LS - An International Journal of Life Sciences
DOI: 10.5958/2319-1198.2018.00021.0

Development and Standardisation of Banana Pseudostem Based Novel Functional Blended Ready to Drink (RTD) Beverages and Studies Nutritional Changes during Storage

K.N. Shiva[1], P. Adiyaman[2]*, Ravindra Naik[3] and N. Marimuthu[4]

[1]Principal Scientist, [2]Senior Research Fellow, [4]Technical Assistant, Department of Post Harvest Technology, ICAR-National Research Centre for Banana (NRCB), Tiruchirappalli, Tamil Nadu, India
[3]Principal Scientist, ICAR-Central Institute of Agricultural Engineering, Regional Centre, Coimbatore, Tamil Nadu, India
*Corresponding author email id: adhiyaman1984@gmail.com

Received: 9-6-2018; Accepted: 23-9-2018

ABSTRACT

Banana pseudostem contributes about 30% of the total plant biomass which contains significant amount of minerals. The aim of the present investigation was to study the development and standardisation of functional ready to drink (RTD) banana pseudostem beverages using ginger rhizome and nannari root extracts and study their storage stability up to 6 months under ambient temperature and 13.5°C. Ginger rhizome and nannari root extracts at the concentration of 4% were found to be appropriate for the preparation of ginger and nannari-flavoured RTD banana pseudostem beverages. Nutrients analysis revealed that the flavoured RTD banana pseudostem beverages had significant amount of nutrients, namely total sugar (10.62 to 10.83 g/100 ml), total Carbohydrate (CHO) (13.92 to 16.08 g/100 ml), vitamin 'C' (0.673 to 0.707 mg/100 ml), sodium (0.920% to 0.935%), potassium (8.13% to 8.30%), zinc (1.034 to 1.117 ppm), copper (0.9183 to 0.9190 ppm) and manganese (0.9544 to 1.0144 ppm). After 6 months of storage, the drink blended with ginger rhizome extract was found best in terms of nutrient retention and colour and appearance, flavour, consistency, taste and overall acceptability followed by nannari-flavoured banana pseudostem RTD beverages.

Keywords: Banana pseudostem, Ginger rhizome, Nannari root, RTD beverages, Storage, Nutrients and Sensory characteristics

INTRODUCTION

Banana is the common name for herbaceous plants of the genus *Musa*. It is one of the most prominent tropical fruits consumed worldwide by the people of all age groups. Banana is being cultivated in more than 120 countries along the tropical and sub-tropical regions of the world (Sharrock and Frison (1998); Aurore *et al.*, 2009). The major banana producing countries of the western hemisphere are Brazil, Colombia, Ecuador, Mexico, Honduras, Costa Rica and Venezuela. The top banana growing countries in the eastern hemisphere are India, Philippines, Indonesia, Thailand, Taiwan, Tanzania, Vietnam, Uganda and Rwanda (Sharrock and Frison, 1998). India is the largest producer of banana in the world with a total area of approximately 0.8 metric hectares and an annual production of 29.16 MT. The important states producing banana in India are Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra and Gujarat. The

How to cite this article: K.N. Shiva, P. Adiyaman, Ravindra Naik and N. Marimuthu, 2018. Development and Standardisation of Banana Pseudostem Based Novel Functional Blended Ready to Drink (RTD) Beverages and Studies Nutritional Changes during Storage. *LS - An International Journal of Life Sciences,* Vol. 7, No. 3, pp. 151-158.

total area under banana cultivation in Tamil Nadu is 118.04 ha with a production of 5.65 MT (National Horticulture Board, Ministry of Agriculture, Government of India, 2014).

After harvesting, approximately 25–30 T of banana pseudostem waste are produced, which are common for making compost, vermin-compost and vermin-wash. Only negligible amount was contributed in diet. The scotching waste can be used for making handmade paper, particle boards, stationery items, briquettes and so on. However, most of them became wasted and also creates major agro-waste problem and environmental nuisance. The banana pseudostem has been reported to contain high-quality starch including digestible and non-digestible (resistant) starch (Ho *et al.*, 2012). The banana pseudostem juice also contains rich amount of calcium, potassium, sodium, magnesium and chlorides; all of them are essential for maintaining body fluid and electrolyte balance. Moreover, in many parts of India, the banana pseudostem has been used as food (Mohapatra *et al.,* 2010). These results confirmed that the banana pseudostem juice could be used as a raw material in the preparation of isotonic drink.

At present, the people's food habits are significantly changing towards the natural and safer drinks in comparison with synthetic or aerated drinks. The acceptability of fruit beverages may be improved further by blending two or more different fruits pulp or natural flavours. In general, consumers gave more preference for banana pseudostem juice due to high nutritional and medicinal properties especially minerals. Blending of banana pseudostem juice with other natural flavours is another area, which not only improving nutrients (vitamins and minerals) and also enhancing flavour, taste and pleasant.

Ginger rhizome (*Zingiber officinale*) and nannari roots (*Hemidesmus indicus*) are the most common aromatics used as flavouring and seasoning compounds in many food and food products. The pungency of ginger is mainly due to volatile oil and chemical compounds, especially gingerols (Baranowski, 1985; Pezzutti and Crapiste, 1997). A number of microbial studies confirmed that the antimicrobial and antibacterial properties of gingerols are present in ginger, and also they found that these compounds are the effective on inhibition of the growth of Bacillus subtilis, Escherichia coli and Mycobacterium sp. (Yamada *et al.*, 1992; Galal, 1996).

The therapeutic action of the nannari root extracts are because of presence of major chemical constituents like coumarinolignoids hemidesmine and hemidesmin. These extracts are used as a coolant and a blood purifier. Various effects of nannari, such as hypoglycaemic (Murshed *et al.*, 2005), hypolipidaemic (Bopanna *et al.*, 1997), antioxidant and anti-thrombotic (Mary *et al.*, 2003), anti-inflammatory (Lampronti *et al.*, 2008), anti-ulcerogenic (Anoop and Jegadeesan, 2003), hepatoprotective (Prabakan *et al.*, 2000), renoprotective (Kotnis *et al.*, 2004) and neutralisation of viper venom (Alam *et al.*, 1996) have been reported. The extracts of nannari roots along with barks of *Ficus bengalensis* and *Pterocarpus marsupium* Roxb. showed excellent antimicrobial activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* (Gayathri and Kannabiran, 2009). In the view of this, the ginger rhizome and nannari root extracts can be used as a natural food flavouring, preservative, easy and safe addition in fruits and vegetables products. Therefore, the present investigation was undertaken to standardise the ginger and nannari-flavoured ready to drink (RTD) banana pseudostem beverages and study their physico-chemical and nutrients changes during storage at ambient temperature of 13.5°C.

MATERIALS AND METHODS

Raw Material

The banana pseudostem was procured from the central farm of National Research Center for Banana, Tiruchirappalli, Tamil Nadu, India. Immediately after collecting the banana pseudostem, it was brought to the laboratory and kept in 13.5°C before further processing.

Preparation of Flavouring Extracts

Fifty grams of fresh ginger rhizome was washed, sliced into small pieces and crushed (mixer and grinder). The ginger rhizome extracts were obtained by hand squashing and filtered through muslin cloth. For nannari root

extracts, the equal quantity of water was added with fresh nannari roots, boiled and their extracts were filtered using muslin cloth. These extracts were kept in refrigerated temperature (4°C) for 1 h and decanted the clear extracts. The ginger rhizome and nannari root extracts at the concentration of 4% were used as flavouring agents in the preparation of flavoured banana pseudostem RTD beverages.

Preparation of Flavoured Ready to Drink (RTD) Banana Pseudostem Beverages

The banana pseudostem was sliced into small pieces, washed and crushed using mixer and grinder. The juice was extracted by squeezing and filtered through double-fold cheese cloth. Subsequently, the filtered juice was kept at refrigerated condition (4°C) for 1 h, decanted cleared juice and diluted into 1:1 using sterilised/reverse osmosis water. The sugar and citric acid required for RTD beverage preparation were calculated as per the fruit product order specification. The prepared RTD banana pseudostem beverages were heated up to 85°C. After reached the pasteurisation temperature, the flavouring extracts were added and maintained the same temperature between 2 and 3 min. Then the flavoured RTD banana pseudostem beverages were cooled to below 55°C, mixed with preservative potassium metabisulfite (KMS), packed in sterilised glass bottles with a capacity of 150 ml leaving a head space of 2 cm and crown corked air tightly. The crown corked RTD beverage bottles were steeped in boiling water for 30 min and stored at ambient temperature and 13.5°C.

Assessing Physico-Chemical Analysis

The change in the physico-chemical and nutritional composition of flavoured RTD banana pseudostem beverages were subjected to analysis at regular interval period of 30 days, namely total soluble solids (TSS) and titratable acidity Saini *et al.* (2001), total sugar, total CHO and starch (Ranganna (1995), ascorbic acid AOAC (1997), minerals, namely sodium and potassium (Summer, 1994), zinc, copper and manganese (Lindsay and Norvell, 1978) and organoleptic characteristics, namely colour and appearance, flavour, consistency, taste and overall acceptability (Watts *et al.*, 1989).

Statistical Analysis

The obtained data were subjected to statistical analysis to find out impact of storage temperature and storage periods on retention of nutrient contents in flavoured RTD banana pseudostem beverages. Factorial completely randomised design was applied for the analysis of the study as described by Rangaswamy (1995).

RESULT AND DISCUSSION

Proximate Composition

Table 1 indicated the results acquired for the chemical analysis of the flavoured and non-flavoured (control) RTD banana pseudostem beverages. Initially, the TSS and titratable acidity of ginger and nannari flavoured and control RTD banana pseudostem beverages were adjusted to 12°Bx and 0.2% and kept as a constant. The chemical analysis of control pseudostem beverages showed higher amount of total sugar (11.07 g/100 ml), total CHO (16.08 g/100 ml), vitamin 'C' (0.736 mg/100 ml) and sodium (1.015%) compared with ginger and nannari-flavoured pseudostem beverages. Among the flavoured pseudostem beverages, the ginger-flavoured pseudostem beverages had significant amount of total sugar (10.83 g/100 ml),

Table 1: Proximate composition of flavoured and non-flavoured (control) ready to drink (RTD) banana pseudostem beverages

Proximate Composition	Treatments		
	Control (Non-Flavoured)	Ginger Flavoured	Nannari Flavoured
TSS (°Bx)	12.0±0.304	12.0±0.158	12.0±0.257
Titratable acidity (%)	0.2±0.004	0.2±0.004	0.2±0.005
Total sugar (g/100 ml)	10.83±0.195	10.62±0.096	11.07±0.190
Total CHO (g/100 ml)	16.08±0.198	14.12±0.136	13.92±0.124
Vitamin 'C' (mg/100 ml)	0.673±0.001	0.707±0.011	0.736±0.006

total CHO (14.12 g/100 ml), sodium (0.935%), potassium (8.30%), zinc (1.117 ppm/100 ml), copper (0.9190 ppm/100 ml) and manganese (1.0144 ppm/100 ml) followed by nannari-flavoured pseudostem beverages. At the same time, vitamin 'C' content (0.673 mg/100 ml) was found slightly lower amount in ginger-flavoured pseudostem beverages than nannari-flavoured pseudostem beverages.

Total Soluble Solids (TSS) and Titratable Acidity

The TSS and titratable acidity were presented in Tables 2 and 3. The experimental results showed that the TSS content of flavoured and control RTD pseudostem beverages increased with the increased storage period, whereas a gradual decrease in titratable acidity was found in all the treatments. The changes in TSS (12°Bx to 13.8°Bx) and titratable acidity (0.2% to 0.152%) were found to be highest in control pseudostem beverages followed by nannari and ginger-flavoured pseudostem beverages. But the changes in TSS (12°Bx to 13.0°Bx) and titratable acidity (0.2% to 0.168%) were minimum in ginger-flavoured pseudostem beverages during storage at ambient temperature and 13.5°C. This may be due to the active compounds of ginger (gingerols), which act as a preservative and minimise the oxidation reactions. All the treatments stored in 13.5°C condition showed minimum changes in TSS and titratable acidity compared with ambient condition. The decrease in the titratable acidity might be due to utilising acids for hydrolysing of polysaccharides into simple sugar during storage. Similar increase in TSS of papaya juice and aloe vera-based RTS beverage (12 °Bx to 13.3 °Bx) during storage has been reported by Boghani *et al.* (2012). The decrease in titratable acidity during storage was also observed by Jain *et al.* (2003) in anola juice blended with natural antioxidant (spice extract).

Table 2: Changes in the TSS (°Bx) of flavoured and non-flavoured (control) ready to drink (RTD) banana pseudostem beverages during storage

Treatments	Storage Temperatures	Storage Periods (Months)						
		Initial	1	2	3	4	5	6
Control (non-flavoured)	RT	12.0	12.0	12.0	12.4	12.8	13.2	13.8
	13.5°C	12.0	12.0	12.0	12.2	12.6	12.8	13.0
Ginger flavoured	RT	12.0	12.0	12.0	12.4	12.6	12.8	13.0
	13.5°C	12.0	12.0	12.0	12.0	12.2	12.2	12.4
Nannari flavoured	RT	12.0	12.0	12.0	12.4	12.6	13.0	13.4
	13.5°C	12.0	12.0	12.0	12.0	12.4	12.4	12.6
CD at 5%	Treatments (T): 0.054; Storage temperatures (S): 0.044; Storage periods (M): 0.082; TS: NS; SM: 0.116; TM: 0.142; TSM: NS							

RT – Ambient temperature

Table 3: Changes in the titratable acidity (%) of flavoured and non-flavoured (control) ready to drink (RTD) banana pseudostem beverages during storage

Treatments	Storage Temperatures	Storage Periods (Months)						
		Initial	1	2	3	4	5	6
Control (non-flavoured)	RT	0.2	0.2	0.192	0.184	0.165	0.158	0.152
	13.5°C	0.2	0.2	0.2	0.198	0.184	0.182	0.178
Ginger flavoured	RT	0.2	0.2	0.196	0.190	0.188	0.172	0.168
	13.5°C	0.2	0.2	0.2	0.198	0.192	0.190	0.184
Nannari flavoured	RT	0.2	0.2	0.196	0.188	0.182	0.166	0.162
	13.5°C	0.2	0.2	0.2	0.198	0.192	0.188	0.180
CD at 5%	Treatments (T): 0.001; Storage temperatures (S): 0.0009; Storage periods (M): 0.002; TS: 0.002; SM: 0.002; TM: 0.003; TSM: NS							

RT – Ambient temperature

Total Sugar and Total CHO

Results pertaining to total sugar and CHO changes during storage revealed that the total sugar and CHO decreased gradually in flavoured and control pseudostem beverages during storage at ambient temperature and 13.5°C (Figures 1 and 2). The initial total sugar and CHO content of ginger and nannari-flavoured pseudostem beverages were found to be 10.83 and 14.12 g/100 ml and 10.62 and 13.92 g/100 ml, which decreased slowly to 10.55 and 13.78 g/100 ml in ginger-flavoured pseudostem beverages and 10.30 and 13.70 g/100 ml in nannari-flavoured pseudostem beverages compared with control. Among the ginger and nannari-flavoured pseudostem beverages, the nannari-flavoured pseudostem beverages recorded highest changes of total sugar and total CHO at the end of 180 days storage at ambient temperature and 13.5°C. A minimum changes in total sugar and total CHO were found when all the samples stored at 13.5°C compared with ambient temperature. The decrease in the total sugar might be due to the increase in soluble solids content caused by hydrolysing of total sugar into simple sugar during storage. Similarly, the total sugar content of jackfruit RTS was decreased from 15.67% to 14.49% at the end of 6 months storage (Krishnaveni, 1998). Sivakumar (2004) also observed decreasing trend of total sugar content (13.12 to 12.81 g/100 ml) in mango RTS at the end of 270 days storage in ambient temperature.

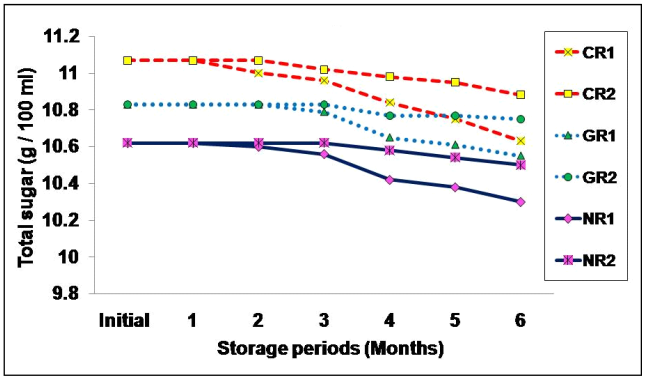

Figure 1: Changes in the total sugar content of flavoured and non-flavoured (control) ready to drink (RTD) banana pseudostem beverages during storage

C – Control (Non-flavour; **G** – Ginger flavour; **N** – Nannari flavour, **R1** – Ambient temperature; **R2** – 13.5°C

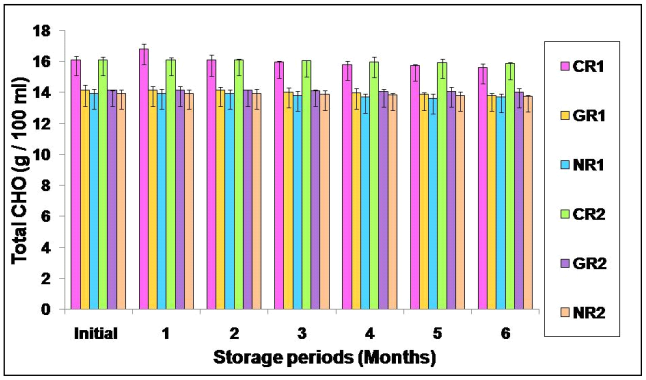

Figure 2: Changes in the total CHO content of flavoured and non-flavoured (control) ready to drink (RTD) banana pseudostem beverages during storage

C – Control (Non-flavour; **G** – Ginger flavour; **N** – Nannari flavour, **R1** – Ambient temperature; **R2** – 13.5°C

Vitamin 'C'

Table 4 indicated the values of vitamin 'C' content at initial stage and at different storage intervals for different treatments. There was a gradual decrease in vitamin 'C' content with the extension of storage periods, and this decrease was found to be highest (0.736 to 0.508 mg/100 ml) in control pseudostem beverages followed by flavoured pseudostem beverages. The highest values for vitamin 'C' (0.640 mg/100 g) after 6-month storage at ambient temperature and 13.5°C were recorded in ginger-flavoured pseudostem beverages. Among the ambient temperature and 13.5°C, the samples stored at 13.5°C recorded maximum retention of vitamin 'C' in all the treatments at the end of 180 days storage. The result of the present study agreed with that of Karuna *et al.* (2005), who found considerable loss of ascorbic acid in litchi beverages during storage. The ascorbic acid content of Nagpur mandarin (*Citrus reticulata* Blanco) juice was reduced from 31.6 to 22.30 mg/100 ml after a 6-month storage in ambient temperature (Pareek *et al.*, 2011).

Mineral Content

The initial and final mineral content of flavoured and control pseudostem beverages are presented in Figure 3 and Table 5. Initially, ginger-flavoured pseudostem beverages had slightly highest amount of potassium (8.30%), zinc (1.117 ppm/100 ml), copper (0.919 ppm/100 ml) and manganese (1.0144 ppm/100 ml), whereas the sodium content (1.015%) was found to be highest in

Table 4: Changes in the vitamin 'C' (mg/100 ml) of flavoured and non-flavoured (control) ready to drink (RTD) banana pseudostem beverages during storage

Treatments	Storage Temperatures	Storage Periods (Months)						
		Initial	1	2	3	4	5	6
Control (non-flavoured)	RT	0.736	0.730	0.700	0.656	0.630	0.565	0.508
	13.5°C	0.736	0.736	0.724	0.706	0.690	0.672	0.633
Ginger flavoured	RT	0.673	0.671	0.664	0.656	0.645	0.631	0.616
	13.5°C	0.673	0.673	0.670	0.664	0.657	0.648	0.640
Nannari flavoured	RT	0.707	0.703	0.695	0.682	0.665	0.642	0.625
	13.5°C	0.707	0.707	0.704	0.695	0.683	0.675	0.662
CD at 5%	Treatments (T): 0.003; Storage temperatures (S): 0.002; Storage periods (M): 0.004; TS: 0.004; SM: 0.006; TM: 0.008; TSM: 0.011							

RT – Ambient temperature.

Table 5: Changes in the micro-nutrients content (ppm/100 ml) of flavoured and non-flavoured (control) ready to drink (RTD) banana pseudostem beverages during storage

Treatments	Storage Temperatures	Micro-Nutrients (ppm/100 ml)					
		Zinc		Copper		Manganese	
		Initial	Final	Initial	Final	Initial	Final
Control	RT	0.890	0.883	0.9165	0.9158	1.0004	0.9996
	13.5°C	0.890	0.886	0.9165	0.9162	1.0004	1.0000
Ginger flavoured	RT	1.117	1.114	0.9190	0.9187	1.0144	1.0140
	13.5°C	1.117	1.116	0.9190	0.9188	1.0144	1.0142
Nannari flavoured	RT	1.034	1.029	0.9184	0.9180	0.9544	0.9538
	13.5°C	1.034	1.032	0.9184	0.9182	0.9544	0.9541
CD at 5%	Treatments (T): 0.009; Storage temperatures (S): NS; Storage periods (M): NS; TS: NS; SM: NS; TM: NS; TSM: NS						

RT – Ambient temperature; I – Initial; F – Final

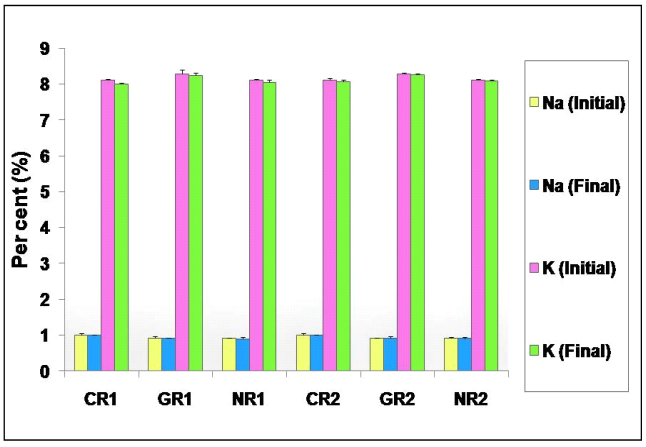

Figure 3: Changes in the sodium and potassium content of flavoured and non-flavoured (control) ready to drink (RTD) banana pseudostem beverages during storage
C – Control (Non-flavour; **G** – Ginger flavour; **N** – Nannari flavour, **R1** – Ambient temperature; **R2** – 13.5°C

control pseudostem beverages. The nannari-flavoured pseudostem beverages also contained significant amount of zinc (1.034 ppm/100 ml) and copper (0.9184 ppm/100 ml), but it is slightly low compared with ginger-flavoured pseudostem beverages. Potassium content (8.12% and 8.13%) was found similar in control and nannari-flavoured pseudostem beverages, but a little highest content of manganese (1.0004 ppm/100 ml) was observed in control pseudostem beverages than nannari-flavoured pseudostem beverages (0.9544 ppm/100 ml). At the end of 6 months storage, only negligible loss of mineral content was obtained in all the treatments. The present study also found the storage temperatures and treatments were not major impact on the mineral content of banana pseudostem beverages throughout the study periods.

Table 6: Changes in the organoleptic evaluation of flavoured and non-flavoured (control) ready to drink (RTD) banana pseudostem beverages during storage

Treatments	Storage Temperatures	Organoleptic Evaluation									
		Colour and Appearance		Taste		Consistency		Flavour		Overall Acceptability	
		I	F	I	F	I	F	I	F	I	F
Control	RT	8.0	7.4	7.5	6.8	7.0	6.8	7.0	6.4	7.38	6.85
	13.5°C	8.0	7.8	7.5	7.0	7.0	7.0	7.0	6.8	7.38	7.15
Ginger flavoured	RT	9.0	9.0	8.5	8.3	7.5	7.5	8.5	8.0	8.38	8.20
	13.5°C	9.0	9.0	8.5	8.4	7.5	7.5	8.5	8.3	8.38	8.30
Nannari flavoured	RT	8.5	8.2	8.5	8.0	7.5	7.5	8.0	7.3	8.13	7.75
	13.5°C	8.5	8.5	8.5	8.3	7.5	7.5	8.0	7.8	8.13	8.03

RT – Ambient temperature; I – Initial; F – Final.

Organoleptic Evaluation

The sensory quality of flavoured and control pseudostem beverages were analysed once in 30 days such as colour and appearance, flavour, consistency, taste and overall acceptability. The mean score obtained for each attributes is given in Table 6. Initially and finally, the ginger-flavoured pseudostem beverages had highest organoleptic scores, namely colour and appearance (9.0 and 9.0), flavour (8.5 and 8.0), consistency (7.5 and 7.5), taste (8.5 and 8.3) and overall acceptability (8.38 and 8.20) followed by nannari-flavoured and control pseudostem beverages. This is mainly because the ginger flavour was extensively accepted by majority of the consumers, and it enhances the juice colour and also gives pleasant aroma, whereas the control pseudostem beverages had considerable loss of sensory quality at the end and 180 days storage at ambient temperature of 13.5°C. Among the storage conditions, statistically significant loss of sensory qualities was observed in all the treatments, especially colour and appearance, flavour and taste. Nevertheless, the maximum retention of sensory qualities was recorded when all the samples stored at 13.5°C than ambient condition. Saxena *et al.* (1996) developed carbonated RTS beverages using 10% grape–mango and grape–pineapple blends with good (7.5) overall quality during storage period of 6 months.

CONCLUSION

In present investigation, efforts were made to developed functional banana pseudostem beverages using ginger rhizome and nannari root extracts. The flavoured pseudostem beverages contained significant amount of total sugar, total CHO, vitamin 'C' and mineral content. At the end of 6 months storage, minimum nutrients loss (TSS, titratable acidity, total sugar, total CHO, vitamin 'C' and minerals) was found in ginger pseudostem beverages. This might be due to the effect of gingerols which act as antibacterial and antimicrobial properties in ginger extracts. Among the storage temperatures, 13.5°C retained maximum nutrients in all the samples than ambient temperature. Organoleptic evaluation revealed that the ginger rhizome and nannari root extracts could be successfully incorporated in development of functional pseudostem beverages with improved sensorial quality profile such as colour and appearance, flavour, consistency, taste and overall acceptability. The functional pseudostem beverages could be successfully stored for the period of 6 months without any significant loss in chemical and organoleptic qualities.

REFERENCES

Alam MI, Auddy B and Gomes A, 1996. Viper venom neutralization by Indian medicinal plant (*Hemidesmus indicus* and *Pluchea indica*) root extracts. *Phytotherapy Research*, Vol. 10, No. 1, pp. 58–61.

Anoop A and Jegadeesan M, 2003. Biochemical studies on the anti-ulcerogenic potential of *Hemidesmus indicus* R. Br. var. indicus. *Journal of Ethnopharmacology*, Vol. 84, No. 2–3, pp. 149–156.

Aurore G, Parfait B and Fahrasmane L, 2009. Bananas, raw materials for making processed food products. *Trends in Food Science and Technology*, Vol. 20, pp. 78–91.

Baranowski D, 1985. Storage stability of processed ginger paste. *Journal of Food Science*. Vol. 50, pp. 932–933.

Boghani AH, Raheem A and Hashmi SI, 2012. Development and storage studies of blended papaya-aloe vera ready-to-serve beverage. *Food Processing Technology*, Vol. 3, No. 10, pp. 43–47.

Bopanna KN, Bhagyalakshmi N, Rathod SP, Balaraman R and Kannan J, 1997. Cell culture derived *Hemidesmus indicus* in the prevention of hypercholesterolemia in normal and hyperlipidemic rats. *Indian Journal of Pharmacology*, Vol. 29, No. 2, pp. 105–109.

Galal AM, 1996. Antimicrobial activity of 6-paradol and related compounds. *International Journal of Pharmacognosy*, Vol. 34, No. 1, pp. 64–73.

Gayathri M and Kannabiran K, 2009. Antimicrobial activity of *Hemidesmus indicus, Ficus bengalensis* and *Pterocarpus marsupium* roxb. *Indian Journal of Pharmaceutical Science*, Vol. 71, No. 5, pp. 578–581.

Ho LH, Noor Aziah AA and Bhat R, 2012. Mineral composition and pasting properties of banana pseudo-stem flour from *Musa acuminata X balbisiana* cv. Awak grown locally in Perak, Malaysia. *International Food Research Journal*, Vol. 19, No. 4, pp. 1479–1485.

Jain SK, Khurdiya DS, Gaur YD and Ladha ML, 2003. Thermal processing of aonla (*Emblica officinalis Gaertn*) juice. *Indian Food Packer*, Vol. 32, pp. 208–211.

Karuna K, Mankar A and Singh T, 2005. Effect of storage period on quality characters of litchi beverage. *Programme Horticulture*, Vol. 37, pp. 89–91.

Kotnis MS, Patel P, Menon SN and Sane RT, 2004. Renoprotective effect of *Hemidesmus indicus,* a herbal drug used in gentamicin-induced renal toxicity. *Nephrology*, Vol. 9, No. 3, pp. 142–152.

Krishnaveni A, 1998. *Studies on the Storage Behaviour of Jackfruit Products*. Madurai: Dept. of Food Science and Nutrition, Home Science College and Research Institute, M.Sc. (FSN). Thesis.

Lampronti I, Khan MTH, Borgatti M, Bianchi N and Gambari R, 2008. Inhibitory effects of Bangladeshi medicinal plant extracts on interactions between transcription factors and target DNA sequences. *Evidence-Based Complementary and Alternative Medicine*, Vol. 5, No. 3, pp. 303–312.

Mary NK, Achuthan CR, Babu BH and Padikkala J, 2003. *In vitro* antioxidant and antithrombotic activity of *Hemidesmus indicus* (L). *Journal of Ethnopharmacology*, Vol. 87, No. 2–3, pp. 187–191.

Mohapatra D, Mishra S and Sutar N, 2010. Banana and its by-product utilisation: an overview. *Scientific and Industrial Research*, Vol. 69, pp. 323–329.

Murshed S, Rokeya B and Nahar N, 2005. Hypoglycemic and hypolipidemic effect of *Hemidesmus indicus* root on diabetic model rats. *Diabetes Research*, Vol. 39, pp. 15–23.

National Horticulture Board, Ministry of Agriculture, Government of India, 2014. Indian Horticulture Database. National Horticulture Board, Ministry of Agriculture, Government of India.

Pareek S, Paliwal R and Mukherjee S, 2011. Effect of juice extraction methods and processing temperature time on juice quality of Nagpur mandarin (*Citrus reticulata Blanco*) during storage. *Journal of Food Science and Technology*, Vol. 48, No. 2, pp. 197–203.

Pezzutti A and Crapiste, 1997. Sorpional equilibrium and drying characteristics of garlic. *Journal of Food Engineering*, Vol. 3, pp. 113–123.

Prabakan M, Anandan R and Devaki T, 2000. Protective effect of *Hemidesmus indicus* against rifampicin and ionized-induced hepatotoxicity in rats. *Fitoterapia*, Vol. 71, No. 1, pp. 55–59.

Ranganna, S, 1995. Hand book of analysis and quality control for fruit and vegetable products. New Delhi: Tata McGraw Hill Publishing Co., Ltd.

Saxena AK, Teotia MS and Berry SK, 1996. Studies on the development of grape–mango and grape–pineapple beverage blends. *Indian Food Packer*, Vol. 50, No. 4, pp. 26–29.

Sharrock S and Frison E, 1998. Focus Paper-II: *Musa* production around the world- trends varieties and regional importance. *INIBAP Annual Report 1998*. Montpellier, France: International Network for the Improvement for Banana and Plantains. pp 41–46.

Sivakumar KP, 2004. *Processing of Value Added Products from Fruit Powder*. Madurai: Department of Food Science and Nutrition, Home Science College and Research Institute, Ph.D. (FSN). Thesis.

Watts BM, Ylimake GL, Jeffery LE and Elias LG, 1989. Basic sensory methods for food evaluation. Ottawa, Ontario, Canada: International Development Research Center.

Yamada Y, Kikuzaki H and Nakatani N, 1992. Identification of antimicrobial Gingerols from ginger. *Journal of Antibacterial and Antifungal Agents*, Vol. 20, No. 6, pp. 309–311.