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Studies on Pretreatment of Minimally Processed Banana Central Core

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Abstract

In general, banana pseudo stem (central core) is an abundant natural resource in tropical and subtropical regions. Banana central core is used traditionally as vegetable and preparing soup. Banana central core is having property of dissolving kidney stone. Stem juice of banana central core is used for treating diarrhoea, dysentery, diabetes, antilithic, antiulcerogenic, hypoglycemic, hypolipidemic, antioxidant actions inflammation etc. However, the usage of the central core is very low because of its tedious pre-preparation process. The main objective of this investigation is to evaluate the equipment designed by CIAE-IEP- NRCB, for the minimal processing of banana central core and to standardize the pretreatment to arrest the oxidation during processing with extended shelf life. Central core of banana has the property of quick oxidizing, because of the action of polyphenol oxidase. Various pretreatments like Citric Acid (CA), Ascorbic acid (AA) and Potassium Meta bisulphite (KMS) with varying concentrations (0.05, 0.1 and 0.2%) and combinations were used for standardizing the pretreatment method for minimal processing. Samples were stored under both ambient and refrigerated condition for analysis. They were standardized based on the analysis in colour, pH & Microbial load on daily basis. Based on the present investigation it has found that KMS at 0.2% and combination of KMS (0.1%) + AA (0.1%) gave good result. The colour and pH was acceptable level till day 3 in ambient and day 5 in refrigeration. There were no changes in colour and off odour till these days. Sensory evaluation conducted by 5 point hedonic scale gave pretreated day fifth refrigerated sample (0.1% KMS + 0.1% AA) as the best result.

Keywords: Antilithic, Antioxidants, Antiulcerogenic, Ascorbic Acid, Banana Central Core, Citric Acid, Dicing, Hypoglycemic, Hypolipidemic, Minimal Processing, Polyphenol Oxidase, Potassium Meta Bisulphite

1. Introduction

Banana is popularly known as 'Kalpatharu' (a plant of all virtues) each and every part of the plant can be utilized in many ways for various purposes. It can cater the need of fruit, vegetable, flower, leaf and fibre industries. India is the largest producer of banana in the world, contributing about 25% to the global production, producing 29.80 million tonnes from an area of 8.30 lakh hectares with a productivity of 35.9 t/ha. Banana is grown almost in all the states of the country [1]. By virtue of gigantic growth, banana plant produces large amount of biomass. More than two-thirds of the total biomass produced during banana cultivation consisted of pseudo stem, leaves, mid rib, peduncle and corm. Traditionally, central core of the Pseudostem is utilized for the preparation curries at home [2], [3].

About 5-7 tonnes of central cores can be extracted from one hectare. Banana central core stem juice is extracted from the central core stem, which is having property of dissolving kidney stone. Banana central core stem pickle or candy is prepared by making slices of the core stem [4]. All these products are prepared manually, till now, no machinery is available for extraction of stem juice or sliced/diced product. Central Institute of Agricultural Engineering, Regional centre, Coimbatore in collaboration with National Research Centre for Banana, Trichy, has developed machineries like Banana central core slicer and dicer for converting central core stem-bio-mass into economically viable minimally processed banana central core for value addition.

In general, banana central core is an abundant natural resource in tropical and subtropical regions and

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has potential for providing profitable products such as manure [5] and feed [6]. After banana harvesting, the central cores are cut and left in the fields. In order to add value to banana plantation, the central core could be processed into products. Banana central core sap has astringent qualities. In traditional medicine, the sap is used to treat a wide variety of ailments, including leprosy, hysteria, fever, digestive disorders, haemorrhage, epilepsy, haemorrhoids and insect bites [7].

2. Materials and Methods

Samples of Banana Central Core were collected from the National Research Centre for Banana (NRCB) at Trichy, Tamilnadu. Karpooravalli variety of banana central core was used throughout the experiment.

2.1 Standardization of Pre-Treatment for Diced Banana Central Core

Fresh central core was removed from the pseudo stem and sorted it for regular shape. To standardize the pre-treatment for the banana central core sample, the hand dicing unit available at Central Institute of Agricultural Engineering, Regional centre, Coimbatore was used. The banana central core sample were sliced using a sharp knife of about 7 mm thickness. The sliced circular was placed on the cutting die and dicing was carried out by applying the pressure using the pushing handle of the manual dicer. The diced sample was directly collected into clean water to avoid discoloration of the sample when it comes in contact with open air. The diced samples were used for further experimentation, to standardise the pre-treatment to be given to the sample.

2.2 Pre-Treatment of Diced Banana Central Core

With an aim to arrest the browning of the diced banana central core and to increase the shelf life by preventing the oxidation, various chemicals were used as pre-treatment at different storage conditions. The chemical were Potassium Meta Bisulphite (KMS), Citric Acid (CA) and Ascorbic Acid (AA) at varying concentration and combination, such as to prevent oxidation.

For the packaging studies LDPE sample of 100 microns were used throughout the experimentation. LDPE samples were selected based on the earlier work by [8]–[10] for papaya and okra. The thickness of 100 microns was selected based on the market survey for minimally processed vegetables.

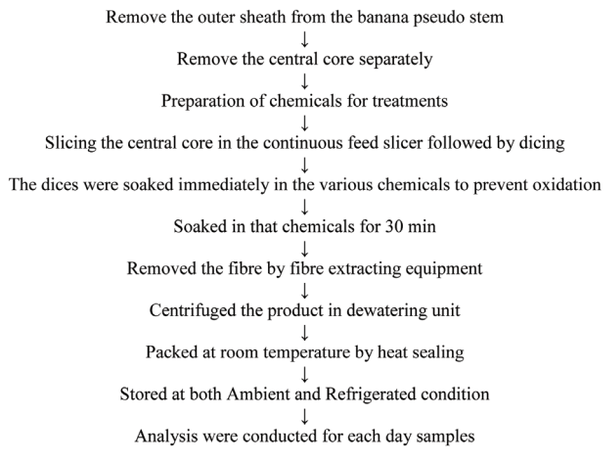

Figure 1. Flow chart for minimal processing of banana central core..

2.3 Pre-treatment of Chemical for Diced Banana Central Core

Initially the treatment was conducted by addition of 1g, 2g and 4g of ascorbic acid (0.05, 0.1, and 0.2%) in 2000 ml of water at room temperature to form solution. Sample of about 800 g of diced banana central core was soaked soon after dicing in the chemical solution. The method was replicated four times. The same procedure was repeated for other two chemicals viz., Citric Acid and Potassium metabisulphite.

The diced cubes were immersed in Potassium metabisulphite, Citric acid and Ascorbic acid at 0.05%, 0.1%, 0.2% concentrations for 30 min. Samples were centrifuged in lab scale dewatering centrifuge developed at CIAE IEP for 2 minutes to remove the surface moisture. The diced samples were packed in LDPE packs of 100 Micron. They were stored at ambient temperature (29±3˚C) and Refrigeration (6˚C±1˚C) for 6 days.

Various dependent parameters like Colour, pH and Microbial load was analysed at regular interval. The nutritional content such as protein and mineral composition was recorded for initial and final day sample for best treatment. The typical flow chart of pre-treatment is given in Figure 1.

2.4 Combination of the Chemical as Pre-treatment

Based on the initial experiments the total concentration of the chemical required for treatment was worked out. Subsequently, the treatment was given at various combinations as below so that the total concentration of the pre-treated sample is well within the limit. The details are as given below.

Here 2g of each chemical (0.1%) was taken as per the combinations.

Table 1. Effect of KMS on colour at different storage conditions and storage days

DAYS	CONTROL		POTASSIUM META BISULPHITE (KMS)					
			0.05%		0.10%		0.20%	
	A	R	A	R	A	R	A	R
0	5.45i	5.45i	5.4i	5.4i	5.26i	5.26i	5.14i	5.14i
1	6.12h	5.45h	5.6h	5.53h	5.47h	5.4h	5.34h	5.23h
2	6.30g	6.28g	5.79g	5.67g	5.51g	5.38g	5.47g	5.52g
3	6.77f	6.4f	6.34f	5.75f	5.6f	5.67f	5.58f	5.58f
4	7.11e	6.56e	6.49e	5.86e	5.93e	5.72e	5.69e	5.63e
5	7.29d	6.99d	6.56d	5.97d	6.01d	5.86d	5.8d	5.9d
6	8.01c	7.06c	6.72c	6.02c	6.09c	6.2c	5.99c	5.92c
7	8.56b	7.19b	6.90b	6.67b	6.28b	6.43b	6.02b	5.99b
8	8.82a	7.27a	7.01a	7.24a	6.4a	6.87a	6.09a	6.01a
CD(0.05)	T	D	C	T×D	D×C	T×C	T×D×C	
	0.04527	0.06791	0.03201	0.13582	0.09604	0.06402	0.19207	

NA= Not Acceptable; A= Ambient Storage; R= Refrigerated Storage; T=Treatments; D=Days of storage; C=Storage conditions; KMS= Potassium Meta Bisulphite.

- 2g of KMS (0.1%) + 2g of CA (0.1%) in 2000 ml of water
- 2g of CA (0.1%) + 2g of AA (0.1%) in 2000 ml of water
- 2g of KMS (0.1%) + 2g of AA (0.1%) in 2000 ml of water

2.5 Qualitative Analysis for the Minimal Processing

- Colour estimation using Digital Photo calorimeter: Deep Vision-set Abs, Model 312
- pH by Digital pH meter: Eutech instruments, S-355718
- Sensory analysis using five point hedonic scales by Peryam and Pilgrims (1957)
- The statistical analysis was performed using the AGRES (version 7.1) software

3. Results and Discussion

3.1 Determination of Moisture Content

The moisture content for the sample on the initial day of packaging was 93% and it increased up to 97% on the eighth day of storage on both ambient and refrigerated conditions. Treatments did not show many variations in moisture content. Thus it is seen that the moisture content of the product increases during the storage days. This may be due to the fact that the samples were stored in LDPE packs.

3.2 Chemical Used for Pre-Treatment of Diced Banana Central Core

1. Chemical pre-treatment: KMS (0.05, 0.1 and 0.2 %); Ascorbic Acid (0.05, 0.1 and 0.2 %) and Citric acid (0.05, 0.1 and 0.2 %)
2. Storage conditions = Ambient storage (29± 3˚C) and refrigerated storage (6±1˚C)

3.3 Colour Estimation by Photo Colorimeter

Consumers take product appearance into consideration as a primary criterion [11]; colour has been considered to have a key role in food choice, food preference and acceptability, and may even influence taste thresholds, sweetness perception and pleasantness. Enzymatic browning is one of the most important reactions that affect the colour during processing of fresh-cut banana pseudo stem.

Hence, diced banana central core was treated with Potassium Meta bisulphite (KMS), Citric Acid (CA) and Ascorbic Acid (AA) at various concentrations as 0.05, 0.1 and 0.2% respectively. The treated samples were stored at both ambient and refrigerated conditions for 8 days and analysed for colour on each day of storage by using a colorimeter. Among the treatments, the concentration 0.2% helps to improve the sample colour and prevents the oxidation till day 8 in refrigerated condition, which was under the consumer acceptance level as shown in Table 1. Higher concentration of 0.2% pre-treatment gave better results than 0.05 and 0.1 % pre-treatment.

Table 2. Effect of colour on various combinations

DAYS	CONTROL		AA (0.2%)		KMS (0.2%)		KMS (0.1%) + AA (0.1%)		KMS (0.1%) + CA (0.1%)	
	A	R	A	R	A	R	A	R	A	R
0	0.15f	0.15g	0.11g	0.11g	0.09g	0.09g	0.1g	0.1g	0.12g	0.12g
1	0.24e	0.21f	0.16f	0.15f	0.1f	0.09f	0.11f	0.1f	0.13f	0.12f
2	0.37d	0.29e	0.22e	0.21e	0.1e	0.09e	0.14e	0.11e	0.15e	0.12e
3	0.45c	0.41d	0.29d	0.27d	0.1d	0.11d	0.14d	0.11d	0.17d	0.15d
4	0.67b	0.57c	0.42c	0.39c	0.12c	0.11c	0.15c	0.11c	0.19c	0.17c
5	0.81a	0.72b	0.63b	0.56b	0.12b	0.12b	0.17b	0.15b	0.21b	0.18b
6	NA	0.93a	0.84a	0.71a	0.14a	0.12a	0.19a	0.17a	0.23a	0.21a
CD (0.05)	T	D	C	T×D	D×C		T×C		T×D×C	
	0.00236	0.00279	0.00149	0.00624	0.00395		0.00334		0.00883	

T=Treatments; D=Days of storage; C=Storage conditions; A= Ambient Storage;

R= Refrigerated Storage; AA= Ascorbic Acid; KMS= Potassium Meta Bisulphate; CA= Citric Acid

Similar trend of retention of colour when pre-treated with Citric acid and Ascorbic acid at higher concentration (0.2 %) over 0.05 % and 0.1 % was noticed both at ambient and at refrigerated treatment. The results were not satisfactory in both the individual treatments. Hence combinations of the chemicals were done to standardize the minimal processing. Our study is in line with earlier study which shows that at a temperature of 5˚C diced pumpkin treated with antimicrobial solution containing 0.2% citirc acid and 0.1% potassium meta bisulfite and stored under MAP conditions (packed in LDPE bags) could be stored in good condition for a period of 25 days with a minimum PLW of 0.06%, minimum loss in nutrient composition and staying microbially safe [8].

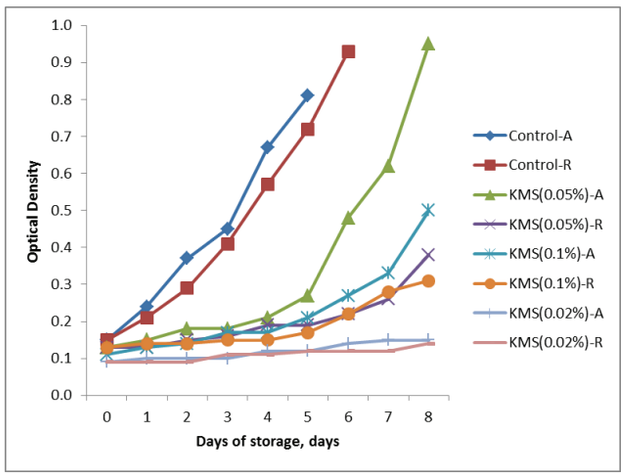

Figure 2. Effect of KMS on pH at different storage conditions and storage days.

3.4 pH Analysis by Digital pH Meter

In general, the pH of vegetables is relatively high, 5.5 to 6.5. A decrease in pH will not accepted by consumers [12]. pH of fresh sample was 5.45 and it ranged from 5.14 to 7.24 for treated samples. Samples when treated with concentration 0.2% KMS gave good result when compared to other concentrations (0.05 and 0.1%). The values varied from 5.14 to 6.09 in the ambient and 5.14 to 6.01 in the refrigerated condition. The pH range is given in Figure 2.

Similar trend of increase in pH was observed when pre-treated with Citric acid and Ascorbic acid at higher concentration (0.2 %) over 0.05 % and 0.1 % was noticed both at ambient and at refrigerated treatment. Recent studies on the preservation of cauliflower by using different concentrations and combinations of potassium metabisulphite (KMS) and citric acid cauliflower was used. They were steeped in 10 and 15 per cent salt solution containing 0.25% KMS were rated best among different treatments in maintaining better physico-chemical, sensory qualities and checking microbial growth [13].

3.5 Effect of Combinations of Chemicals on Colour of Diced Banana Central Core

Based on the colour and pH values obtained for the minimally processed banana central core treated with different concentrations of pre-treatments, it was concluded that the concentration 0.2% of KMS and AA was acceptable in preventing the enzymatic browning. Keeping this concentration (0.2 %), as the basis of treatment, the experiment was further designed with the following combinations 0.2 %

KMS, 0.2 % AA, 0.1% of KMS and 0.1% of AA, 0.1% KMS and 0.1% of CA, Control (No treatment).

The diced banana central core samples pre-treated with the above combination were stored at both ambient and refrigerated conditions. It was found that the samples treated with the combination of KMS and AA was better in colour. The colour value of the fresh sample treated with KMS and AA was increased high at ambient condition and low at refrigerated condition. Whereas, the colour value of the samples treated with the other combinations was not satisfactory when compared to the KMS an AA combinations. Table 2 showed the effect of colour on various combinations tried.

3.6 Effect of Combinations of Chemicals on pH of Diced Banana Central Core

Statistical analysis revealed that there was a significant interaction between pre-treatments with pH at different days of storage and storage conditions. The pH of vegetable should remain in the range of 5 to 6.5. Keeping this in mind, it is seen that the two pre-treatment of 0.2% KMS and KMS (0.1%) +AA (0.1%) helped to maintain this range of pH. In case of 0.2 % KMS, the pH range was in between 5.2 to 6.12 an in case of KMS (0.1%) +AA (0.1%), it ranged from 5.12 to 6.05. These two treatments was found to be suitable and considered as effective treatment. These results were showed in Figure 3.

3.7 Effect of Various Chemical Pre-Treatment Combinations on Microbial Load

On comparing the growth obtained for the samples treated with various combinations, it was found that the samples stored in refrigerated conditions has no growth till day 8, as the ambient has growth in it, as shown in Table 3. But the treatment AA (0.1%) + CA (0.1%) has more growth than other two, that too in refrigerated condition. Hence, the treatments KMS (0.2%) and KMS (0.1%) + AA (0.1%) are best in these combinations.

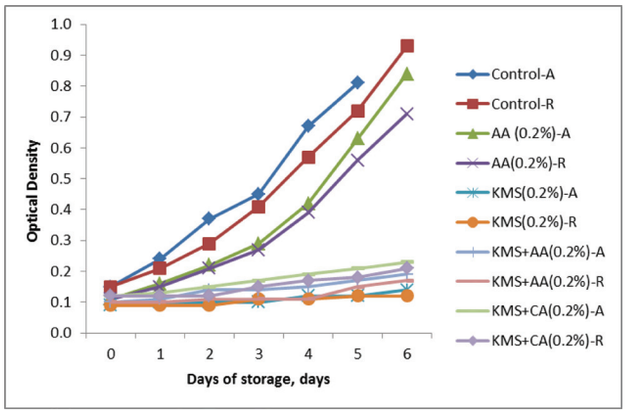

Figure 3. Effect of chemical preservatives on pH at different storage conditions and days of storage.

Among the best treatments, 0.2% KMS and the combination KMS (0.1%) + AA (0.1%) seemed to be the best as the colour value of the samples were under acceptable level till day 5 of refrigeration and day 4 of ambient condition respectively.

Hence, it was concluded that the treatments KMS (0.2%) and KMS (0.1%) + AA (0.1%) were the best for prevention of oxidation and thereby controls the browning of minimally processed banana central core. Based on the requirement, the end user can adopt either of the combination. At a temperature of 5+/-2˚C diced pumpkin treated with antimicrobial solution containing 0.2% citric acid and 0.1% potassium metabisulphite and stored under MAP conditions (packed in LDPE bags) could be stored in good condition for a period of 25 days with a minimum loss in micronutrient composition and staying microbial safe [8].

3.8 Textural Analysis of Banana Central Core

As a part of the experimentation, textural analysis study was taken up for central core of Karpooravalli variety. The probes such as P/5N needle and HSK blade were used for testing penetration and cutting strength, respectively for

Table 3. Microbial plate count for combined treatments for the samples

DAYS	CFU/g	CONTROL		AA (0.2%)		KMS (0.2%)		KMS (0.1%) + AA (0.1%)		KMS (0.1%) + CA (0.1%)	
		A	R	A	R	A	R	A	R	A	R
0	$\times 10^6$	TFTC	TFTC	NG	NG	NG	NG	NG	NG	NG	NG
2	$\times 10^6$	79	TFTC	39	NG	NG	NG	NG	NG	NG	NG
4	$\times 10^6$	127	TFTC	47	35	NG	NG	TFTC	NG	37	NG
6	$\times 10^6$	TNTC	TFTC	65	49	TFTC	NG	59	NG	63	NG
8	$\times 10^6$	TNTC	TNTC	163	97	TFTC	NG	102	NG	114	NG

CFU/g - Colony Forming Units/ gram of sample taken; NG- No Growth; TNTC- Too Numerous To Count; TFTC-Too Few To Count

Table 4. Effect of pre-treatments on sensory characteristics of vegetable from banana central core

S.No	Sample	Taste	Flavour	Color	Texture	Overall acceptability
1	Treated control	4.13c	4.19c	4.00c	4.13c	4.13c
2	Treated Ambient (3rd day)	3.75b	3.75b	3.94b	3.63b	3.81b
3	Treated and refrigerated (5th Day)	4.31d	4.19c	4.19d	4.13c	4.13c
4	Control (Fresh)	3.69a	3.69a	3.13a	3.44a	3.56a
	CD (0.05) (T)	0.0968	0.0839	0.0918	0.1442	0.1141

banana central core leaves. The crushing (50 and 75%) was done by using the P75 mm compression plate.

The average results of the texture analysis are as follows.

- Maximum force of penetration : 27 ± 2.56 N
- Maximum cutting force : 123 ± 4.24 N
- Maximum crushing for 50 percent: 340 ± 15.13 N
- Maximum crushing for 75 percent crushing: 430 ± 21.78 N

3.9 Sensory Evaluation

Consumer acceptability and satisfaction is an important criterion for any finished product. Sensory evaluation of the processed central core was done by a group of panel lists who were asked to evaluate the product by giving scores for appearance, colour, taste, flavour, odour and overall acceptability of the samples on the basis of a five point hedonic scale ranging from 'like extremely' to 'dislike extremely'. The details of the sensory evaluation was given in the Table 4.

The improvement in sensory quality of the Samples might be due to the treatments with chemicals as studied by S. C. Sgroppo *et al.* [12]. During storage, there were slight changes in physicochemical characteristics such as surface color and pH. The sensory attributes were rated as acceptable by consumers. It is reported that minimally processed and treated with suitable pre-treatments can be preserved, packaged and stored at 5°C for 14 days. Habibunnisa *et al.* [8] has studied that minimally processed vegetables in fresh, ready-to-cook form are gaining the confidence of both the trader and the consumer. This has led to a need to develop technology for increasing shelf life while maintaining the microbial, nutritional and sensory quality of minimally processed vegetables.

4. Conclusion

It could be concluded that the diced samples should be pre-treated with 0.2% KMS or KMS (0.1%) +AA (0.1%) to obtain the best results. The pre-treated samples had the best life of 3 days in ambient conditions and 5 days at refrigerated conditions. The sensory qualities were checked for the standardized treatments. The freshly treated and 5th day of the samples gave high score in overall acceptability. Also it tastes better than fresh control (untreated fresh sample). The set of minimal processing equipment developed by CIAE – IEP - NRCB could be effectively used for minimal processing of banana central core for saving cost and labour. The set of equipment will satisfy the scope of entrepreneurship development programme and women self-help groups, who are actively involved in such a processing criteria.

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