene bag (2.90 mg /100 g of fresh weight). The depletion in ascorbic acid content was due to oxidation of L-ascorbic acid into dehydro-ascorbic acid by enzymes ascorbinase (Mapson, 5). Higher retention of ascorbic acid in banana during storage with calcium compound has also been reported by Prasad *et al.* (6) and Jagadeesha *et al.* (3). There was a gradual enhancement in score of organoleptic rating under all the wrapping materials and afterwards it declined with prolongation of storage period. The initial increase in organoleptic score was due to softness increase in TSS, flavour, development of colour and decrease in acidity. Fruits stored under $CaCl_2$ (4%) + polyethylene bag had high organoleptic score upto 16^{th} day of storage of banana fruits at ambient temperature (Table 3). It was shown that shelf-

Table 3. Sensory evaluation of banana fruit during storage.

Treatment	Period of storage (days)						Mean
	06	08	10	12	14	16	
T_1-$CaCl_2$ 2%	58	71	82	88	74	62	72.50
T_2- $CaCl_2$ 4%	60	73	86	92	78	56	74.16
T_3- Polyethylene bag	51	71	86	82	74	54	69.67
T_4- Banana dried leaves	50	70	84	80	70	58	68.67
T_5- Newspaper	52	76	79	78	70	42	66.16
T_6- $CaCl_2$ 2% + polyethylene bag	60	75	89	94	81	72	78.50
T_7- $CaCl_2$ 4% + polyethylene bag	62	77	90	96	85	74	80.67
T_8- $CaCl_2$ 2% + banana dried leaves	58	72	88	91	82	70	77.00
T_9- $CaCl_2$ 4% + banana dried leaves	60	74	89	92	83	71	78.17
T_{10}- $CaCl_2$ 2% + newspaper	55	66	76	90	83	59	71.50
T_{11}- $CaCl_2$ 4% + newspaper	56	78	82	92	84	60	75.33
T_{12}- Control	50	70	76	80	60	45	63.50
Mean	56.00	72.75	83.92	87.92	77.00	60.25	
Rating (Score)	Excellent = 90-100; Good = 80-90; Fair = 70-79						

life of banana fruits was enhanced with application of $CaCl_2$ (4%) + polyethylene bag or $CaCl_2$ (2%) + polyethylene bag, which also reduced the spoilage, prolonged marketability with fair organoleptic score.

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