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Development and quality assessment of value added plantain stem juice incorporated with grape juice

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The current scenario in the food industry mainly concentrates on value addition and agricultural waste reutilization. The objective of this study was to develop a blended crush with the incorporation of plantain stem (*Musa sapientum* Linn.) and grape (*Vitis vinifera* Linn.) juice and to analyze its physicochemical and nutritional values in order to determine the quality and consumer acceptability of the crush. The crushes were prepared with plantain stem juice and grape juice in different proportions (v/v) and compared both with pure standard plantain stem crush and grape crush. The physicochemical characteristics of the crush variations were found affected by the proportion of plantain stem juice incorporated. However, both juices are equally attributed in enhancing the nutritive value of the blended beverages when compared with the standards.

Keywords: Blended crush, Grape, *Musa sapientum*, Nutrient, Plantain stem, Physicochemical, Sensory, *Vitis vinifera*.

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Introduction

The globalization of the food industry has shown a high increase in the demand for fruit juices and the current scenario in the food industry shows a growing demand for value addition. A study by Sloan (2003) suggests 47% of consumers believe that fortified food and beverages are able to supply their recommended vitamin intake[1]. One of the prime methods in the development of fortified beverage is practiced by blending two or more kinds of fruit or vegetable juices which combine to give a unique taste and enhanced nutrition in terms of vitamin and mineral composition[2,3]. Blended beverages can also expand incorporation of underutilized agricultural produce by blending it with the existent and most preferred fruit juices in the market.

Plantains are the fourth most important crop in developing countries, with a worldwide production of about 100 metric tons[4]. India is the largest producer of banana and plantain with an annual production of 16.91 tons from 490,700 hectares, and accounts to 19% of total world production[5]. In addition to plantain production, huge quantity of waste biomass (i.e. pseudo stem, leaves, suckers, etc.) is generated. The utilization of the white central portion of the banana stem, called banana pith has been limited to the generation of biogas, ethanol production and paper making[6-9].

Plantain stem juice has been reported to have excellent therapeutic efficacy such as dissolving pre-formed stones and preventing stones in urinary bladder[10-12]. It has also been found to contain condensed tannins and pectin which have antihelminthic and hypoglycemic properties, respectively[13,14]. Grape juice contains phenolic compounds that include resveratrol, flavon-3-ols, caffeic acid, ellagic acid and quercetin which possess antioxidants, antibacterial, antiviral activities and cancer chemo-preventive activity in different stages of carcinogenesis[15-22].

Current study was carried out to expand the utility of plantain stem, which is a low cost underutilized agricultural waste. The study focused on developing a unique blended crush by combining plantain stem juice with grape juice. For a long time, the use of thick flavoured sugar syrups as a beverage has been very common. During the last few decades, products like fruit juices, squashes, cordials, crushes, syrup and ready-to-serve beverages have been introduced on commercial scale to a large extent. Crushes based on

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Fruit Product Order (FPO) guidelines can be defined as a highly concentrated, non alcoholic, clear beverage which contains at least 25% fruit juice mixed with sugar syrup. They are diluted to taste with water and may contain preservatives and they should have a TSS of minimum 55° Brix. The objective of this study was to formulate and analyze the acceptability of blended crush prepared with plantain stem juice and grape juice in terms of colour, body, taste, flavour and overall acceptability. The study also evaluates the physicochemical characteristics (*p*H, TSS, titratable acidity, moisture, total sugars) and nutrient composition (carbohydrates, protein, vitamins A and C, calcium and iron) of the blended crush.

Materials and Methods

Preparation of blended crush with Plantain stem and Grape juice

Plantain stem (*Musa sapientum* Linn.) was washed, cleaned, the green part of the stem was peeled off and its white inner portion was cut into small pieces and blanched at 65°C. The juice was extracted by mechanical crushing followed by filtration. Grapes (*Vitis vinifera* Linn.) were washed, destemmed, destoned and blanched at 65°C[23,24] and were then mechanically crushed and filtered. The blanching process made the extraction process easy and also increased the quantity of juice obtained. It also prevented the browning of the plantain stem. The crush was prepared in different variations (Table 1), along with two pure standards of plantain stem crush (S1) and grape crush (S2) for comparison. Sugar solution was prepared with sugar and water at a proportion of 2:1 (w/v), respectively by heating till the one thread stage (110°C). All the crush variations were pasteurized and stored in sterilized clean glass bottles.

Physicochemical analysis

The variations of blended crush with Plantain stem juice and Grape juice were analyzed for physicochemical properties such as moisture, total solids, titratable acidity, *p*H, TSS, total , reducing and non-reducing sugars. Moisture content was determined following the oven method. Total solids content was estimated by deducting percent moisture from 100. Titratable acidity was determined by titrimetric analysis against 0.1N NaOH. The *p*H was measured using a digital glass electrode *p*H meter. TSS of the crushes was determined using a Digital Hand Refractometer and results were expressed in °Brix. The reducing, non-reducing and total sugars were estimated by titration against Fehling's A and B. Non-reducing sugars were previously inverted with HCl[25].

Nutrient analysis

All the variations were subjected to nutrient analysis. Estimation of carbohydrate was carried out by the gravimetric method. Protein estimation was carried out by Kjeldahl method[26]. Estimation of vitamin C and vitamin A was carried out by HPLC method[27]. Calcium and iron were estimated by the method of Atomic absorption spectrophotometry[28,29].

Sensory analysis and overall acceptability

The sensory analysis was carried out for all the variations of blended crush, standard plantain stem crush and standard grape crush by a panel of 20 semi trained members. The panel members were introduced to the sensory score card and briefed on the characteristic organoleptic properties to be rated. Scoring was done using 9 point hedonic scale, for colour, flavour, taste, body and overall acceptability, where 9 meant 'liked extremely' and 1 meant 'disliked extremely'. Samples were diluted with water in the ratio of 1:3 (v/v) and served chill in transparent glass cups[30].

Statistical analysis

The statistical significance of sensory values of the experimental samples and the standard were evaluated by analysis of variance. Association between the physicochemical parameters of the variations of the blended beverage and the correlation between sensory

Table 1 — Percentage composition of blended crush variations

Ingredients	Blended crush variations*						
	S1	V1	V2	V3	V4	V5	S2
Grape juice %	-	8.4	12.6	17	20.8	25	33.4
Plantain juice %	33.4	25	20.8	17	12.6	8.4	-
Sugar solution %	66.6	66.6	66.6	66.6	66.6	66.6	66.6
Sodium benzoate (g)	0.5	0.5	0.5	0.5	0.5	0.5	0.5

*S1- Plantain stem crush 1; S2- Grape crush 2; V1- Variation 1; V2- Variation 2; V3- Variation 3; V4- Variation 4; V5- Variation 5.

characteristics and overall acceptability were done using correlation analysis. All analysis was done using Microsoft Excel.

Results and Discussion

Physicochemical analysis

The titratable acidity (TA) expressed in terms of tartaric acid for all variations of the blended crush ranged between 0.1-0.26g/100ml (Table 2). The acidity of variation 5 was similar to the acidity of Campbell grape juice reported by Shirley *et al*[31]. The acidity range was similar to the *p*H range in the study on different grape concentrates by Katherine *et al*[32]. The proportion of plantain stem juice on the acidity of the crush variations was very minimal, but it increased by 0.24 with the increase in the proportion of grape juice when compared to standard plantain stem crush (S1). Titratable acidity decreased with increasing moisture and *p*H. A positive correlation was evident between TA and total solids, total soluble solids, total reducing and non-reducing sugars.

There was a considerable decrease in *p*H as the proportion of grape juice increased in the crush. The *p*H of the crush variations ranged between 3.22 and 4.93 ensuring long shelf-life due to its acidity. The *p*H values (Table 2) obtained for the crushes were low when compared with the *p*H of vegetable juices which is between 4 and 6[(Ref..33)]. Thus, it can be concluded that grape juice has a major influence on the *p*H of the crush when compared to plantain stem juice.

Sugar content plays a major role in the viscosity of a beverage. Higher the sugar contents of the crush, higher the viscosity, thus improving the textural property of the crush[34]. The amount of reducing sugars ranged between 15 and 20% of the total sugars in the crush variations. There was a considerable increase in the amount of reducing sugars with the increase in the proportion of grape juice in the crush (8.14-10.67g/100ml). A significant reduction has been previously reported in soluble sugars, fructose, glucose and sucrose in the processed (blanching) samples[35]. The significant losses in the amount of reducing sugar in the blended crushes could be attributed to the blanching process carried out prior to juice extraction. Non-reducing sugars ranged between 16.64-18.79g/100ml and it was found to be highest in variation 5 (29.46g/100ml) and lowest in variation 1 (24.78g/100ml). It had a positive correlation with total solids, total soluble solids, titratable acidity, reducing and non-reducing sugar (Figs 1 and 2).

There is an increase in the moisture content by 6.21% in variation 1, in comparison with Standard grape crush (S2). Grape juice incorporation influenced the percentage of total solids in the crush when compared to standard plantain stem crush (S1).

Sugar and organic acids are the major constituents of soluble substances TSS and acidity of fruit are extremely important parameters which decide the quality of the syrup[36]. The total soluble solids among the variations of blended crush ranged between 46-55° Brix. The TSS of the blended crush variations was significantly influenced by the volume of grape juice incorporated.

Nutrient analysis

Blending of plantain stem juice with grape juice enhanced the nutritive value of all blended crushes (Table 3). Carbohydrate and calcium content of all variations increased with increasing incorporation of grape juice and ranged from 70% (V1) to 73.6% (V5) and 22.5 to 31.2 mg, respectively. All blends showed the presence of iron and the percentage composition of vitamin C is in the range of published data as other common fruit juices[37].

Table 2 — Physicochemical properties of blended crush variations

Physicochemical parameters	Blended crush variations*						
	S1	V1	V2	V3	V4	V5	S2
Moisture %	46	36.34	35.22	34.12	33.2	33.84	30.13
Total solids %	54	63.6	64.78	65.88	66.88	66.16	69.87
Titratable acidity g/100ml	0.02	0.1	0.12	0.162	0.192	0.26	0.32
*p*H	4.93	4.43	3.36	3.32	3.24	3.22	3.01
Total soluble solids °Brix	46	50.4	53.3	55	58.4	60.2	62
Total sugars g/100ml	23.48	24.78	25.83	27.25	28.2	29.46	30.8
Reducing sugars g/100ml	7.16	8.14	8.48	8.92	9.54	10.67	11.45
Non-reducing sugars g/100ml	16.32	16.64	17.35	18.33	18.66	18.79	19.35

*S1- Plantain stem crush 1; S2- Grape crush 2; V1- Variation 1; V2- Variation 2; V3- Variation 3; V4- Variation 4; V5- Variation 5.

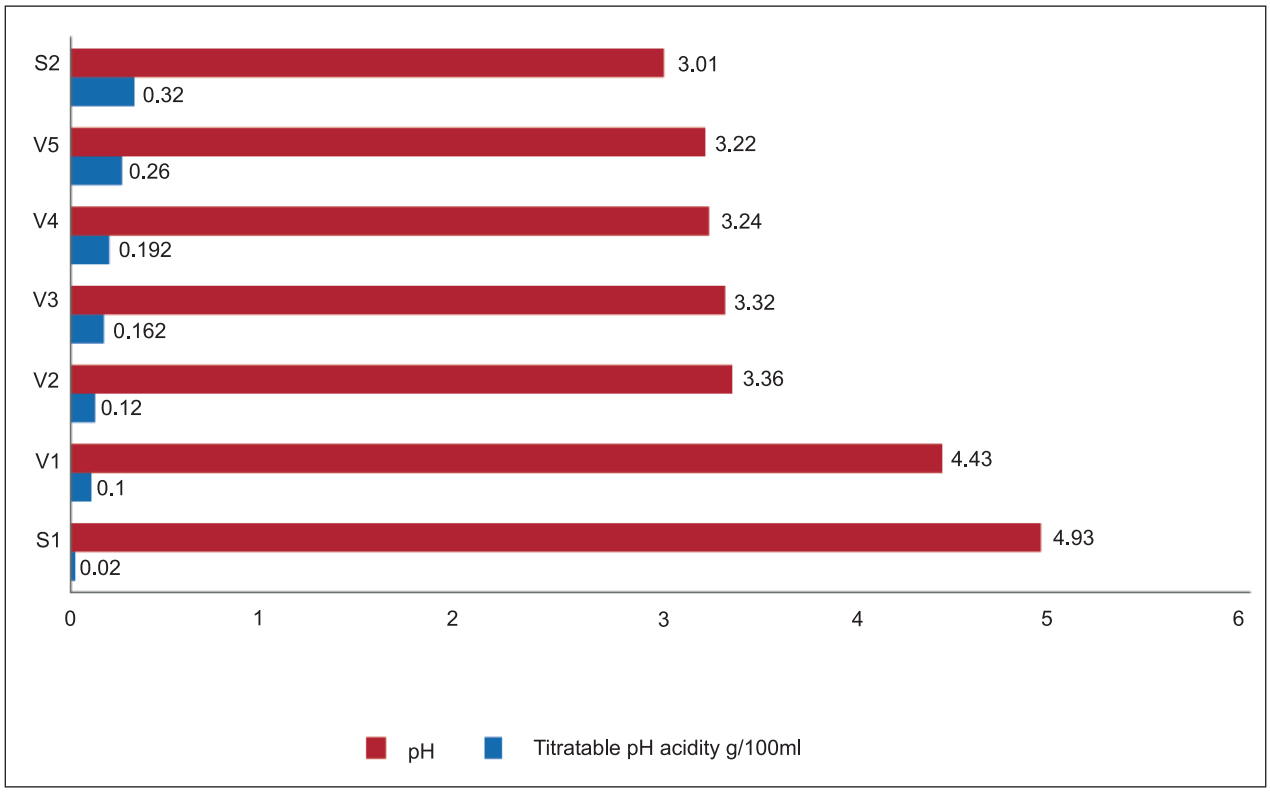

Fig.1 — Acidity and *p*H of blended crush variations

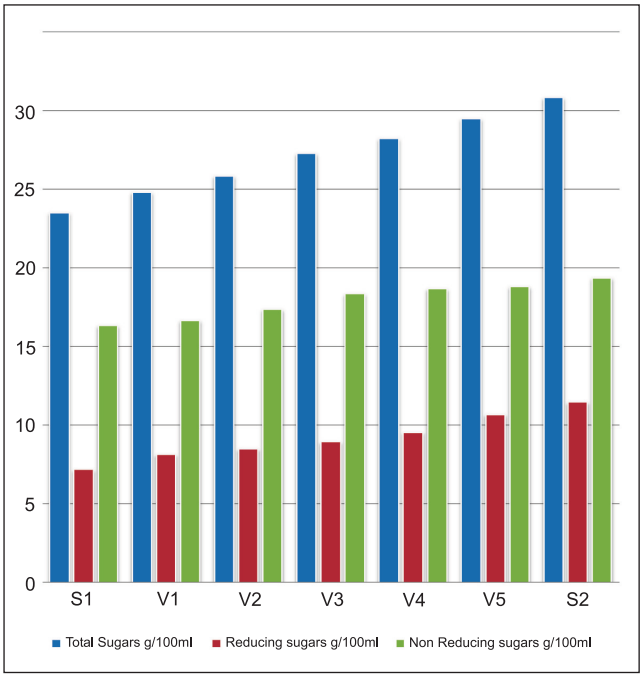

Fig. 2 — Reducing and non-reducing sugar content of blended crush variations

Sensory analysis

Overall acceptance

The overall acceptability scores of the blended crush (Table 4) indicated that V5 (25% plantain stem juice) incorporation was most preferred. Greater incorporation of plantain stem juice decreased the overall acceptability of the product. The scores revealed that equal blending of the two juices (1:1) is most acceptable.

Colour

Colours was rated best for pure grape juice (S1) and least for pure plantain stem juice (S2) by the sensory panel (Table 4). Sensory ratings for colour of the blended crush increased with increasing proportions of grape juice.

Flavour

The flavour scores of the blended crush were directly proportional to the volume of grape juice in the blended crush thus indicating that the flavour of grape juice predominated over the flavour of plantain stem juice. The flavour of all blended crush variations (V1-V5) received a score ranging from 6.13 to 7.13 (Table 4).

Table 3 — Nutrient composition of blended crush variations

Nutrients	Blended crush variations*						
	S1	V1	V2	V3	V4	V5	S2
Carbohydrates (g)	68.7	70.41	70.85	71.33	72.88	73.64	78.01
Protein (g)	1.34	1.31	1.21	1.14	1.021	0.9858	0.87
Calcium (mg)	20.49	22.56	24.	28.12	29.48	31.21	32.4
Iron (mg)	0.76	0.61	0.55	0. 49	0.42	0.31	0.25
Vitamin A (µg)	-	15.31	23	30.89	37.62	49.48	61.26
Vitamin C (mg)	0.87	0.59	0.56	0.48	0.42	0.37	0.34

*S1- Plantain stem crush 1; S2- Grape crush 2; V1- Variation 1; V2- Variation 2; V3- Variation 3; V4- Variation 4; V5- Variation 5.

Table 4 — Sensory scores of blended crush variations

Blended crush variations	Parameters				
	Colour	Taste	Flavour	Body	Overall acceptability
S1	5.13±1.20	5.60±0.61	5.53±0.88	5.33±1.01	5.4± 1.08
V1	6.00±0.89	6.00±0.82	6.13±0.96	6.47±0.72	6.87±1.15
V2	6.27±0.77	6.33±1.07	6.27±1.06	6.67±1.30	7.07±0.85
V3	6.33±0.87	6.47±0.81	6.53±1.20	6.73±1.00	7.27±0.85
V4	6.53±1.36	6.67±1.01	6.80±0.83	7.00±1.51	7.33±1.01
V5	6.87±0.81	6.80±1.28	7.13±0.81	7.20±0.83	7.40±0.61
S2	7.00±0.89	7.07±1.00	7.33±0.70	7.33±1.01	7.53±1.09

*S1- Plantain stem crush 1; S2- Grape crush 2; V1- Variation 1; V2- Variation 2; V3- Variation 3; V4- Variation 4; V5- Variation 5.

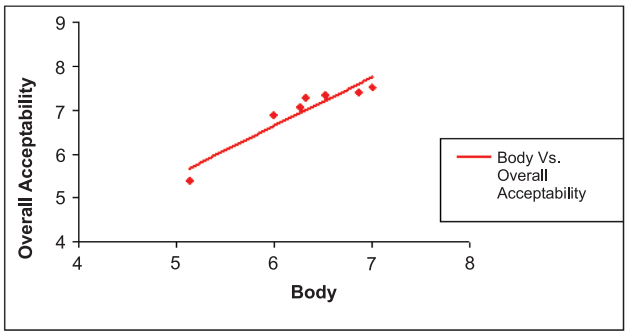

Fig. 3 — Body vs overall acceptability of the blended crush variations

Body

The body of the crush was considerably affected by the proportion of plantain stem juice which was not as viscous as grape juice. The crush with 75% grape juice (V5) scored the highest for body (7.20) when compared to the other variations (V2-V4). The body of the crush variations also had a positive correlation with the overall acceptability scores and was significantly affected by the proportion of grape juice in the crush (Figure 3).

Taste

Taste of the blended crush was influenced by the volume of grape juice in them irrespective of the proportion of plantain stem juice. This is in accordance with Lawles (1986) who stated that the suppression of a particular taste in a mixture was frequently observed in beverages and foods[38]. Variation 5 was rated the highest score of 6.80 and V1 received the lowest score of 6. The taste parameters also had a strong correlation with the overall acceptability.

Conclusion

Thus, it can be concluded that plantain stem juice and grape juice make a good blended beverage as they complement each other in terms of nutritive value ensuring value addition to the crush. Plantain stem juice with high moisture content, when blended with grape juice tends to have better physicochemical characteristics. As such plantain stem juice when made into crush may fall below the Fruit Product Order (FPO) regulations and guidelines in terms of TSS but when blended with grape juice it tends to meet the FPO specifications. Standard plantain stem crush was recorded to have a *p*H close to 5 which is unfavourable and might lead to microbial contamination. However, blending with grape juice increases its acidity and therefore enhancing the quality and shelf-life of the crush. Blending improved the viscosity, *p*H and sugar components of the crush. Sensory analysis indicated that all variations were acceptable. Blending a vegetable juice with a fruit juice imparted an acceptable and a unique taste and flavour to the crush.

Thus, it can be concluded that the formulated product is an ideal low cost blended beverage as the value addition of plantain stem juice in grape juice can bring down the production cost. The nutritional and organoleptic quality of the crush is highly acceptable. Plantain stem juice and grape juice are rich in bioactive components and it is quite convincing that the value addition will not only enhance the nutritive value but also the antioxidant properties and therapeutic efficacy of the blended beverage. It is to be noted that at present the major area of plantain stem utilization is in paper industry and other fibre industry. Hence, this formulation will be a new avenue for plantain stem utilization, and further studies can be carried out with other fruit juice blends.

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