



Development of Ready to Drink Banana Pseudostem Beverage Incorporated with Pineapple and Grape Extract

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ABSTRACT

Background: Banana pseudostem (*Musa acuminata*) comprises nearly 30% of plant biomass and carries a substantial quantity of fiber and moisture. Banana pseudostem beverage was developed from banana tender core, natural extracts (Pine apple and Grape) and 2% citric acid used as an antibrowning agent. The present study aimed to develop ready-to-drink banana pseudostem juice incorporated with pineapple and grape extract. The banana pseudostem juice (80%) was incorporated with pineapple (20%) and grape (20%) extracts.

Methods: The proximate composition of the ready-to-drink banana pseudostem beverage and the physicochemical properties of banana pseudostem extract were analyzed using standard procedures. Sensory evaluation and microbial quality were analyzed for ready-to-drink banana pseudostem beverages stored at 25°C and 4°C. The beverages were evaluated at 6 days interval period.

Result: The ready-to-drink beverages were evaluated at a 6-day interval period. The result of the physicochemical properties of the ready-to-drink banana pseudostem beverage incorporated with pineapple and grape extract during storage at ambient and refrigerated temperature. The banana pseudostem beverage pH value gradually increased and its acidity value decreased. The total soluble solids remained constant, viscosity at 25°C was decreased, at 4°C viscosity was increased during the storage period up to 12 days. During storage conditions, the total soluble solids remain constant, while the viscosity increased at 4°C and reduced at 25°C. Minimal substantial changes were observed in the quality of ready-to-drink banana pseudostem beverages during storage conditions. The pineapple extract-flavored pseudostem beverages during storage conditions. The pineapple extract-flavored pseudostem beverage was very well-liked by consumers, according to the organoleptic evaluation. The quality of ready-to-drink banana pseudostem beverages was minimal significant changes were observed. Based on the organoleptic evaluation, the pineapple extract flavored pseudostem beverage was highly accepted by consumer preference. The banana pseudostem beverage incorporated with pineapple extracts was microbiologically safe for 12 days at 25°C and 4°C for human consumption. After 12 days at (25°C) and (4°C), the banana pseudostem beverage incorporated with pineapple extracts proved microbiologically safe.

Key words: Banana pseudostem, Grape, Microbial analysis, Pineapple, Ready-to-drink.

INTRODUCTION

Banana is one of the major fruit crops grown in India. About every part of this plant can be used including the fruit, leaves, flower buds, trunk and pseudostem. In recent years, the production of the banana crop has increased with a global annual production of 116 million tons. India is the world's second-largest banana producer, accounting for 23% of global output which produces 26.2 million tons of bananas (Thorat and Bobade, 2018). India's major banana producing states are Maharashtra, Kerala, Tamil Nadu, Gujarat, Bihar, West Bengal, Assam, Andhra Pradesh and Karnataka (Desai *et al.*, 2016).

The banana pseudostem contains a rich source of fiber. Globally, bananas and banana pseudo stem are cultivated in 5.14 million hectares with a total production of 105.32 million tons (Dixit, 2019). The banana tender core mainly contains 90% moisture and it cannot be maintained fresh over a long period (Dawn *et al.*, 2016). (Ho *et al.*, 2012) suggested that the banana pseudostem is highly perishable because it comprises more moisture content and has a short shelf life. The surface of the banana pseudostem is easily subjected to browning after harvest which will affect the sensory evaluation and economic value of banana pseudostem products.

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To utilize banana pseudostem it has to be processed and incorporated into food products to increase its value including both nutritional and sensory characteristics (Ma, 2015). The banana tender core is rich in fiber, vitamin B₆ and potassium and it helps in weight control and constipation. So, tender core beverages can be the best remedy for kidney stones (Lakshman *et al.*, 2015).

The banana pseudostem beverage is bland with a slightly bitter taste. To concern consumer acceptance pineapple and grape extract are incorporated in the banana pseudostem beverage as the taste and flavor enhancer. The functional beverage industry encompasses a wide range of varieties targeting different health-related concerns. The present study aimed to determine the biochemical composition of banana pseudostem (*Musa Acuminata*) and to assess the various physicochemical, sensory and microbial changes of banana pseudo stem beverage incorporated with pineapple and grape extract at ambient (25°C) and refrigerated (4°C) storage conditions and to find out the shelf stability of ready-to-drink banana pseudostem beverage at ambient (25°C) and refrigerated (4°C) storage conditions.

MATERIALS AND METHODS

The experiment was carried out at the Food Processing Laboratory, College of Fish Nutrition and Food Technology, Chennai from November 2021 to March 2022. Fresh banana pseudostem (*Musa Acuminata*), pineapple (*Ananas comosus*) and grape (*Vitis vinifera*) were procured from Mathur local market, Chennai.

The fruits were maintained under hygienic conditions and stored at ambient temperature during processing and transportation. The banana pseudostem was washed in running tap water to remove unwanted materials. The proximate composition of banana pseudostem was calculated. The washed banana pseudostem was sliced into round circular pieces with a thickness of 1 cm and chopped into cubes (1x1 cm). The chopped banana

pseudostem was treated with the 2% citric acid solution for 15 minutes, to prevent browning of banana pseudostem. Further, the citric acid-treated banana pseudostem cubes were water-blanching at 65°C for 15 minutes to prevent the browning reaction (Ravi *et al.*, 2010). The water-blanching pseudo stem pieces were crushed with water in the ratio of 5:1 and the extract was filtered through muslin cloth.

The pineapple (*Ananas comosus*) was peeled to get the pulp of the fruit. It was then cut into slices with a thickness of 3 cm and water blanching at 60°C for 5 mins (Agarry *et al.*, 2013) and crushed using the mixer, filtered the extract through a muslin cloth. The seedless black grapes (*Vitis vinifera*) were washed with potable water, crushed using a mixer and filtered through muslin cloth.

Preparation of ready-to-drink banana pseudostem beverage incorporated with pineapple and grape extract

The formulation of ready-to-drink banana pseudostem beverage incorporated with pineapple and grape extract is shown in Table 1. The banana pseudostem beverage was incorporated with pineapple extract in a ratio of 80:20 and the banana pseudostem beverage was incorporated with grape extract in a ratio of 80:20. The powdered sugar was added to banana pseudostem beverage incorporated with pineapple and grape extracts in the ratio of (1:10) and sodium benzoate (0.5 g/L) was also added. Ready-to-drink banana pseudostem beverages incorporated with pineapple and grape extract were filled in sterilized glass bottles/300ml and corked in airtight glass bottles. The headspace of the glass bottles was 1 cm. The glass bottles were pasteurized at 80°C for 15 mins (Buvaneshwari *et al.*, 2020) and stored at ambient (25°C) and refrigerated (4°C) temperature.

Proximate composition of Banana Pseudostem

Moisture, Crude Protein, Crude fiber and Ash content of banana pseudostem parameters were determined as per the standard method (AOAC, 2006).

Table 1: Formulation of ready to drink banana pseudostem beverage.

Pineapple flavoured RTD		Grape flavoured RTD	
Ingredients	Quantity	Ingredients	Quantity
Banana pseudostem	500g	Banana Pseudostem	500g
Pineapple	60ml	Black Seedless Grape	60ml
Sugar	55g	Sugar	55g
Salt	5g	Salt	5g
Water	100ml	Water	100ml
Citric acid	2%	Citric acid	2%

Preparation: For RTD preparation the banana pseudostem were chopped and treated in citric acid. The banana stem was blanched, cooled and crushed. The extract was then obtained by filtering them through muslin cloth. The pineapple was cut into slices, blanched and cooled. To obtain the extract, they were crushed and filtered using muslin cloth. The pseudostem extract and pineapple extract is blended to acquire pineapple flavoured RTD. The sugar was added to the blended RTD and permitted for sedimentation.

Preparation: For RTD preparation the banana pseudostem were chopped and treated in citric acid. The banana stem was blanched, cooled and crushed. Then they were filtered using muslin cloth to obtain its extract. The grape was blanched and cooled. Then they were crushed and filtered using muslin cloth to obtain its extract. The pseudostem extract and grape extract is blended to acquire Grape Flavoured RTD. The sugar was added to the blended RTD and permitted for sedimentation.

Physicochemical analysis of banana pseudostem

The physicochemical properties such as pH, titratable acidity and total soluble solids were analyzed for the banana pseudostem extract by a standard method (AOAC, 2000; Bornare and Sumaiya, 2015). The viscosity was determined using the Ostwald viscometer described by IS 354: 1987.

Microbiological analysis

The RTD banana pseudostem beverage incorporated with pineapple and grape extract was based on the number and kind of microorganisms present. The prepared beverages were analyzed for the total plate count was analyzed by the standard method described by IS 5402: 2012. The yeasts and mold growth were analyzed by the standard method described by IS 5403: 1969. The *E.coli* was determined by the standard method described by IS 5887: 1976.

Sensory analysis

Sensory analysis for banana pseudostem beverage incorporated with pineapple and grape extracts was carried out by semi-trained panelists using a 9 point hedonic scale as prescribed by (Stone and Sidel, 1985). The pasteurized beverage was provided in a coded paper. The panelists are asked to score for appearance, color, taste, flavor, mouth feel and overall acceptability. A score of above 5.0 was considered as the margin for acceptance.

Statistical analysis

The results of the physicochemical and sensory characteristics was analysed statistically by Microsoft Excel Software. All the analysis was carried out in triplicates and the average mean $\pm$ standard deviation was calculated.

RESULTS AND DISCUSSION

Proximate composition of banana pseudostem

The results for the proximate composition of raw banana pseudostem as shown in Table 2. The banana pseudostem shows a moisture of 96.02 ± 0.21 , protein of 2.5 ± 0.12 , ash content of 0.3 ± 0.05 and crude fiber of 15.5 ± 0.24 . The moisture content of 96.02% was more related to the value reported by (Dawn *et al.*, 2016). This may be due to the banana pseudostem species. The protein content of banana pseudostem (*Musa acuminata*) was found to be 2.5% on a wet weight basis. The obtained result was similar to the result reported by (Bhaskar *et al.*, 2011). The ash content of the banana pseudostem was 0.3% and the similar values were reported for the banana pseudostem by (Bhaskar *et al.*, 2011). The crude fiber of the banana pseudostem was 15.5%.

Physico-chemical properties of banana pseudo stem extract

The results of the physico-chemical properties of banana pseudostem extract were shown in Table 3. The total soluble solids and pH values in were 1°Brix and 5.25 respectively. These values were slightly different reported by (Bornare and Sumaiya, 2015). The titratable acidity of banana

pseudostem extract was 0.17g/100ml and similar values were obtained by (Bornare and Sumaiya, 2015).

Storage studies of ready-to-drink banana pseudostem beverage incorporated with pineapple and grape extract

Changes in pH

The pH value of ready-to-drink banana pseudostem beverage incorporated with pineapple and grape extract stored at ambient (25°C) and refrigerated (4°C) during storage was shown in Fig 1. In the present study, the pH values of banana pseudostem beverage (V_0) stored at ambient (25°C) temperature during storage were found to be slightly increased from 5.25 to 6.00. The pH value of ready-to-drink banana pseudostem incorporated with pineapple beverage (V_1) and grape beverage (V_2) stored at ambient (25°C) and refrigerated (4°C) during storage. The pH values of V_1 and V_2 were found to be increased from 4.60 to 4.78 and 4.60 to 4.70 respectively. There is no significant difference between V_1 and V_2 during storage upto 12 days. The pH value of ready-to-drink banana pseudostem incorporated with pineapple beverage (V_3) and grape beverage (V_4) stored at ambient (25°C) and refrigerated (4°C) during storage. The pH values of V_3 and V_4 were found to be increased from 4.52 to 4.82 and 4.52 to 4.73 respectively.

The results showed that there was no significant ($p < 0.05$) difference was noticed in pH values during storage conditions. The pH was slightly increased after 6th day of the ambient (25°C) and refrigerated (4°C) storage conditions up to 12 days. In the present study, the banana pseudostem beverages of pH values were increased during storage which might be due to a decrease in titratable acidity and the similar results were reported by (Buvaneshwari *et al.*, 2020). (Islam *et al.*, 2014), in his study revealed that there was a significant increase in pH (5.6) during the storage period. This might be due to increase in titratable acidity and pH are inversely proportional to each other. (Hirdyani, 2015), reported that there was a significant decrease in pH during storage.

Changes in titratable acidity

The titratable acidity of banana pseudostem stored at ambient temperature was shown in Fig 2. The titratable

Table 2: Proximate composition of banana pseudostem.

S.No.	Constituents	Amount
1	Moisture (%)	96.02 $\pm$ 0.21
2	Protein (%)	2.5 $\pm$ 0.12
3	Ash (%)	0.3 $\pm$ 0.05
4	Crude fiber (%)	15.5 $\pm$ 0.24

Table 3: Physico-chemical analysis of banana pseudostem.

S.No	Parameters	Values
1	pH	5.40 $\pm$ 0.10
2	Total soluble solids (Brix %)	1 $\pm$ 0.00
3	Titratable acidity(%)	0.17 $\pm$ 0.21

*Values are shown as mean $\pm$ standard error of triplicates.

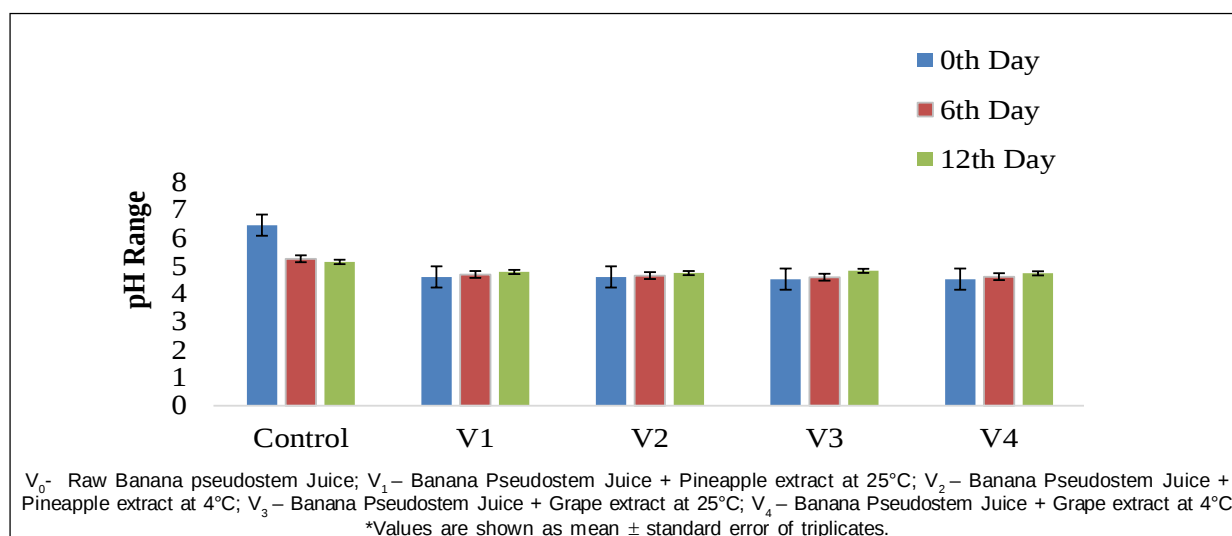


Fig 1: Changes in pH of the ready to drink banana pseudostem beverage incorporated with pineapple and grape extracts.

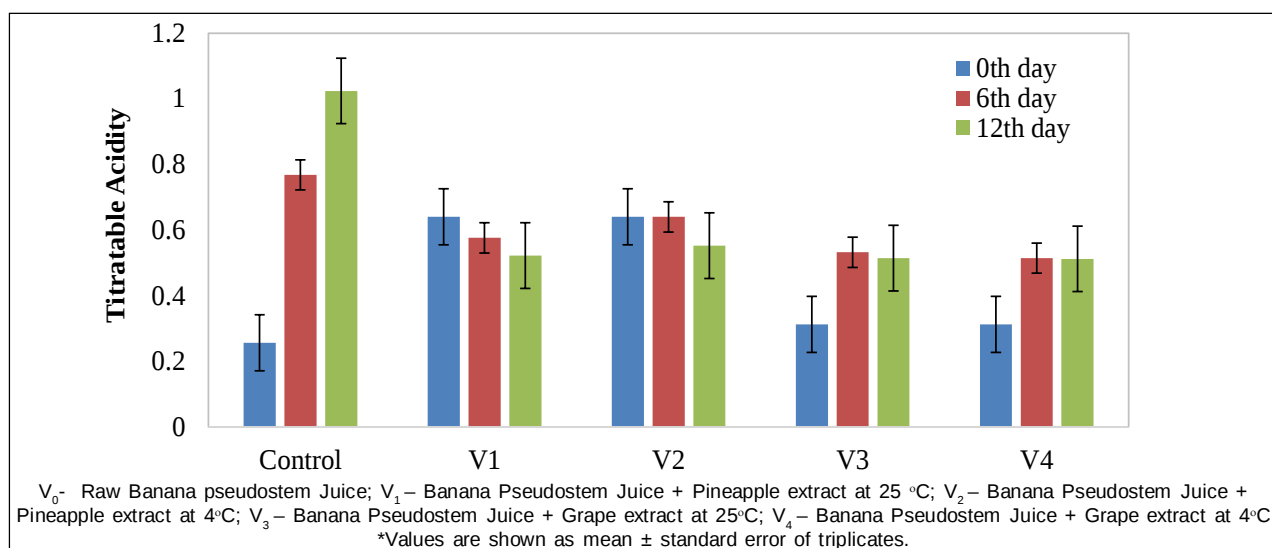


Fig 2: Changes in titratable acidity of the ready to drink banana pseudostem beverage incorporated with pineapple and grape extracts.

acidity of banana pseudostem beverage (V₀) stored at ambient temperature during storage was found to be decreased from 0.19 to 0.14g/100ml. The titratable acidity of RTD banana pseudostem incorporated with pineapple beverages stored at ambient and refrigerated storage conditions (V₁ and V₂) was found to be decreased from 0.64 to 0.52 and 0.64 to 0.55 g/100ml. There was no significant difference between V₁ and V₂ during storage up to 12 days. The titratable acidity of V₃ and V₄ were found to be decreased from 0.56 to 0.51 and 0.57 to 0.51g/100ml. In an initial storage condition, no significant difference ($p < 0.05$) was present in the titratable acidity of the samples during ambient (V₁ and V₃) and refrigerated (V₁ and V₄) storage conditions. There was no significant difference between V₃ and V₄ during storage up to 12 days. In the present study, the titratable acidity values of all samples were decreased during storage

due to decreasing concentration of pineapple and grape extract in the respective blends and similar reports were obtained by (Bornare and Sumaiya, 2015). The titratable acidity of banana pseudostem beverage was decreased during storage and this might be due to the conversion of acids into salts and sugars by enzymes particularly invertase and similar results have been reported by (Buvaneshwari *et al.*, 2020); (Bornare and Sumaiya, 2015).

Changes in total soluble solids

The total soluble solids of ready-to-drink banana pseudo stem beverage incorporated with grape extracts were stored at ambient (25°C) and refrigerated (4°C) temperature during storage were shown in Fig 3. The total soluble solids of banana pseudostem beverage (V₀) stored at ambient temperature during storage were found to be 9.00 to 9.00

°Brix. The results indicated that the total soluble solids of ready-to-drink banana pseudostem beverage incorporated with pineapple extracts were stored at ambient (25°C) and refrigerated (4°C) temperature during storage for up to 12 days. The total soluble solids of V_1 and V_2 were 8.00 to 8.00 °Brix and 8.00 to 8.00 °Brix respectively. There was no significant difference between V_1 and V_2 during storage up to 12 days.

The total soluble solids of ready-to-drink banana pseudostem beverage incorporated with grape extracts were stored at ambient (25°C) and refrigerated (4°C) temperature during storage up to 12 days were shown in Fig 3. The total soluble solids of V_3 and V_4 were 8.00 to 8.00 °Brix and 10.00 to 10.00 °Brix respectively. There is no significant difference between V_3 and V_4 during storage up to 12 days. (Shiva *et al.*, 2018) reported the total soluble solids of RTD beverage gradually increased with the values of 12 °Brix to 13.8 °Brix during storage up to 6 months. The total soluble solids were increased with the gradual passage of storage time which might be due to the hydrolysis of polysaccharides into monosaccharides and oligosaccharides (Hirdyani, 2015). Banana pseudostem beverage revealed that juice blends found an increasing trend in total soluble solids during storage at ambient and low temperatures in lime- aonla and mango pineapple spiced RTS beverages (Jan and Masih, 2012). In the present study, RTD banana pseudo stem beverage of TSS values was constant during storage for up to 12 days due to the shorter storage period.

Changes in viscosity

The viscosity of banana pseudostem beverage incorporated with pineapple and grape extracts during storage was presented in Table 4. The viscosity of banana pseudostem beverage (V_0) stored at ambient temperature during storage was found to be decreased from 177.00 to 130.00 mpa.s. up to 12 days. The viscosity of V_1 and V_3 were found to decreased

from 185.00 to 100.00 and 145.60 to 85.00 mpa.s respectively.

The viscosity of ready-to-drink banana pseudostem beverage incorporated with pineapple and grape extract was stored at refrigerated (4°C) temperature during storage up to 12 days. The viscosity of V_2 and V_4 were found to increase from 185.00 to 220.00 and 145.60 to 180.00 mpa.s respectively. In the present study, there was a significant difference between the viscosity of V_1 and V_3 samples were decreased, V_2 and V_4 samples were increased during storage up to 12 days.

Changes in Color

The color of the ready-to-drink banana pseudostem is an important attribute for the organoleptic acceptability of the product. The color of banana pseudostem beverage incorporated with pineapple and grape extracts was stored at ambient temperature as shown in Fig 4.1, 4.2 and 4.3. The result values were obtained by absorbance i.e., the maximum absorbance shows the color of the product. The banana pseudostem beverage (V_0) had maximum light absorbed at 490nm during a storage period of up to 12 days, the results showed that the banana pseudostem beverage was blue-green. The absorbance value differs on wavelength

Table 4: Viscosity of ready-to-drink banana pseudostem juice in incorporated with pineapple and grape extract.

Banana pseudostem beverage	Viscosity (poise)
V_0	0.0177
V_1	0.0185
V_2	0.0145

V_0 -Raw Banana pseudostem Juice.

V_1 -Banana Pseudostem Juice + Pineapple extract at 25°C.

V_2 -Banana Pseudostem Juice + Pineapple extract at 4°C.

*Values are shown as mean $\pm$ standard error of triplicates.

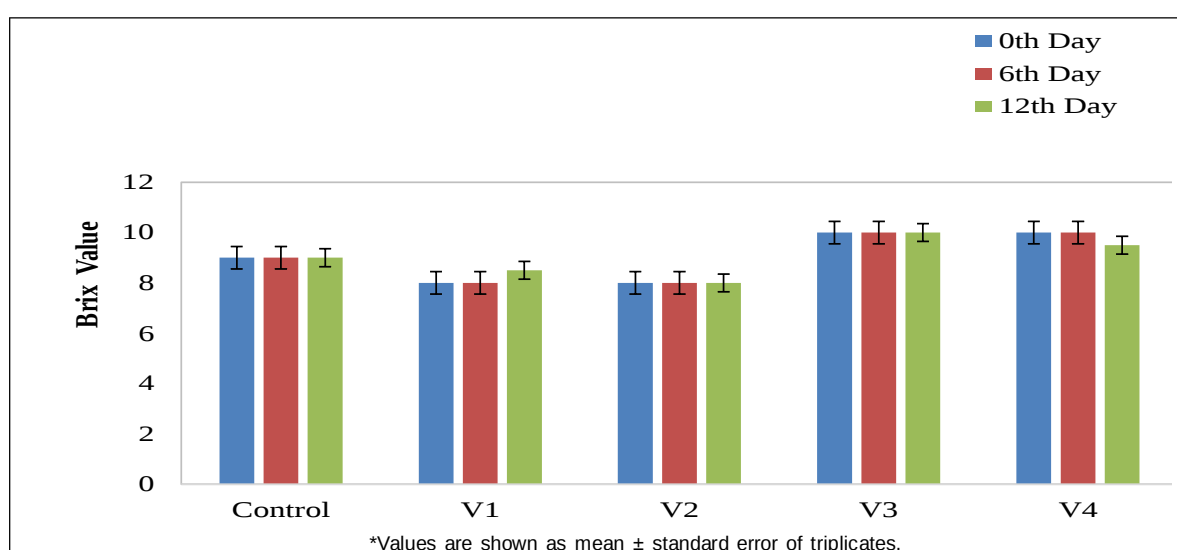


Fig 3: Changes in total soluble solids of the ready to drink banana pseudostem beverage incorporated with pineapple and grape extract.

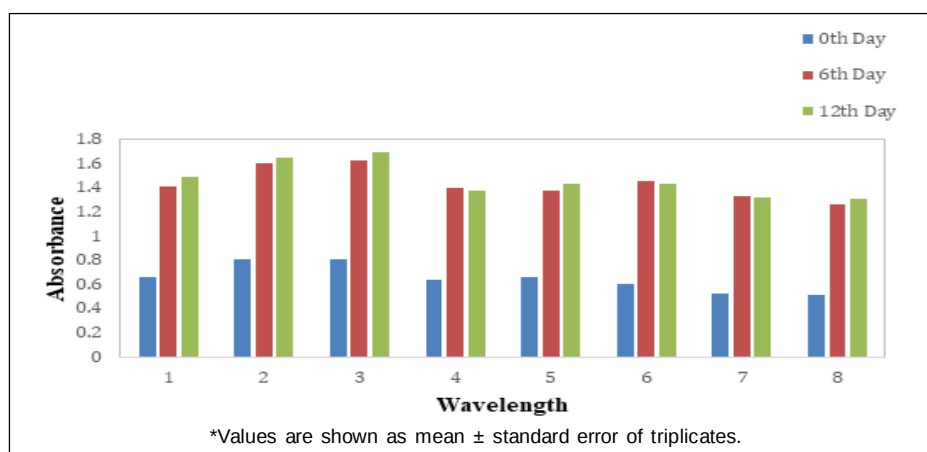


Fig 4.1: Color measurement of banana pseudostem juice (control).

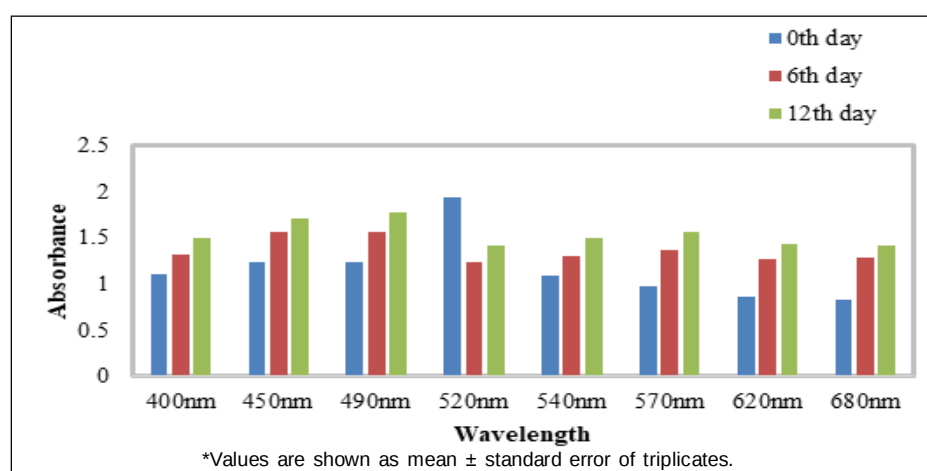


Fig 4.2: Color measurement of banana pseudostem juice incorporated with pineapple extract (V_1 and V_2).

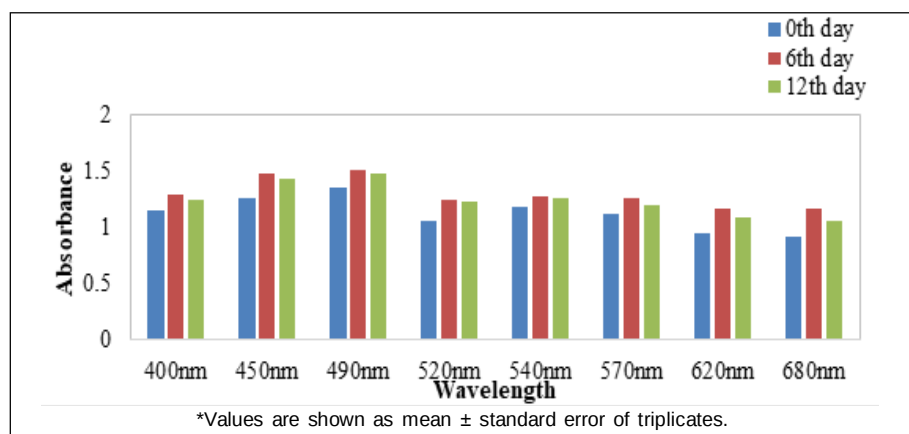


Fig 4.3: Color measurement of banana pseudostem juice incorporated with grape extract (V_3 and V_4).

this might be due to the browning of the beverage. The V_1 and V_2 samples had maximum light absorbed at 520nm during a storage period of up to 12 days, the results showed that the product was green-yellow. There was no significant difference between V_1 and V_2 samples during storage up to 12 days. The V_3 and V_4 samples had maximum light absorbed at 460nm during a storage period up to 12 days, the results showed that the product was violet-blue in color. There was no significant

difference between V_3 and V_4 samples during storage up to 12 days. In the present study, significant changes occur in (V_1 , V_2) and (V_3 , V_4) samples during storage up to 12 days due to the maximum absorbance of light and wavelength.

Sensory analysis

The results of the sensory analysis of ready-to-drink banana pseudostem beverage incorporated with pineapple and grape

Table 5: Sensory score of ready-to-drink banana pseudostem beverage incorporated with pineapple and grape extract.

Quality attributes	V ₀	V ₁	V ₃
Color	7.18 ±0.95	7.31±0.71	7.68±0.89
Appearance	7.27±0.88	7.4±0.73	7.77±0.97
Flavor	6.81±0.86	7.77±0.75	7±0.92
Mouthfeel	7.09±0.88	7.81±0.73	7.04±0.95
Taste	7.40±0.95	7.95±0.65	7.18±1.09
Overall acceptability	7.22±0.65	7.81±0.79	7.5±0.91

*Values are shown as mean ± standard error of triplicates. V₀- Banana pseudostem beverage (Control); V₁ - BPS beverage incorporated with pineapple extract at 25°C; V₃ - BPS beverage incorporated with grape extract at 25°C.

Table 6: Microbiological analysis of ready-to-drink banana pseudostem beverage incorporated with pineapple and grape extract during storage at ambient (25°C) and refrigerated (4°C) temperatures.

Sample	Total plate count (CFU/ml)			Coliform count			Yeast and mold count		
Days	0 th day	6 th day	12 th day	0 th day	6 th day	12 th day	0 th day	6 th day	12 th day
V ₀	1×10 ³	1×10 ³	1×10 ³	Nil	Nil	Nil	Nil	Nil	Nil
V ₁	1×10 ³	1×10 ³	1×10 ³	Nil	Nil	Nil	Nil	Nil	Nil
V ₂	1×10 ³	1×10 ³	1×10 ³	Nil	Nil	Nil	Nil	Nil	Nil
V ₃	1×10 ³	1×10 ³	1×10 ³	Nil	Nil	Nil	Nil	Nil	Detected
V ₄	1×10 ³	1×10 ³	1×10 ³	Nil	Nil	Nil	Nil	Nil	Nilre

*Values are shown as mean ± standard error of triplicates. V₀- Banana pseudostem beverage; V₁ - BPS beverage incorporated with pineapple extract at 25°C; V₂ - BPS beverage incorporated with pineapple extract at 4°C; V₃ - BPS beverage incorporated with grape extract at 25 °C; V₄ - BPS beverage incorporated with grape extract at 4°C.

extract were evaluated by 50 semi-trained panelists based on their appearance, color, flavor, mouthfeel, taste and overall acceptability were shown in Table. 5. The highest scores of 7.68 and 7.77 indicated that the color and appearance of ready to drink banana pseudostem beverage incorporated with grape extract (V₃) were rated best by the sensory panel and similar results were observed by (Ravi *et al.*, 2011). The highest scores of 7.77, 7.81 and 7.95 indicated that the flavor, mouthfeel and taste of ready-to-drink banana pseudostem beverage incorporated with pineapple extract (V₁) were rated best by the sensory panel because sourness of pineapple extract. The overall acceptability score of ready-to-drink banana pseudostem beverage incorporated with pineapple (V₁) was preferred by panelists.

Microbiological analysis

The total plate count, *E.coli*, yeast and mould of banana pseudostem beverage incorporated with pineapple and grape extract were stored at ambient temperature for up to 12 days were shown in Table 6. Initially there was no microbial count observed in the developed banana pseudostem beverage samples, there was no bacterial, fungi and mould growth observed in the refrigerated and ambient temperature samples throughout their shelf life of 12 days. In the case of the ambient condition stored samples, there was no growth seen over the 12-day storage period. After that, there was no fungi and mould growth were seen in the storage period of up to 12 days. In the present study, the results showed that no microbial count was observed for up to 12 days and similar results were observed by (Buvaneshwari *et al.*, 2020). FSSAI (2017) reported that the microbiological requirements of fruit beverages, carbonated beverages and ready to serve

beverages including fruit beverages were not more than 50 CFU/ml for TPC, not more than 2 CFU/ml for YMC (FSSAI, 2017). The results indicated that the microbial quality of banana pseudostem beverage, V₁, V₂ and V₄ samples were satisfactory. It remained fresh up to 12 days at ambient and refrigerated conditions and it was safe for human consumption.

CONCLUSION

Nowadays, the fast economic development has changed the trend of food consumption from calorie assurance to diet nutrient enrichment. Consumers today are well aware of the importance of nutrient-rich food. In the present study, the developed ready-to-drink banana pseudostem beverage incorporated with pineapple extract was microbiologically safe during ambient and refrigerated temperatures for up to 12 days of storage with good acceptability and taste. It was found nutritionally as well as organoleptically desirable. It delivers bioactive compounds to our body and it is also recognized as a functional beverage. This functional pseudostem beverage could be successfully stored for 12 days without any significant loss in chemical and organoleptic qualities.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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