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Preparation and organoleptic evaluation of banana (cv. Rajapuri) pseudostem candy

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Abstract
The core of the banana pseudostem is most suitable for the preparation of the osmotically dehydrated candy. The banana (cv. Rajapuri) pseudostem candy was prepared and evaluated during both the year 2019-20 and 2020-21 at the laboratory, Department of Post-harvest Technology, KRC, College of Horticulture Arabhavi, Karnataka (India). The prepared candies were stored for 90 days under ambient storage conditions. The sensory parameters like colour and appearance, texture, taste and flavour and overall acceptability were evaluated by the semi-trained panel of judges using 9-point hedonic scale at initial and also at 30 days interval up to 3 months of storage. Among different treatments, banana pseudostem candies prepared by steam blanching of cubes for 2.5 minutes and steeping them in 40-60ºBrix syrup with the addition of pineapple flavour (T_6) recorded highest organoleptic scores for colour and appearance (7.88), texture (7.99), taste and flavour (8.11) and overall acceptability (8.15) after three months of storage compared to control, which recorded the lowest score for all the organoleptic parameters.

Keywords: Candy, pseudostem and organoleptic evaluation

Introduction
Banana (*Musa* spp.) is one among the world's most important tropical fruit crops and a member of the Musaceae family. It is thought to be one of the prime fruit crops cultivated by humans at the dawn of civilization. Cultivar Rajapuri belonging to the AAB group, is a popular local variety among North Karnataka growers and consumers. In addition to banana fruit production and processing, a large amount of biomass (pseudostem, flower, leaves and suckers) is also produced. After harvesting of bunches, the unwanted biomass left in the field is dumped as waste into lakes and rivers, burned or simply left on the bunds itself, contaminating the water sources and surrounding air, which ultimately affects the environment and the health of biological entities. As a necessary consequence, converting these waste banana pseudostem into value-added products could significantly benefit the environment and enhance their economic value. The use of such pseudostem not only helps to solve the disposable problem, but also creates wealth in terms of food, health, value-added products, additional income and employment opportunities.

One hectare of banana plantation can yield around 60-70 tonnes of pseudostem, considering an average of 20 kg of pseudostem from a single banana plant. On a fresh weight basis, central core constitutes around 10-15 per cent of the banana pseudostem, which is about 7-10 t/ha approximately.

Central core of the pseudostem is effective against parasites of the kidney and liver. The sap extracted from central core is a traditional remedy for kidney stones. There is a huge potential for many commercial edible products that could be developed from it. The banana pseudostem juice is also rich in calcium, potassium, sodium and magnesium, which are necessary for maintaining body fluid and electrolyte balance. Furthermore, the pseudostem has been utilized as food in many parts of India (Mohapatra *et al.*, 2010) [9]. The banana pseudostem is a rich source of nutrients, vitamins (B and C), minerals (potassium, sodium, calcium, magnesium, phosphorous, iron, zinc, boron and manganese) and phytochemical constituents (phenols, flavonoids, saponins, and total dietary fibre) possessing several health benefits (Ramu *et al*., 2017) [12].

Osmotic dehydration is an important technique of food preservation and processing in which foods *viz*., fruits and vegetables are immersed in the osmotic solution containing concentrated salt and sugar. The osmotic agent used may be fructose, corn syrup, glucose, sodium chloride

or sucrose. Cell membrane of fruits and vegetables works as semi permeable membrane which permits water to move from low concentrated fruits and vegetables to high concentrated osmotic solution. Comparing to other conventional methods, osmotic dehydration treatment is a simple procedure which requires no mechanical aid and involves decreased cost of energy. It is easy to perform at room temperature, which ensures the retention of colour, texture and nutrients (Hasannuzzaman *et al*., 2014).

Central core of the pseudostem is highly suitable for the preparation of the osmotically dehydrated candy because of its porous structure and quick uptake of the osmotic solution. Osmotic dehydration presents some benefits such as reducing the damage of heat to colour and flavour, inhibiting the browning enzymes and reducing the energy cost. Osmotic dehydration also resulted in increased shelf-life, little loss of aroma in dried and semi-dried foodstuffs (Khan, 2012) [8]. So, considering all the points, the present study was carried out to standardize the protocol for preparation of the banana pseudostem candy and to do its organoleptic evaluation.

Material and methods

The pseudostems from healthy banana cv. Rajapuri plants, which are free from damage was collected immediately after harvesting of the bunch from the field of ICAR- AICRP on Fruits, KRC College of Horticulture, Arabhavi, Gokak, Belguam (Karnataka).

Banana pseudostems were washed thoroughly with tap water to remove the dirt and adhering soil. The pseudostems were split by a sharp stainless steel knife and the cores were taken out and washed again. The cores were cut horizontally into wheels and fibrous outer skin was removed using stainless steel knife and weighed on the electric balance. Immediately these core wheels were immersed in 0.2 per cent potassium meta bi-sulphate for an hour to reduce browning, later wheels were taken out and blanched for 2.5 minutes as per the treatments and soon after blanching dipped in cold water to avoid over cooking. In case of steam blanching treatments, cubes were blanched with steam using pressure cooker and after blanching for 2.5 minutes, cubes were cooled to room temperature.

Blanched pseudostem core wheels were pricked and steeped in sugar syrup (40ºB) with the addition of citric acid (1%). After 24 hours of steeping in syrup, core wheels were strained out from syrup and the degree Brix of sugar syrup was raised to 50ºB with the addition of sugar and boiling the syrup. After cooling, the core wheels were immersed back in the syrup for another 24 hours. The next day the same process was repeated and the degree Brix of sugar syrup was raised to 60ºB, then pineapple flavour (1%) was added (according to treatments) to the syrup and left for 24 hours. After that wheels were strained out of sugar syrup using a strainer and were cut horizontally and vertically into small cubes to give the desired shape by removing unattractive parts. Cubes were slightly washed with RO water to remove the excess syrup to avoid stickiness during drying and then the cubes were dried at 60ºC using an electric tray drier for 6 hours. Dried cubes were weighed and then packed in aluminium pouches with a proper label. Packed candies were stored in ambient conditions for storage studies. organoleptic properties of pseudostem candy were evaluated initially and also at every 30 days interval up to 90 days of storage.

Treatment details

The experiment was laid out in a completely randomized design (CRD) with 6 treatments and 4 replications. Consisting of the following treatments.

T_1: Without blanching + steeping in 40-60ºBrix syrup
T_2: Blanching for 2.5 min. + steeping in 40-60ºBrix syrup
T_3: Steam Blanching for 2.5 min. + steeping in 40-60ºBrix syrup
T_4: Without blanching + steeping in 40-60ºBrix syrup + pineapple flavour
T_5: Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour
T_6: Steam Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour

Organoleptic evaluation

Organoleptic evaluation of pseudostem candy was done at initial and at monthly intervals up to 3 months of storage. It was carried out by a semi-trained panel of judges consisting of teachers and post-graduate students of Kittur Rani Channamma College of Horticulture, Arabhavi. The panelists evaluated the sensory characters like colour and appearance, texture, taste and flavour and overall acceptability of the banana pseudostem candy prepared according to different treatment combinations using a nine point hedonic scale with scores ranging from 9-1 according to their preferences (Like extremely- dislike extremely respectively) in an individual booth with day light under ambient conditions. The average of the scores were calculated and the mean scores were tabulated according to the individual sensory character of the banana pseudostem candy. Table 1 shows the score card used for the present study (Ranganna, 2003) [13].

Table 1: Score card

Hedonic scale	Colour and appearance	Texture	Taste and flavour	Overall acceptability
Like extremely	9	9	9	9
Like very much	8	8	8	8
Like moderately	7	7	7	7
Like slightly	6	6	6	6
Neither like nor dislike	5	5	5	5
Dislike slightly	4	4	4	4
Dislike moderately	3	3	3	3
Dislike very much	2	2	2	2
Dislike extremely	1	1	1	1

Statistical analysis

The data recorded on the organoleptic parameters of the banana pseudostem candy were subjected to statistical analysis in a Completely Randomized Design. Analysis was done by using Web Agri. Stat. Package 2 developed by ICAR research complex, Goa. Interpretation of the data was carried out in accordance with Panse and Sukhatme (1985) [11]. The level of significance used in 'F' test was p = 0.01. Critical difference values were calculated wherever 'F' test was significant. The data on organoleptic evaluation of banana pseudostem candy was recorded during two consecutive years (2019-2020 and 2020-2021) were pooled and the results are presented here.

Results and Discussion

Organoleptic evaluation of any product is a must in order to know about the consumer acceptability of the product and to

understand the product better for further improvement. Organoleptic evaluation is a scientific method that provides objective information on how products are experienced by the consumer. It can be used to assess food and beverage beyond regulatory requirements or general safety and quality concerns, using the human senses and statistical analysis to record insights. Sensory analysis has become increasingly accepted as a standard component of food testing. More and more, it is viewed as imperative for helping to ensure the quality and market success of food products. Organoleptic evaluation of the banana pseudostem candy was done at initial and at monthly intervals during 90 days of ambient storage. There was a significant difference in scores were recorded for all the organoleptic parameters between treatments at all intervals of storage (Table 2 and 3). Results obtained in this study were in accordance with Desai *et al*. (2016) [2] in flavoured candy from banana pseudostem and Jeethendra (2020) in pseudostem candy.

Table 2: Changes in the colour and appearance and texture (score out of 9.00) of the banana pseudostem candy as influenced by different treatments and storage period

Treatments	Colour and appearance				Texture			
	Days after storage							
	Initial	30	60	90	Initial	30	60	90
T_1	6.24	6.07	5.92	5.81	6.34	6.10	5.99	5.84
T_2	7.67	7.57	7.49	7.38	7.67	7.59	7.51	7.43
T_3	7.90	7.82	7.74	7.64	8.20	8.11	7.93	7.85
T_4	6.65	6.50	6.36	6.21	6.41	6.20	6.08	5.93
T_5	8.05	7.90	7.87	7.80	7.93	7.78	7.68	7.54
T_6	8.29	8.10	7.95	7.88	8.38	8.24	8.08	7.99
Mean	7.47	7.32	7.22	7.12	7.49	7.33	7.21	7.09
S.Em±	0.04	0.04	0.03	0.05	0.05	0.04	0.04	0.08
C.D. @ 1%	0.16	0.17	0.13	0.20	0.18	0.16	0.16	0.30

T_1: Without blanching + steeping in 40-60ºBrix syrup
T_2: Blanching for 2.5 min. + steeping in 40-60ºBrix syrup
T_3: Steam Blanching for 2.5 min. + steeping in 40-60ºBrix syrup
T_4: Without blanching + steeping in 40-60ºBrix syrup + pineapple flavour
T_5: Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour
T_6: Steam Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour

The organoleptic score for the colour and appearance of the banana pseudostem candy was recorded highest (8.29, 8.10, 7.95 and 7.88) in T_6 (Steam Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour) at all intervals. It was followed by T_5 (Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour) at initial and 30 DAS (8.05 and 7.90 respectively), whereas after 60 and 90 DAS, it was on par with T_5 (7.87 and 7.80 respectively) under ambient conditions. Comparatively lowest scores (6.24, 6.07, 5.92 and 5.81) were registered in T_1 (Without blanching + steeping in 40-60ºBrix syrup) at initial, 30, 60 and 90 days after storage respectively. The candy prepared from blanching treatments has retained an attractive colour and appearance compared to control treatments (T_1 and T_4). The changes in the scores for colour and appearances of the candy during storage (Table 2) may be attributed to the non- enzymatic browning reactions occurring in the candy and also may be due the oxidation of the chemical compounds or ingradients present in the candy caused them to lower their attractiveness to little extent throughout 90 days of storage under ambient conditions. Similar results were recorded by Harshitha (2018) [4] in pumpkin candy, stored under ambient conditions for 90 days pseudostem and Jeethendra (2020) in candy. The maximum scores (8.38, 8.24, 8.08 and 7.99) for the texture of the banana pseudostem candy was observed in T_6 (Steam Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour) and it was found to be on par with T_3 (8.20, 8.11, 7.93 and 7.85) compared to the minimum score (6.34, 6.10, 5.99 and 5.84) in T_1 (Without blanching + steeping in 40-60ºBrix syrup) at all intervals. The steam blanching treatments (T_6 and T_3) has retained the good texture compared to water blanched (T_2 and T_5) treatments and no blanched treatments (T_1 and T_4). Changes in the scores for the texture of the pseudostem candy after storage (Table 2) may be attributed to the degradation of pectic substances and other cellular components in the candy and also might be due to moisture absorption by packaging material used (Sharma *et al*., 2004). Statistically, top scores (8.38, 8.29, 8.21 and 8.11) and (8.29, 8.12, 7.99 and 7.88) for the taste and flavour of the banana pseudo stem candy at all intervals of storage was recorded in the treatments T_6 (Steam Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour) and T_5 (Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour) respectively. Where, the addition of pineapple flavour was done compared to the other treatments without the addition of pineapple flavour. The lowest score (6.18, 6.01, 5.84 and 5.62) for the taste and flavour noticed in T_1 (Without blanching + steeping in 40-60ºBrix syrup) at initial, 30, 60 and 90 days after storage. The addition of pineapple flavour certainly increased the taste and flavour of the candies and was most preferred by the panelists during organoleptic evaluation. Similar observations were made by Desai *et al*. (2016) [2] in candy prepared from banana pseudostem with artificial flavours like mango, pineapple, orange and lemon flavors and by Jeethendra (2020) in pseudostem candy which was flavoured with natural pineapple fruit juice. The scores for the overall acceptability of the banana pseudostem candies were significant between treatments and decreased slightly during each passing storage interval (Table 3). The flavoured candies (T_6, T_5 and T_4 respectively) got higher scores for the overall acceptability than the other non-flavoured candies (T_3, T_2 and T_1 respectively) at all intervals. The overall acceptability score was statistically peak in T_6 (8.43, 8.31, 8.23 and 8.15) and T_5 (8.28, 8.16, 8.07 and 7.97). Whereas, the lowest scores for overall acceptability was recorded in T_1 (6.28, 6.08, 5.98 and 5.80) at initial, 30, 60 and 90 days after storage.

Table 3: Changes in the taste and flavour and overall acceptability (score out of 9.00) of the banana pseudostem candy as influenced by different treatments and storage period

Treatments	Taste and flavour				Overall acceptability			
	Days after storage							
	Initial	30	60	90	Initial	30	60	90
T_1	6.18	6.01	5.84	5.62	6.28	6.08	5.98	5.80
T_2	7.12	6.97	6.84	6.71	7.88	7.78	7.68	7.60
T_3	7.38	7.26	7.16	7.06	8.07	7.97	7.85	7.75
T_4	6.68	6.50	6.34	6.17	6.43	6.28	6.16	6.02
T_5	8.29	8.12	7.99	7.88	8.28	8.16	8.07	7.97
T_6	8.38	8.29	8.21	8.11	8.43	8.31	8.23	8.15
Mean	7.34	7.19	7.06	6.92	7.56	7.43	7.32	7.22
S.Em±	0.05	0.05	0.08	0.06	0.05	0.05	0.04	0.05
C.D. @ 1%	0.18	0.20	0.30	0.24	0.20	0.21	0.16	0.20

T_1: Without blanching + steeping in 40-60ºBrix syrup
T_2: Blanching for 2.5 min. + steeping in 40-60ºBrix syrup
T_3: Steam Blanching for 2.5 min. + steeping in 40-60ºBrix syrup
T_4: Without blanching + steeping in 40-60ºBrix syrup + pineapple flavour
T_5: Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour
T_6: Steam Blanching for 2.5 min. + steeping in 40-60ºBrix syrup + pineapple flavour

The scores for all the organoleptic parameters decreased gradually as the storage progressed. The decreasing trend in the mean scores in colour and appearance (7.47 to 7.12), texture (7.49 to 7.09), taste and flavour (7.34 to 6.92) and overall acceptability (7.56 to 7.22) after 90 days of storage can be witnessed. The similar decreasing trend in the organoleptic scores were also obtained in apricot osmotic dehydration (Sharma *et al*., 2004) [14]; in pumpkin candy (Muzzaffar, 2006) [10]; in osmotically dehydrated papaya cubes (Ankita *et al*., 2014) [1]; in strawberry osmotic dehydration (Khan *et al*., 2014) [7] in osmotic dehydration of wild pear slices (Devi, 2014) [3]; in dried carrot slices (Sra *et al*., 2014) [15] and in pumpkin candy (Harshitha, 2018) [4].

Conclusion

Based on the results gathered from this investigation it can be concluded that, the blanching and the addition of pine apple flavour could significantly increase the organoleptic scores for the colour and appearance, texture, taste and flavour and over all acceptability of the banana pseudostem candy. Steam Blanching of cubes for 2.5 min. and steeping in 40-60ºBrix syrup with addition of pineapple flavour proved to be the best protocol for the preparation of banana pseudostem candy with higher overall acceptability.

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