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Effect of pre-treatment on quality of minimally processed culinary banana cv. Kachkal (ABB group)

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Abstract
A study was undertaken to assess the suitable pre-treatment for maintaining quality of minimally processed culinary banana. The experiment was laid out in factorial CRD with nine treatments replicated three times. The minimally processed banana slices were subjected to pretreatments like Calcium chloride (2%); Calcium chloride (3%); Ascorbic acid (2%); Ascorbic acid (3%); Citric acid (2%); Citric acid (3%); KMS (2%); KMS (3%) and distilled water (control), packed in areca nut leaf sheath and polystyrene packages which were wrapped with cling film and stored in refrigerated conditions till it remains in good condition. The TSS, acidity, ascorbic acid, calcium, starch and phenols showed decreasing trend with the increase in storage period. However, TSS retention was more in KMS treated samples (5%)) with least browning, while higher ascorbic acid (11.37mg/100g) and phenol (17.04mg/100 g) contents were observed in ascorbic acid treated samples. Similarly, citric acid treatment showed higher acidity (0.168%) in the samples. Maximum starch (0.35%) and calcium (10meq/100g) contents were recorded in calcium chloride treated samples. The maximum degree of browning was observed in control as compared to other treatments and the least browning was observed in the samples treated with KMS. Among the treatments, highest PLW was observed in control and minimum in ascorbic acid treated samples. At the end of the storage period, overall score obtained for the minimally processed cooked banana was highest in KMS treated samples. Thus, it might be concluded from the study that minimally processed culinary banana pre-treated with KMS (2% or 3%) could be stored in refrigerated condition up to maximum of 10 days without quality deterioration as compared to other treatment.

Keywords: Browning, culinary banana, minimal processing

Introduction
Okra [*Abelmoschus esculentus* (L.) Moench] is an annual herbaceous plant, native of tropical Culinary bananas, often called as plantains, are mostly evolved from the edible banana varieties of two species *Musa acuminata* (genome "A") and *Musa balbisiana* (genome "B") (Stover and Simmonds, 1987) [29]. Plantains and cooking bananas look almost similar to unripe dessert bananas, but they are larger in size, more fleshy and starchy (Emaga *et al.*, 2008) [13]. Considering the nutritional aspects, plantains and bananas are the world's 4th leading agricultural crop (Ganapathi *et al.*, 1999) [15]. According to Doymaz (2010) [12], bananas and plantains are rich in nutrients, starch, sugar and vitamin A and C, potassium, calcium, sodium and magnesium. Plantains are nutritionally low protein food material but relatively high in carbohydrates, vitamins and minerals (Offem and Njoku, 1993) [26]. The culinary banana locally called Kachkal (ABB group) found only in Northeast India, and is used as a vegetable in preparing various traditional dishes (Khawas *et al.*, 2014) [18]. In Sri Lanka, cooking banana CV Alukesel is mainly used in curries. The minimally processed banana CV Alukesel was considered as a potential value added sale item at super markets. (Siriwardan *et al*. (2015) [28].
Minimally processed products (fresh cuts) are fruits or vegetables subjected to a process of physical alteration such as cutting, trimming, slicing while ensuring that they retain the fresh state after processing (Moretti *et al*.,2000) [23]. Consumer demand for fresh-cut tropical products is increasing rapidly in the world market (Kader, 2006) [17]. In the last decade the population's consumption preferences changed drastically, creating a growing demand for minimally processed agricultural products, sustained by the preservation of freshness, nutritional quality, and the convenience offered by the products. The aims of minimal processing are to make the food safe chemically and microbiologically; to retain the desired flavour, colour and texture of the food products and to provide convenience to the consumer. Thus, keeping these facts in view, the present investigation was undertaken with the objectives to find out suitable pretreatment for maintaining quality and to extend shelf life of minimally processed culinary banana cv. Kachkal.

Materials and Methods

Preparation of culinary banana: In Assam, Kachkal (ABB) is popularly used as culinary banana. Kachkal, also known as 'Purakal' is cultivated throughout Assam. Bunches of mature green fruits were collected from Instructional cum Research farm, Department of Horticulture, B.N. College of Agriculture and brought to the laboratory for the experimentation. After dehanding the bunches, fruits were peeled off and washed with filtered water and dipped in cool water for 2 minutes. Subsequently, fruits were cut into slices of 4-6 mm thickness using a sharp stainless steel knife under aseptic conditions. The slices were dipped separately in individual pre-treatment solutions, such as calcium chloride (2% and 3% w/v), ascorbic acid (2% and 3% w/v), citric acid (2% and 3% w/v), potassium metabisulphite (2% and 3% w/v) and distilled water (control) for ten minutes. Samples were allowed to drain and air dried for 15 minutes and slices were packed in arecanut leaf sheath package and polystyrene package of 100g capacity and wrapped with cling film. The packages in three replicates were placed on trays and stored in a refrigerated condition. 5±1 °C and 85-90% RH.

Physiochemical Analysis

Physiochemical analysis of the samples (slices of culinary banana) was carried out on first day *i.e.* before keeping in storage and on 7th day of storage following the standard estimation methods.

Total soluble solids: Total soluble solids was measured by using Erma Hand Refractometer and expressed in °Brix or percentage AOAC (1975) [1].

Titratable acidity: Titratable acidity was estimated by using the standard method of AOAC (1975) [1]. Ten gram of pulp was macerated with little distilled water and taken in volumetric flask and made the volume with distilled water and filtered. Tenml of the filtrate was taken in conical flask, which was titrated against 0.1 N NaOH using phenolphthalein as indicator. Titratable acidity as anhydrous citric acid, was calculated and expressed in percentage with the following formula

$$\text{Titratable acidity (\%)} = \frac{\text{Titre value x Normality of alkali x Equivalent weight of citric acid}}{\text{Weight of sample x Aliquot x 1000}} \text{x100}$$

Ascorbic acid: Ascorbic acid content was determined by the visual titration method using 2,6dichlorophenol indophenol dye (Freed,1966) [14], expressed inmg per 100g. Ten gram of sample was taken in 100ml volumetric flask and volume made up with 4 percent oxalic acid and filtered. Tenml of filtrate was taken and titrated against the standard dye. The pink colour indicates the end point. It was calculated by the following formula:

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{titre value x dye factor x volume made up x 100}}{\text{wt.of sample taken for estimation x Aliquot of sample taken for titration}}$$

Degree of browning (absorbance): Treated sample (2.5g) was homogenized with 2.5ml distilled water and 7.5ml of 50 per cent ethanol. The solution was well shaken and absorbance was measured at 420nm keeping 50 percent ethanol as the blank using a UV spectrophotometer (Miller, 1998).

Starch content: Sample of known weight (0.5g) was homogenized in 80 per cent ethanol to remove sugars. Then it was centrifuged and the residue was retained. The residue was washed repeatedly with hot 80 per cent ethanol till the washing did not give colour with anthrone reagent. Then the residue was dried well over a water bath. To the residue 0.5ml water and 6.5ml of 52 percent perchloric acid was added. Then it was extracted at 0 ºC for 20 minutes, centrifuged and the supernatant was saved. The extraction was repeated using fresh perchloric acid, centrifuged again and pooled the supernatant and volume was made up to 100ml. 0.1ml of the supernatant was pipette out and volume was made up to 1ml with water. In a series of test tubes 0ml, 0.2ml, 0.4ml, 0.6ml, 0.8ml and 1ml of the working standard was taken and volume was made to 1ml in each tube with water for standard curve preparation. 4ml of anthrone reagent was added to each tube and the tubes were heated for 8 minutes in a boiling water bath. Cooled rapidly and read the intensity of the green colour at 630nm on spectrophotometer. (Hedge and Hofreiter, 1962) [16]

Calcium Content: One g of sample was taken and ground it with a pestle and mortar and place in 100ml conical flask with 10ml of nitric acid (HNO_3). After placing the sample in conical flask, digestion is done for 20-30 minutes. After ashing 5ml of di-acid mixture is given for digestion and again dried for ashing. Repetition of di-acid mixture is given and dried till it become ash. The volume was made up to 50ml and 0.1N EDTA was used for titration and expressed inmeq/100 g. (Baruah and Barthakur, 1999) [7].

Detection of Ca

1. Taking 5ml of 'Ca' aliquot in china dish
2. Taking 5ml of NaoH and 5ml of sample in the china dish and the reading was taken.

Phenolic compounds: Five g of sample was taken and ground it with a pestle and mortar in 10 times volume of 80 percent ethanol. The homogenate was than centrifuged at 10,000 rpm for 20 minute and the supernatant was saved. The residue was re-extracted with five times the value of the 80 percent ethanol, centrifuged and the supernatants were pooled. Supernatants were evaporated to dryness and the residue was dissolved in a known volume of distilled water (5ml). Different aliquots of 0.2 to 2ml were pipette out into test tubes and volume was made up to 3ml with water in each tube. 0.5ml of Folin-ciocalteau reagent was added and after 3 minute, 2ml of 20 percent Sodium carbonate solution was added in each tube. The tubes were placed in boiling water for exactly 1 minute, cooled and the absorbance was measured at 650nm against a reagent blank. The standard curve was prepared using different concentration of catechol and content of phenolic compound was expressed in percentage (Malik and Singh, 1980) [21].

Sensory Evaluation: Minimally processed banana sample were subjected to sensory evaluation on day 7. The pre-treated and fresh samples were fried in a pan with groundnut oil, by placing on an induction plate. This was considered as fried samples and was evaluated by a panel of 7 untrained judges for appearance, colour, flavour, taste and overall acceptability. The quality was evaluated using 9 point hedonic scale rating (Amerine *et al.*, 1965) [4]. The colour of the sample was evaluated from the uncooked sample while flavour and taste were evaluated using fried samples

Results and Discussion

Effect of pre-treatment on physiochemical changes during storage

Total soluble solids (TSS): The TSS content of the minimally processed culinary banana showed decreasing trend in all the treatments except in KMS treated and control sample. Among the treatments, T_8 (KMS treated) showed maximum TSS (5.0%) as compared to rest of the treatments. The lowest TSS content was observed in citric acid treated (T_6) sample which decreased from 4.40 to 3.67 percent.

Dessert banana, cooking banana and plantain, contain many compounds which are soluble in water such as sugars, acids, vitamin C, amino acids and some pectin. These soluble compounds form the soluble solid content of the fruits. Increase in TSS content reflects hydrolysis of starch into sugars as banana fruits ripen, whereas decrease in TSS content is due to the utilization of carbohydrates as metabolites (Dadzie, 1998) [10].

The interaction effect of treatment and packaging material was found to be non-significant at 7 day of storage period. At 0 day TSS (4.40%) was observed in KMS treated sample, which attained maximum TSS (5.0%) at the end of storage period, regardless of packaging. The reason for increase in TSS could be attributed to the water loss and hydrolysis of starch and other polysaccharides to soluble form of sugar. Similar observation was also observed by Alam *et al.* (2013) [13] in minimally processed papaya; Okan *et al*. (2011) [27] in cherry fruits.

Titratable acidity: A continuous decreasing trend was found in acidity content in all the treatments of minimally processed culinary banana except in citric acid treated sample. The acidity content of minimally processed culinary banana decreased significantly as storage days progressed. This reduction in titratable acidity might be due to the increased respiration rates following peeling and cutting. As indicated by Kim *et al*. (1993) [19], acids are known to be used quickly during respiration compared to other compounds.

The minimally processed banana was significantly influenced by different treatment on acidity. It increased from initial value of 0.126 percent to highest level of acidity (0.168%) in citric acid treated sample as compared to other treatments. Among, the various interactions, significantly highest acidity was seen in citric acid (2%) treated sample packed in areca nut leaf sheath package at 7 days of storage. The higher acidity in treated samples may be due to the decreased hydrolysis of organic acids and subsequent accumulation of organic acids which were oxidized at slow rate because of decreased respiration (Alam *et al*., 2013) [13]. Similar findings was also reported by Vikee *et al*. (2018) [31] on Nagpur mandarin.

Ascorbic acid: A proportionate decrease in ascorbic acid content of the minimally processed culinary banana during the storage period was observed in the present study. The ascorbic acid content of minimally processed culinary banana was significantly influenced by different treatment during storage. Among the treatments, ascorbic acid treated sample retained highest ascorbic acid content (11.37mg/100g) as compared to other treatments. The sample without any treatment recorded minimum ascorbic acid content (7.03mg/100g) at 7 days of storage. Similarly, at 0 day, variation in ascorbic acid content was observed due to the treatment. The decrease in ascorbic acid with the increase in the storage period might be due to the degradation of ascorbic acid to dehydro ascorbic acid by oxidative enzymes and decrease in ascorbic acid during storage might be due to oxidation and direct effect of storage temperature on vitamins (Ladaniya and Singh, 1999; Reddy *et al*., 1999) [20]. Similar observation were also reported by Danyen *et al.* (2011) [11] on pineapple; Naik *et al.* (2017) [25] on minimally processed pomegranate arils.

Interaction effect of treatment and packaging was found non-significant. However, the rate of decrease in ascorbic acid was higher in untreated sample as compared to treated samples. This might be due to rapid loss of L-ascorbic acid by oxidation because of greater availability of oxygen. Another reason might be due to rapid conversion of L-ascorbic acid into dehydro-ascorbic acid in the presence of enzyme ascorbinase (Atress *et al*., 2010) [6].

Calcium content: Perusal of data indicated that calcium content of minimally processed culinary banana was significantly affected by treatments. A decreasing trend in calcium content was observed in minimally processed culinary banana during storage period. The calcium content decreased from initial value (13.30meq/100g) till the end of storage period (8.57meq/100g). The maximum calcium content (10.15meq/100g) at 7 days of storage period was found in calcium chloride treated sample.

The effect of packaging on calcium content of minimally processed banana was found to be non-significant. Due to interaction effect the highest calcium content (10.20meq/100g) was found in calcium treated sample at 7 days of storage. Decreased in calcium content in all the treatments irrespective of packaging was observed at the end of storage period. The maximum retention of calcium was found in calcium chloride treated sample. This may be due to increase in calcium content of tissues. Conway and Sams (1984) [9] reported that application of calcium chloride increases calcium content of the apple tissues, which reduces the post-harvest decay.

Starch content: The starch content of minimally processed culinary banana was significantly affected by treatments. It decreased with extend of storage period irrespective of treatments. Banana sample treated with calcium chloride recorded highest starch content of 1.04 per cent at day 0, which decreased to 0.35 per cent at 7 days of storage. And the lowest (0.16%) was found in the sample without treatment (control).

No significant effect of packaging on starch content was observed in minimally processed culinary banana. Starch content due to interaction was non-significant during storage period. However, the maximum retention of starch content (0.35%) was recorded in calcium chloride treated sample. The higher starch content may be due to the lesser break down of starch due to influence of chemicals by preventing the activities of enzyme amylase and hydrolyses. The decreasing trend of starch occurs as the storage period progressed due to the utilization of starch during respiration. Similar results were also observed by Suryawanshi (2008) in minimally processed potato.

Phenol content: The phenol content significantly decreased during storage. The decrease was due to high activity of PPO. The maximum phenol content (17.04mg/100g) was observed in ascorbic acid treated sample. It decreased gradually during storage period. At initial stage (0 day), the level of phenol of minimally processed culinary banana was in the range of

20.80 to 21.70mg/100g and at end of storage it ranged from 4.82 to a17.04mg/100g.This might be due to an increasing surface area contact with oxygen as a result of cutting and this had an effect on the activity of the major enzymes involves in the functional compounds degradation (Leon *et al*., 2015) in minimally processed cherry and plum salad.

The interaction between treatment and packaging had no significant effect on phenol content of minimally processed banana. During minimal processing the enzyme PPO is released from the vacuoles and in the contact with phenols the reactions start. These copper-containing enzyme catalyses two reactions: the hydroxylation of monophenols to 0-diphenols and oxidation of 0-diphenols to 0-quinones. O-quinones are highly reactive compounds that are converted non-enzymatically to coloured pigments called melanines, which are responsible for less attractive appearance and loss of nutritional quality (Cantos *et al*., 2002) [8].

Degree of browning: The enzymatic browning of fruits, after harvest, storage or inconsequence of injuries has great visual impact and decreases the commercial quality, sensory acceptance and the nutritional value of this fruit

The degree of browning of minimally processed culinary banana showed an increment in absorbance value during storage. The minimum browning (lowest absorbance value of 0.41) was noticed in minimally processed banana treated with 3 per cent KMS at 7 days of storage. All the treatments showed a lesser degree of browning as compared to control, indicating less browning development in minimally processed culinary banana. Reduction in degree of browning in banana may be attributed to the reduced activity of polyphenol oxidase activity and oxygen concentration which might be due to the effect of chemicals used in pretreatments (Manolopoulou and Varzakas, 2011) [22].

A significant interaction effect was noted between treatment and packaging on degree of browning. The absorbance value for browning in minimally processed culinary banana was in the range of 0.41 to 0.77 absorbance. However, effect of packaging was found non-significant during storage. The inhibitory effect of sodium metabisulphite and ascorbic acid on the browning was reported by Vega *et al.* (2008) [30] in apples. Similar results were found by Siriwardan *et al*. (2015) [28] in banana var. Alukesel. Ahvenainen, (1996) [2] justified that the browning occurs due to presence of four different components; oxygen, oxidizing enzyme (polyphenol oxidase), metallic ion (copper) and a suitable substrate (phenolic substrate).

Table 1: Effect of pretreatment and packaging on physico chemical properties of culinary banana during storage

Treatment	TSS						Acidity					
	0 day			7 day			0 day			7 day		
	P1	P2	Mean	P1	P2	Mean	P1	P2	Mean	P1	P2	Mean
T_1	4.25	4.25	4.25	4.00	3.67	3.83	0.136	0.134	0.135	0.041	0.013	0.027
T_2	4.25	4.20	4.22	4.00	4.26	4.13	0.135	0.134	0.134	0.018	0.013	0.016
T_3	4.30	4.25	4.27	4.00	4.00	4.00	0.136	0.126	0.131	0.013	0.022	0.018
T_4	4.30	4.30	4.30	4.00	4.00	4.00	0.122	0.130	0.126	0.027	0.018	0.022
T_5	4.50	4.40	4.45	4.00	4.00	4.00	0.121	0.131	0.126	0.169	0.168	0.168
T_6	4.50	4.30	4.40	3.33	4.00	3.67	0.125	0.120	0.123	0.166	0.167	0.166
T_7	4.40	4.30	4.35	4.00	4.00	4.00	0.132	0.130	0.131	0.013	0.013	0.013
T_8	4.40	4.40	4.40	5.00	5.00	5.00	0.130	0.131	0.131	0.027	0.027	0.027
T_9	4.65	4.50	4.57	4.70	4.83	4.76	0.134	0.132	0.133	0.013	0.013	0.013
Mean	4.39	4.32	---	4.11	4.19	---	0.130	0.130	---	0.054	0.050	---
LSD at 5%	T=0.04 P=0.02 T x P=0.06			T=0.26 P = NS T x P=NS			T=0.002 P=NS T x P=0.003			T=0.007 P=0.003 T x P=0.01		

T_1 (2% Calcium chloride); T_2 (3% Calcium chloride); T_3 (2% Ascorbic acid); T_4 (3% Ascorbic acid); T_5 (2% Citric acid); T_6 (3% Citric acid); T_7 (2% KMS); T_8 (3% KMS) and T_9 (Control *i.e.* distilled water).

P1=Areca nut leaf sheath P2=Polystyrene

Table 2: Effect of pretreatment and packaging on physico chemical properties of culinary banana during storage

Treatment	Ascorbic acid						Calcium					
	0 day			7 day			0 day			7 day		
	P1	P2	Mean	P1	P2	Mean	P1	P2	Mean	P1	P2	Mean
T_1	14.00	14.20	14.10	7.06	7.06	7.06	14.21	14.16	14.18	10.00	10.00	10.00
T_2	14.20	14.10	14.15	7.10	7.06	7.08	15.20	15.00	15.10	10.10	10.20	10.15
T_3	15.40	14.80	15.10	11.35	11.37	11.35	14.51	14.50	14.50	8.67	8.00	8.33
T_4	15.20	15.10	15.15	11.37	11.38	11.37	14.40	14.50	14.45	9.33	9.33	9.33
T_5	14.60	14.40	14.50	7.13	7.11	7.11	12.50	12.60	12.55	7.67	8.00	7.83
T_6	14.50	14.20	14.35	7.26	7.18	7.18	12.60	12.40	12.50	8.00	7.67	7.83
T_7	14.40	14.20	14.30	7.13	7.11	7.11	12.19	12.20	12.19	8.20	8.00	8.00
T_8	14.20	14.00	14.10	7.06	7.08	7.08	12.12	12.10	12.11	8.00	8.33	8.33
T_9	14.10	14.00	14.10	7.03	7.03	7.03	12.00	12.20	12.10	7.00	7.33	7.16
Mean	14.51	14.33	---	8.05	8.04	---	13.30	13.29	---	8.57	8.54	---
LSD at 5%	T = 0.51 P = NS T x P = NS			T = 0.68 P = NS T x P =NS			T= 0.04 P = NS T x P=0.06			T = 0.42 P = NS T x P=0.59		

T_1 (2% Calcium chloride); T_2 (3% Calcium chloride); T_3 (2% Ascorbic acid); T_4 (3% Ascorbic acid); T_5 (2% Citric acid); T_6 (3% Citric acid); T_7 (2% KMS); T_8 (3% KMS) and T_9 (Control *i.e.* distilled water).

P1=Areca nut leaf sheath P2=Polystyrene

Table 3: Effect of pretreatment and packaging on physico chemical properties of culinary banana during storage

Treatment	Starch						Phenol					
	0 day			7 day			0 day			7 day		
	P1	P2	Mean	P1	P2	Mean	P1	P2	Mean	P1	P2	Mean
T_1	1.05	1.04	1.04	0.35	0.34	0.35	22.00	21.40	21.70	8.37	8.56	8.46
T_2	1.04	1.04	1.04	0.33	0.33	0.33	21.40	20.40	20.90	8.34	8.58	8.46
T_3	1.05	1.04	1.04	0.25	0.26	0.25	21.00	21.00	21.00	16.02	16.02	16.02
T_4	1.06	1.04	1.05	0.27	0.28	0.28	20.60	21.00	20.80	17.40	16.68	17.04
T_5	1.06	1.05	1.05	0.25	0.26	0.26	21.40	21.10	21.25	5.01	5.10	5.05
T_6	1.05	1.04	1.04	0.28	0.24	0.26	21.25	21.10	21.17	6.07	5.88	5.98
T_7	1.02	1.06	1.04	0.24	0.25	0.25	22.00	21.40	21.70	8.26	8.29	8.28
T_8	1.06	1.05	1.05	0.26	0.22	0.24	21.15	21.00	21.07	8.38	8.43	8.41
T_9	1.09	1.07	1.08	0.15	0.17	0.16	21.14	21.20	21.17	4.85	4.80	4.82
Mean	1.05	1.04	---	0.27	0.26	---	21.32	21.06	---	9.19	9.15	---
LSD at 5%	T=0.02 P = NS T x P=NS			T= 0.02 P = NS T x P= NS			T= NS P = NS T x P=NS			T= 0.40 P= NS T x P= NS		

T_1 (2% Calcium chloride); T_2 (3% Calcium chloride); T_3 (2% Ascorbic acid); T_4 (3% Ascorbic acid); T_5 (2% Citric acid); T_6 (3% Citric acid); T_7 (2% KMS); T_8 (3% KMS) and T_9 (Control *i.e.* distilled water).
P1=Areca nut leaf sheath P2=Polystyrene

Table 4: Effect of pre treatment and packaging on physico chemical properties of culinary banana during storage

Treatment	Degree of browning					
	0 day			7 day		
	P1	P2	Mean	P1	P2	Mean
T_1	0.47	0.48	0.48	0.54	0.52	0.53
T_2	0.46	0.48	0.47	0.51	0.54	0.52
T_3	0.43	0.44	0.43	0.46	0.47	0.46
T_4	0.42	0.43	0.42	0.45	0.45	0.45
T_5	0.45	0.46	0.46	0.54	0.53	0.53
T_6	0.45	0.45	0.45	0.52	0.51	0.51
T_7	0.42	0.41	0.41	0.44	0.43	0.43
T_8	0.41	0.40	0.40	0.42	0.41	0.41
T_9	0.47	0.48	0.48	0.77	0.76	0.76
Mean	0.44	0.45		0.52	0.51	
LSD at 5%	T=0.0 P = NS T x P=NS			T= 0.01 P = 0.01 T x P= NS		

T_1 (2% Calcium chloride); T_2 (3% Calcium chloride); T_3 (2% Ascorbic acid); T_4 (3% Ascorbic acid); T_5 (2% Citric acid); T_6 (3% Citric acid); T_7 (2% KMS); T_8 (3% KMS) and T_9 (Control *i.e.* distilled water).
P1=Areca nut leaf sheath P2=Polystyrene

Sensory properties of minimally processed culinary banana

Sensory evaluation is one of the most important criteria for acceptability of any food product by consumer. The sensory qualities included colour, flavour and taste. Overall acceptability of minimally processed culinary banana decreased continuously with the increase of storage period irrespective of pre-treatment.

However, among the treatment, overall score was highest in 3 per cent KMS treated sample (24.6) as compared to fresh sample (25.5),indicating a better retention of quality of minimally processed sample. Out of all the treatment, lowest was found in calcium chloride (2%) treated sample (18.8). There was least deterioration in colour of cooking banana samples treated with ascorbic acid and KMS after a storage period of 7 days. Similar trend of results were obtained by Siriwardana *et al.* (2015) [28]. Potassium metabisulphite was more effective than L- ascorbic acid for conservation of the original color, preventing the enzymatic browning (Vega *et al*., 2008) [30].

The pretreatment showed significant effect on overall acceptability of minimally processed culinary banana as the microbial proliferation was retarded and keeping quality was prolonged for 7-10 days.

Table 5: Overall score of sensory evaluation of minimally processed culinary banana

Treatments	Colour	Flavour	Texture/Taste	Overall score
T_1	6.4	6.2	6.2	18.8
T_2	6.6	7.0	7.0	20.6
T_3	7.6	7.4	7.8	22.8
T_4	8.4	8.0	8.2	24.4
T_5	7.6	7.4	7.2	22.2
T_6	7.8	8.0	8.0	23.8
T_7	8.2	8.0	8.4	24.0
T_8	7.6	8.2	8.4	25.5

T_1 (2% Calcium chloride); T_2 (3% Calcium chloride); T_3 (2% Ascorbic acid); T_4 (3% Ascorbic acid); T_5 (2% Citric acid); T_6 (3% Citric acid); T_7 (2% KMS); T_8 (3% KMS) and T_9 (Control *i.e.* distilled water).

Conclusion

The results of the present study indicated that minimally processed culinary banana pretreated with KMS (3%) could be stored for 10 days. The sensory attributes were acceptable in the entire pretreated samples up to 7 days except control, which was terminated after 3 days of storage. Minimally processed banana pretreated with KMS were microbiologically safe to consume with acceptable colour and taste. Areca nut leaf sheath package was found suitable for packing minimally processed banana with acceptable quality. In the study, two packaging materials *i.e.* areca nut leaf sheath package and polystyrene were used and both the materials were found to be suitable for the purpose. However, areca nut leaf sheath package would be more suitable from the organic point of view.

The study revealed a significant effect of pretreatments on the physiochemical characteristics and sensory properties of minimally processed culinary banana. The result indicated that minimally processed culinary banana pre-treated with KMS (2% or 3%) could be stored in refrigerated condition up to maximum of 10 days without quality deterioration as compared to other treatment.

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