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Studies on storage stability of sugar beet (*Beta vulgaris*) Jaggery added pomegranate RTS beverage

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Abstract
In the present research, the efforts have been made to utilize the jaggery extracted from sugar beet in pomegranate RTS beverage. The extracted jaggery was used @ 0% (Control), 25% (P_1), 50% (P_2) and 75% (P_3) to replace sugar cane sugar in a control pomegranate RTS beverage formulation. The prepared beverages were analysed for its physical, chemical and sensory characteristics. The sample P_2 was found organoleptically accepted over other samples. The TSS, pH and acidity of sample P_2 were found to be 15^0Bx, 3.57 and 0.30%. The prepared beverage was studied for storage stability up to 120 days. The TSS and pH were found in decreasing trend and acidity in increasing trend during storage period.

Keywords: sugar beet sugar, sweetening agent, pomegranate RTS, sensory characteristics

Introduction
Sugar beet (*Beta vulgaris*), a genus of the family *Amaranthaceae* (formerly *Chenopo diaceae*), is one of the diverse and useful group of cultivars from the same species that includes Swiss chard, fodder beet, and red beet (McGrath, 2011) [9]. Sugar beet is the most important of several crops, including spinach beet, swiss chard, garden beet (beetroot) and fodder beet, within *Beta vulgaris* species (Gill and Vear, 1980) [7]. Experimental work in Germany laid the foundations of the beet sugar industry and the Napoleonic wars gave the initial stimulus to its further development as an alternative to cane sugar, especially in France. With various technical developments and favorable government policies, the beet sugar industry has expanded and the crop is cultivated and processed in Europe, North and South America, Asia and Africa (FAO, 2009) [4]. Sugar beet producing roots in first year and seeds in second year is a biennial herb grown in different countries of the world, and provides about 25% of world's sugar requirement. The crop is a major source of sugar in temperate countries. Sugar beet has been specially selected and bred for sucrose production over the past two centuries (Winner, 1993) [15].
According to the Food Standard and Safety Authority of India (2017), the RTS beverage should have a juice content of not less than 10% (5% for lime), TSS of not less than 10% and preservatives as sulphur dioxide not more than 350 ppm or as benzoic acid not more than 600 ppm and 0.3% acidity. These beverages are not diluted before serving, hence the term ready-to-serve. The objective of the present research was to utilize sugar beet sugar in pomegranate RTS beverage.

Materials and Methods
Materials
Pomegranate fruit, citric acid *etc* were obtained from local market of Parbhani. Sugar beet (PA 86-2530) was obtained from fruit and vegetable research station and Dry land research station and cotton research Centre, Vasantrao Naik Marathwada KrishiVidyapeeth, Parbhani.

Preparation of pomegranate RTS beverage
Pomegranate RTS beverage has been prepared by standard procedure. The process of preparation of pomegranate RTS is summarized in Flow sheet-1.

Selection of fruit
↓
Washed
↓
Cut fruit into halves
↓
Arils were separated
↓
Crushed in domestic mixer
↓
Filtered through muslin cloth
↓
Pomegranate juice
↓
Water, citric acid, sugar cane sugar, sugar beet sugar was added
↓
Pasteurized at 75^{0}C for 15 sec
↓
Filled in previously sterilized PET bottles
↓
Stored at ambient (30^{0}C) and refrigerated temperature (4^{0}C)

Flow sheet 1: Flow sheet for pomegranate RTS beverage

Formulation of pomegranate based RTS beverage

Table 1: Formulation of pomegranate based RTS beverage (100 ml)

Sr. No.	Ingredients	Control	P_1	P_2	P_3
1.	Pomegranate Juice (ml)	10	10	10	10
2.	Sugar cane sugar (g)	12	----	----	-----
3.	Sugar beet Jaggery (g)	----	5	10	15
4.	Citric acid (g)	2	2	2	2
5.	Water (ml)	76	83	78	73

Physicochemical properties of sugar beet incorporated pomegranate RTS beverage

Total Soluble Solids (TSS) was measured by using Abbe refractrometer, titrable acidity as per the method given by Ranganna (1986).

Storage studies

Beverage was subjected to storage studies at refrigeration temperature and drown at specific time interval (30 days) to evaluate organoleptic parameters.

Sensory evaluation of sugar beet incorporated pomegranate RTS beverage

Prepared cookies were evaluated for organoleptic characteristics like color, flavor, taste and overall acceptability by a panel of semi trained judges, comprised of postgraduate students and academic staff members of College of Food Technology, V.N.M.K.V., Parbhani. Samples were scored based on a 9-point hedonic scale. Judges were asked to rate the product on 9-point Hedonic scale with corresponding descriptive terms ranging from 9 'like extremely' to 'dislike extremely' (Meilgaard *et al.*, 1999) [10].

Statistical analysis

The data obtained was analyzed statistically by Completely Randomized Design (CRD) as per the procedure given by Panse and Sukhatme (1967) [13]. The analysis of variance revealed at significance of P< 0.05 level, S.E. and C.D. at 5% level is mentioned wherever required.

Result and Discussion

Effect of addition of different proportions of sugar beet sugar on physico chemical composition of pomegranate beverage

The data with respect to effect of addition of different proportions of sugar beet sugar on (25 to 75 per cent) physicochemical composition of pomegranate beverage was presented in Table 2.

Table 2: Effect of addition of different proportions of sugar beet sugar on physico chemical composition of pomegranate beverage

Samples	TSS (^{0}Bx)	pH	Acidity (%)
Control	15.0	3.50	0.32
P_1	15.0	3.53	0.31
P_2	15.0	3.57	0.30
P_3	15.0	3.62	0.28
SE ±	0.348	0.080	0.023
CD @ 5 %	1.073	0.026	0.071

*Each value represents the average of three determinations

Control – with addition of sugarcane sugar or without addition of sugar beet sugar
P_1- With addition of 75 per cent sugarcane sugar + 25 per cent of sugar beet sugar
P_2- With addition of 50 per cent sugarcane sugar + 50 per cent of sugar beet sugar
P_3- With addition of 25 per cent sugarcane sugar + 75 per cent of sugar beet sugar

The TSS of the all the samples were maintained as 15°Bx. The pH of control sample pomegranate beverage was (pH 3.50) similarly P_1 had (pH 3.53) also sample P_2 had (pH 3.57) and that of sample P_3 was (pH 3.62). It was found that P_3 sample had highest pH followed by P_1 and P_2 with added (75 per cent) sugar beet sugar. The pH of the samples P_1 to P_3 added with sugar beet sugar had increasing trend, may be due to addition of sugar beet sugar having alkaline pH. Acidity of control sample of pomegranate beverage was (0.32 per cent) similarly sample P_1 (0.31 per cent), P_2 (0.30 per cent) and P_3 (0.28 per cent). Control sample had highest acidity among all the samples may be due to no addition of sugar beet sugar. Decreasing trend in acidity was found due to increase in the pH of the samples. Study was supported by Gaikwad *et al.*, (2013) [6]

Organoleptic evaluation sugar beet sugar based pomegranate beverage

The organoleptic evaluation of sugar beet sugar based pomegranate beverage was carried out by a ten-member semi trained panel and the score were given by evaluating color and appearance, flavor, taste and overall acceptability which was compared with control sample.

Table 3: Organoleptic evaluation sugar beet sugar based pomegranate beverage

Sample	Color and appearance	Flavor	Taste	Overall acceptability
Control	9.0	8.7	8.7	8.8
P_1	8.3	8.5	8.2	8.1
P_2	8.7	8.5	8.4	8.6
P_3	6.0	7.0	7.0	7.0
SE ±	0.081	0.083	0.043	0.047
CD @ 5 %	0.28	0.256	0.133	0.146

Control – with addition of sugarcane sugar or without addition of sugar beet sugar
P_1- With addition of 75 per cent sugarcane sugar + 25 per cent of sugar beet sugar
P_2- With addition of 50 per cent sugarcane sugar + 50 per cent of sugar beet sugar
P_3- With addition of 25 per cent sugarcane sugar + 75 per cent of sugar beet sugar

The result of table 3 revealed that control sample scored highest (8.8) among all the samples followed by sample P_2. Lowest score was recorded by sample P3 due to higher proportion of sugar beet sugar imparts brownish color to the sample. Control and sample P_2 was found to be at par with each other and found to be statistically significant over other samples. Lowest score was recorded by sample P_3 due to increase in proportion of sugar beet sugar. P_1, P_2 were found to be statistically at par with each other. Result showed that higher proportion of sugar beet sugar was not preferred by the panel members.

From the table it was clear that there was significant change in taste of control and samples added with sugar beet sugar. Sample P_2 recorded highest score followed by P_1 and P_3. Sample P_2 was significantly superior over all the samples. Sample P_3 recorded lowest score due to addition of higher proportion of sugar beet sugar imparts undesirable taste to the beverage. Sample P_2 ranked best among all samples after control. Statistically sample P_2 was significantly superior over other samples. P_3 ranked lower among all the samples due to its undesirable taste and brown color which was not preferred by panel members.

Organoleptic evaluation of sugar beet sugar based pomegranate beverage stored at refrigeration temperature (4^0C)

The sensory evaluation of selected pomegranate beverage (P_2) was carried out for 120 days at refrigerated condition. The different sensory attributes like color and appearance, taste, flavor and overall acceptability. The data on changes in sensory properties are depicted in Table 4.

Table 4: Organoleptic evaluation of sugar beet sugar based pomegranate beverage stored at refrigeration temperature

Sample	Sugar beet sugar based pomegranate beverage (P2)			
Storage days	Color and appearance	Flavor	Taste	Overall acceptability
0	8.7	8.5	8.4	8.6
30	8.7	8.4	8.1	8.6
60	8.6	8.4	8.0	8.5
90	8.5	7.9	7.8	8.4
120	8.3	7.2	7.0	7.3
SE ±	0.023	0.037	0.015	0.013
CD @5 %	0.102	0.112	0.049	0.058

The data in the above table revealed that there was slight change in sensorial parameters in 120 days. Changes in organoleptic qualities were observed at 30 days interval. It was observed that fresh beverage scored highest score (8.6) as compare to stored beverage. From the table it was clear that there was slight change in taste of the beverage (8.4 to 7) during the storage period of 120 days.

During storage of beverage from 0 to 90 days there was decrease in sensory score for overall acceptability (8.4) which was found to be at par with fresh sample. On 120 th day of storage there was significant decrease in sensory score for flavor, taste and overall acceptability (7.3) but liked moderately by the panel members. There were no evidences of microbial spoilage.

It can be concluded from the score that gulwel ghana based beverage can be stored for 120 days at refrigeration temperature without affecting sensorial parameters. However, its acceptability score was slightly decreased and liked moderately. Similar results were reported during storage of beverage was observed by Gaikwad *et al.,* (2013) [6].

Effect of storage on chemical composition of sugar beet sugar based pomegranate beverage stored at refrigeration temperature (4^0C)

The effect of storage on chemical composition of pomegranate beverage was carried out for 120 days and results are tabulated in the table 5.

Table 5: Effect of storage on chemical composition of sugar beet sugar based pomegranate beverage stored at refrigeration temperature (4^0C)

Samples	Sugar beet sugar based pomegranate beverage (P_2)			
Storage days	TSS (^{0}Bx)	pH	Acidity (%)	Anthocyanines (mg/100ml)
0	15.0	3.57	0.30	1.76
30	15.1	3.52	0.32	1.60
60	15.3	3.45	0.34	1.52
90	15.6	3.35	0.37	1.45
120	16.0	3.18	0.40	1.41
SE ±	0.012	0.008	0.036	0.014
CD @ 5%	0.040	0.021	0.112	0.046

*Each value represents the average of three determinations

Table 5 revealed that Total soluble solids initially adjusted in formulation showed negligible change during storage period of 120 days at refrigeration temperature. TSS was found to be 15.0 ^{0}Bx and during storage period it ranges was found to be 16.0 ^{0}Bx. TSS of the pomegranate RTS with natural sweetener was not changed during storage period of 6 months (Karakala *et al.,* 2014) [8].

Decreasing trend was observed in pH of beverage. pH of the sample was decreased from 3.57 to 3.18 during 120 days of storage period. Statistically there was significant decrease in pH. However, the acidity content was gradually increased during storage period from 0.30 to 0.40 per cent and the acidity increased due to decrease in pH content. Increasing trends in acidity with increasing storage period have been observed earlier by Chauhan *et al.,* (2012) [2] and noted that since vitamin C is soluble in water and oxidation sensitive which is gradually decreased and this is the main reason for lowering the value of acidity. Decrease in PH and increase in acidity during storage may be due to degradation of carbohydrates present in fruits Ahmad *et al.,* (2011) [1].

Anthocyanine content of the beverage was found to be decreased from 1.76 mg to 1.41 mg per 200 ml. it was observed that there was 20 % loss of anthocyanines (Mirsaeedghazi *et al.,* 2014) [11]. Anthocyanines decreased by 11% after 20 days of frozen storage. Total anthocyanin pigment decreased significantly through storage, at a rate strongly dependent on storage temperature. Most of the anthocyanin was polymerized rather than being lost during storage (Ochoa *et al.,* 1999) [12]. Many factors affect the stability of anthocyanines including temperature, pH, oxygen, enzymes, ascorbic acid, etc. Loss of anthocyanin pigments is probably due to oxidation as well as due to condensation of anthocyanin pigments with ascorbic acid (Choi *et al.,* 2002) [3]. It was also observed that the loss of anthocyanin at

ambient temperature was more (>60 per cent) than that stored at refrigeration temperature (20 per cent).

Conclusion

Due to the good presence of sucrose in sugar beet it has the potential to be used as sweetening agent in food formulations. As results indicated that formulations with up to 50% of sugar beet sugar presented technological characteristics similar to the reference, and maintained them during the storage.

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