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Development and Quality Evaluation of Banana Pseudo Stem RTS (Ready to Serve) Beverage

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Abstract

The ready to serve (RTS) beverage prepared from disposed part (Banana pseudo stem - BPS) of banana plant with natural flavours was explored by incorporating different levels of BPS in RTS beverage preparation. Among different formulations tested, the amla flavor added beverage was scored significantly higher overall acceptability (7.68) on nine point hedonic scale and it was further compared with control (100% BPS). The effect of addition of natural flavours such as amla, ginger, *Indian pennywort*, mint and sweeteners (sugar and honey) on RTS beverage physico-chemical, nutritional and sensory quality parameters was examined. The best accepted combination of RTS beverage was in the ratio of (banana pseudo stem 80: honey 10 and amla 10). The parameters such as antioxidant activity (324.82 $mg100^{-1}g$), vitamin C (73.64 $mg100^{-1}g$), total phenols (1612.1 $mg100^{-1}g$) flavonoids (124.69 $mg100^{-1}g$), saponins (286.0 $mg100^{-1}g$) and potassium (1137.01 $mg100^{-1}g$) were reported in the banana pseudo stem based RTS beverage with amla flavour. The banana pseudo stem RTS beverage can be stored up to two months in PET bottles at room (25±5° C) and up to six months under refrigerated (4±°C) conditions. The study revealed that the disposed part of BPS can be utilized for value added RTS beverage preparation with neutraceutical content.

Keywords : Banana pseudo stem, Natural flavours, Antioxidant activity, Total phenols, Saponin

Banana is one of the major fruit crop grown in India and stands second position in area and production. The banana stem other wise known as pseudo stem which is inner central core of the pseudo stem. It is cultivated primarily for its fruit and to a lesser extent to make fiber and as ornamental plant. The global production of banana is around 102.03 million tonnes out of which India contributes 29.19 per cent. Except fruit, it generates huge quantity of biomass waste in the form of pseudo-stem, leaves, suckers etc. and out of these, BPS contributes on an average of 60 to 80 t ha^{-1}. Currently, stem biomass after harvesting of fruit is going as an organic waste in the form of manures, dumping on the field itself and utilizing for decoration purposes. Due to this, it creates major agro-waste problem and environmental nuisance (Desai *et al*., 2016). The banana tender core mainly contains 90 per cent of moisture and cannot be stored for longer period of time due to its perishable nature which affects the shelf life. The banana tender core is consumed due to high fiber which helps in weight loss, hyper acidity and relieves the constipation (Kumar *et al*., 2012). It also rich in potassium and pyridoxine (B6), which helps to detoxify the body being a diuretic and production of haemoglobin and insulin. Its potassium content helps in the functioning of muscles, including cardiac muscles. Hence, the stem tender core juice

will be the best remedy for kidney stones (Abhirami *et al*., 2014). The BPS has been reported to contain high quality starch including digestible and non-digestible (resistant) starch. The BPS juice also contains good amount of calcium, sodium, magnesium and chlorides; all of them are essential for maintaining body fluid and electrolyte balance. Moreover, in many parts of India, the BPS has been used as a vegetable (Mohapatra *et al*., 2010). Nowadays, the food habits of people are significantly changing towards the natural, safer foods and drinks over synthetic foods or aerated drinks. Consumers are also giving preference for banana pseudo stem juice due to its high nutritional and medicinal properties especially minerals and high fiber. The acceptability of fruit based beverages may be improved further by blending two or more different fruits pulp or natural flavour and other plant based functional ingredients. Blending of BPS juice with other plant based ingredients and natural flavours is unexploited area, which not only enhances the nutrient content in terms of vitamins and minerals, also imparts the flavour, taste and other sensory quality parameters. Previous workers used BPS in the production of edible products like candy, RTS beverage juice (Shagiwal *et al*., 2022), BPS flour (Aziz *et al*., 2011) and cookies (Sree *et al.*, 2022). However, published data reports that due to high phenolic content, it imparts browning after extraction of juice or when it get exposed to air. So, for preventing the browning, pre-treatment of BPS is necessary. The juice extracted from BPS core cannot be consumed directly since it imparts bitter taste, due to the presence of saponin content in the BPS. Therefore, there is a need to develop acceptable juice by blending with natural flavours or sweeteners to increase the acceptability of BPS juice. Apart from this, the wastage of BPS can be reduced by converting the BPS into valuable by product. With this background a study was planned to develop RTS beverage enriched with functional ingredients or flavoring agents and evaluated their acceptability in terms of nutritional, phytochemical and shelf life quality.

Material and Methods

The present investigation was carried out at the ICAR-AICRP (PHET), UAS, Bangalore. The raw material for the study, *i.e*., Banana pseudo stem (BPS) locally known as '*baaledindu*' were collected from Yalahanka market and other raw materials such as natural flavours (amla, ginger, *Centella asiatica* (Indian pennywort) and mint) and sweeteners (sugar and honey) were procured from local market and refrigerated till use. Procedure for RTS beverage preparation is followed as shown in Fig. 1. The sensory evaluation was carried out to determine the best acceptable product among 50 (50:40:10), 60 (60:30:10), 70 (70:20:10), 80 per cent (80:10:10) BPS incorporation using 9-point hedonic scale as per Ranganna (1998) method.

Analysis of Chemical and Phytochemical Content : The RTS beverage were analysed for proximate composition such as dietary fiber (Ranganna 1986). The minerals such as calcium, magnesium, sodium, potassium, phosphorous, manganese, iron and zinc were estimated according to standard AOAC (2005) method. Bioactive compounds such as antioxidant activity using DPPH method (AOAC, 2005), total polyphenol and flavonoid content were determined by the method of Sadasivam and Manickam (1997) and Onivogui *et al*., (2014) respectively.

Colour Analysis : The colour of RTS beverage wasa estimated by spectrophotometer (Konica Minolta Instrument, Osaka, Japan; Model-CM 5) and the colour values were expressed in terms of lightness (L*), (a*-green to red) and (b*-blue to yellow) values.

Analysis of Shelf Life Quality : RTS beverage was assessed under ambient (25±5°C) and refrigerated (4±°C) conditions. The sensory analysis was carried out by using standard method suggested by Ranganna (1986). The changes such as pH, TSS and titratable acidity were analyzed every month as per as Raghuramulu (2003) method.

Statistical Analysis : The data in triplicate values was analysed with SAS software 9.3 using two way analysis of variance. The difference between the

means were tested using the least significant of difference at 5 per cent level.

Results and Discussion

The results pertaining to changes in physico-chemical properties of BPS beverage during storage period. The organoleptic scores of different functional ingredients (flavoring agents) added is presented in Table 1. The sensory scores for taste and flavor of fresh BPS core juice with ginger, centella and mint added RTS beverage were significantly lower than amla added beverage. Amla flavour juice was acceptable in terms of taste, appearance and color. Hence, amla flavored juice was further tried with sweeteners (sugar and honey).

Perusal of Table 2 indicates sensory assessment of RTS beverage of amla with honey and sugar (two types of sweetener addition). Among two treatments, the T_2 honey based RTS beverage received the significantly higher scores for all the sensory attributes compared to T_1 (sugar).

The results of Table 3 depicts the chemical and phyto-chemical characteristics of the fresh BPS-RTS beverage. Due to the high content of flavonoids (151.13 mg/100 g) and total phenols (1612.86 mg/ 100 g), it has a high antioxidant content (343.61 mg/ 100 g) compared to control. It may protect the cells against free radicals in the body. Minerals include potassium (1194.3 mg/ml), calcium (6.49 mg/ml) and phosphorus (4.56 mg/ml) are abundant in it. Potassium act as a diuretic that aids in the body's detoxification and synthesis of insulin and hemoglobin. The results discussed above are in consistent with those of the

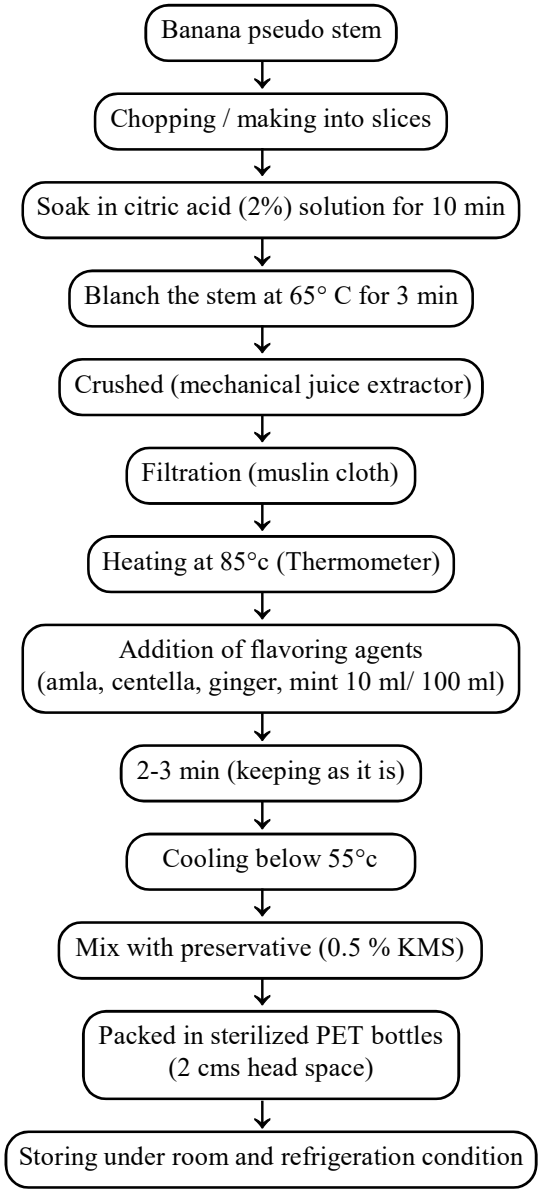

Fig. 1 : Flow chart of Banana pseudo stem based RTS beverage

Table 1

Sensory evaluation of Banana pseudo stem- RTS beverage

Treatments	Appearance	Color	Flavor	Taste	Overallacce ptability
T_1	7.00	7.01	5.84	5.87	7.47
T_2	7.68	7.62	6.70	7.70	7.68
T_3	7.24	7.36	6.45	6.32	6.32
T_4	5.76	5.64	5.54	5.60	5.70
T_5	6.39	6.36	5.54	6.30	6.50

Continued....

Table 1 Continued....

Treatments	Appearance	Color	Flavor	Taste	Overallacce ptability
F- value	*	*	*	*	*
S.E (m)	0.001	0.001	0.116	0.085	0.172
CD at 5%	0.002	0.002	0.370	0.273	0.548

CD - Critical difference, S.Em ± - Standard error of mean, * -Significant. T_1 - Control, T_2 - Amla (10%), T_3 - Ginger (10%), T_4 - Centella (10%), T_5 - Mint (10%)

Table 2

Sensory evaluation of Banana pseudo stem RTS beverage with sweeteners

Treatments	Appearance	Color	Flavor	Taste	Overallacce ptability
T_1	7.09	7.10	5.58	5.87	7.09
T_2	7.70	7.42	6.62	7.74	7.73
F - value	*	*	*	*	*
SE (m)	0.035	0.010	0.206	0.021	0.041
C D at 5%	0.141	0.039	0.830	0.083	0.167

CD - Critical difference, S.Em± - Standard error of mean, * -Significant. T_1 - Sugar, T_2 - Honey

Table 3

Chemical and phytochemical composition of developed BPS - RTS beverage

Chemical and phytochemical parameters	Observations		t- value
	T_1	T_2	
Antioxidant activity (mg /100 g)	304.7	343.61	39.31 *
Vitamin C (mg/100 g)	67.70	73.65	17.29 *
Total phenols (mg/100g)	603.06	1612.86	1614.14 *
Flavonoids (mg/100 g)	133.13	151.13	17.2 *
Tannins (mg/100 g)	7.82	9.463	109.79 *
Saponins (mg/100g)	313.6	286	19.04 *
Reducing sugar (%)	4.45	4.05	12.5 *
Non- Reducing sugar (%)	8.27	8.98	15.55 *
Total sugar (%)	12.72	13.03	51.78 *
Total dietary fiber (%)	0.80	1.00	22.87 *
Soluble fiber (%)	0.45	0.50	27.65 *
Insoluble fiber (%)	0.35	0.50	29.58 *
Macro minerals (mg/ml)			
Calcium	5.3	6.49	20.43 *

Continued....

Table 3 Continued....

Chemical and phytochemical parameters	Observations		t- value
	T_1	T_2	
Magnesium	0.363	1.54	80.98 *
Potassium	1136	1194.3	36.88 *
Phosphorus	5.56	4.56	68.62 *
Micro minerals (mg/ml)			
Iron	1.43	1.3	2 *
Zinc	4.03	3.54	52.32 *
Manganese	0.38	0.14	38.98 *

T_1 -Control, T_2- Honey

earlier researchers Bhaskar *et al.* (2011); Anusuya *et al*. (2012); Aziz *et al*. (2011) and Latharani & Jamuna (2023) for herbal enriched fingermillet based composit flour mix.

The values for L*, a* and b* are shown in Table 4. The L*, a* and b* values of the T2 RTS beverage increased the lightness and yellowness values and reduced the redness with compared to T1 (control). Browning of BPS juice treated with different flavors indicated by an increase in a* and b* value and decrease in L* value (Chandrakala *et al*., 2017) similar type of colour values for Krishna Tulasi herb enriched jaggery was reported by Pooja and Jamuna (2022).

Physico-chemical changes that occur in BPS-RTS beverage stored at room temperature and refrigerated condition is depicted in Table 5 and 6. Over the six-months of storage period, no visual growth of microorganisms was noticed in the refrigerated condition whereas under room temperature, microbial growth and color change occurred during two months of storage period. Hence, study was stopped at that point. The RTS beverage under refrigerated condition remained clear over six months of storage period as shown in the Fig. 2.

Table 4

Colour value of Banana pseudo stem RTS beverage

Treatments	Colour parameters		
	L*	a*	b*
T1	70.24	3.90	22.14
T2	77.34	2.64	22.91
t-value	38.14 *	22.64 *	34.14 *

L* (*i.e.*, [-] to [+] lightness coordinate), a* (*i.e.*, green [-] o red [+]) and b*(*i.e.,* blue [-] to yellow [+]).
T_1 - Control, T_2 - Honey

Fig. 2 : Banana pseudo stem RTS beverage

TABLE 5

Changes in physico-chemical characters of BPS (Honey) based RTS beverage during storage under ambient temperature

Storage period (months)	Clarity		Visual growth		pH		TSS (°Brix)		TTA (% of citric acid)	
	Control	Amla	Control	Amla	Control	Amla	Control	Amla	Control	Amla
0	Clear	Clear	Nil	Nil	4.64 ± 0.32	4.04 ± 0.24	12.0 ± 0.27	13.2 ± 0.33	0.102 ± 0.34	0.21 ± 0.24
1	Clear	Clear	Nil	Nil	4.05 ± 0.21	3.97 ± 0.27	12.9 ± 0.25	13.9 ± 0.35	0.082 ± 0.38	0.15 ± 0.26
2	Clear	Clear	Nil	Nil	3.85 ± 0.28	3.81 ± 0.18	13.5 ± 0.32	14.5 ± 0.29	0.079 ± 0.28	0.10 ± 0.34
3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	-	-	-	-	-	-	F-value	S.Em ±	CD at5%	F-value	S.Em ±	CD at5%	F-value	S.Em ±	CD at5%
	-	-	-	-	-	-	*	0.012	0.034	*	0.013	0.035	*	0.011	0.032
	-	-	-	-	-	-	*	0.011	0.032	*	0.012	0.034	*	0.014	0.045
	-	-	-	-	-	-	*	0.023	0.063	*	0.023	0.065	*	0.021	0.059

* Significant at 5%, Values are mean ± standard deviation (n=3).CD- Critical difference, S.Em± - Standard error of mean, *- Significant
pH: potential of hydrogen, TSS: Total soluble solids, TTA: Total titratable acidity, NA- Not analysed

TABLE 6

Changes in physico-chemical characters of BPS (Honey) based RTS beverage during storage under refrigerated condition

Storageperiod (months)	Clarity		Visual growth		pH		TSS (°Brix)		TTA (% of citric acid)	
	Control	Amla	Control	Amla	Control	Amla	Control	Amla	Control	Amla
0	Clear	Clear	Nil	Nil	4.64±0.32	4.04±0.24	12.0±0.27	13.2±0.33	0.102±0.34	0.211±0.24
1	Clear	Clear	Nil	Nil	4.41±0.35	4.38±0.27	12.1±0.25	13.4±0.34	0.086±0.35	0.198±0.19
2	Clear	Clear	Nil	Nil	4.35±0.24	4.15±0.34	12.3±0.25	13.7±0.36	0.083±0.37	0.196±0.24
3	Clear	Clear	Nil	Nil	4.27±0.22	3.95±0.32	12.4±0.22	13.9±0.25	0.080±0.28	0.182±0.27
4	Clear	Clear	Nil	Nil	4.01±0.25	3.72±0.20	12.6±0.32	14.0±0.28	0.078±0.28	0.180±0.37
5	Clear	Clear	Nil	Nil	3.95±0.19	3.64±0.20	12.8±0.31	14.1±0.29	0.075±0.26	0.177±0.18
6	Clear	Clear	Nil	Nil	3.82±0.12	3.45±0.18	13.0±0.27	14.3±0.19	0.070±0.22	0.174±0.17
	-	-	-	-	F-value	S.Em ±	CD at5%	F-value	S.Em ±	CD at5%	F-value	S.Em ±	CD at5%
	-	-	-	-	*	0.012	0.034	*	0.013	0.035	*	0.011	0.032
	-	-	-	-	*	0.013	0.035	*	0.013	0.035	*	0.012	0.034
	-	-	-	-	*	0.013	0.065	*	0.024	0.065	*	0.018	0.050
	-	-	-	-	*	0.023	0.065	*	0.017	0.047	*	0.023	0.065
	-	-	-	-	*	0.018	0.039	*	0.032	0.089	*	0.027	0.068
	-	-	-	-	*	0.030	0.055	*	0.033	0.078	*	0.022	0.062
	-	-	-	-	*	0.040	0.059	*	0.027	0.069	*	0.017	0.049

* Significant at 5%, Values are mean ± standard deviation (n=3).CD- Critical difference, S.Em± - Standard error of mean, *- Significant
pH: potential of hydrogen, TSS: Total soluble solids, TTA: Total titratable acidity

There was a decreasing trend in the pH of the RTS beverage during storage period. pH decreased from 4.04 ± 0.24 to 3.81 ± 0.18 and 4.04 ± 0.24 to 3.45 ± 0.18 under room and refrigerated conditions over two and six months respectively. The pH value decreased due to the conversion of sugar into alcohols and acids or the sedimentation of certain electrolytes during storage. The TSS of RTS beverage increased from 13.2 ± 0.33 to 14.5 ± 0.29 and 13.2 ± 0.33 to 14.3 ± 0.19 at room and refrigerated temperature, respectively. Similar trend of increase in TSS was observed in control sample also. The increase in TSS was due to the hydrolysis of polysaccharides (starch) into monosaccharides (sugar), the dehydration and degradation of pectic components in the juice along with increase in juice concentration lead to TSS content increase over the course of the storage period. Significant reduction of total titratable acidity over a period of two and six months respectively for room and refrigerated condition in T2 sample. Similar trend was noticed even in control sample also (Table 5 & 6). The fruit's organic constituents interacted chemically with one another through temperature and enzyme action, resulting into drop of TTA which is responsible for extension of shelf life. Significant differences were noticed among the treatments (control and best accepted) under the study. Boghani *et al.*, (2012) who also reported the similar trend in pH, TSS and TTA for blended papaya-aloe vera RTS beverage.

In this study, RTS beverage from the BPS with natural flavours such as amla, ginger, mint and Indian pennywort along with sweeteners like sugar and honey was explored. Among the two sweeteners, honey based amla flavoured RTS beverage was highly acceptable compared to sugar in terms of sensory parameters and also it is nutritionally superior with respect to control (100% BPS). It is rich in anti-oxidant, total phenols, flavonoids, vitamin C and minerals like potassium, phosphorus and calcium. Under refrigerated storage RTS beverage can be stored up to six months without affecting the quality parameters.

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