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Research Article

Sweet Sorghum Syrup as Natural Sweetener for Glazed Tamarind Candy

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Abstract

Sorghum syrup is a natural old-fashioned sweetener that tastes similar to molasses but is slightly less sweet. Sweet sorghum crop was explored as a source to obtain syrup which can be used as sugar alternative for meeting certain requirements of the food industry. The stems of the sorghum plant (var. CSH22 SS) are crushed and the juice is poured into heated pans, the water evaporates off, leaving sorghum syrup. Sweet Sorghum syrup based glazed Tamarind candy was prepared. Organoleptic evaluation resulted that samples A, B and C were superior over samples D and E. The chemical analysis of glazed tamarind candy indicated that the products had balanced nutritional profile, low moisture content that increases its shelf life. The total energy obtained from glazed tamarind candy was 271.12-260.48 Kcal and the cost of production of product was 8.85-8.45 Rs/100g with respect to control sample.

Keywords: Sweet sorghum syrup; Alternative sweetener; Syrup based products; Sugarcane jiggery; Glazed tamarind candy

Introduction

Sweet sorghum (*Sorghum bicolor L. Monech*), which also names sugar sorghum, is a variety of common grain sorghum. Like the common grain sorghum, it can also produce grain. But the essence of sweet sorghum is not from its seed, but from its stalk, which grows high and contains rich sugar. In general, it can produce stalk 45-75 t/ha. The sugar content in the juice of sweet sorghum varies in different varieties. The Brix ranges generally 15-23%. The stalk accumulates high concentrations of easily fermentable sugars (glucose, fructose and sucrose) in the stalks. Sucrose is the major sugar in sweet sorghum juice which constitutes up to 85% of the total sugars. Hence it is widely believed that it is an alternate energy source that is renewable, sustainable, efficient, cost-effective, convenient and safe to use. This syrup contains small amounts of important minerals. A versatile product that grows easily and used for sweetening drinks, making confections and flavoring meats but its most popular usage in place of sugar [1]. In addition to being table syrup to be eaten with bread or pancakes, it can be used in salad dressing, as a sweetener in baked goods or as ice-cream topping [2].

Sorghum, a grass closely related to sugar cane, originated in Africa and from there spread all over the world. Sorghum is popular because it grows in harsh environments, where other crops fare poorly, and requires little water or fertilizer. Sometimes sorghum is referred to as a "poor people's crop." Nineteenth-century slave traders brought sorghum to the New World, where it was at first called "guinea corn." Sweet varieties of the grass were made into syrup, which was patented as sweet sorghum in 1853 [3]. Sorghum is one of the most important dry land cereals grown in India 7.8Mha and 45.8Mha round the world in 99 countries [4].

The syrup making process involves collection of juice and boiling to concentrate in boiling pans with constant boiling and stirring. The juice in the pan is constantly stirred, and the undesirable coagulate is skimmed off frequently. When the syrup attains a density of 70^{O}Brix (tested with a syrup hydrometer or sugar refractometer). The final syrup is allowed to cool to 140-160^{O}F and is stored in plastic containers at room temperature [5].

The sweet sorghum syrup is an Intermediate Moisture Food (IMF) similar to honey and can be stored at room temperature in air tight containers. The sweet sorghum juice has aw of approximately 0.99 and hence is susceptible to rapid microbiological spoilage. The pH of the food grade sweet sorghum syrup is in the typical range of 5.0-5.5. Thus given a combination of low aw and acidic pH it is possible to store sweet sorghum syrup under ambient conditions [6]. The syrup of more than 72^{O}Brix has found storage life of about 2 years. However, it is important to ensure that no moisture ingress occurs into the product during storage.

The sweet sorghum juice has a balanced nutritional profile containing protein, essential amino acids and minerals [7]. One tablespoon (20g) of sorghum syrup contains 62 calories and 15g of carbohydrates. Sweet sorghum has those hard-to-find nutrients such as iron, calcium, and potassium and was the medicine 4 of the olden days when pills were not yet existent [8]. Pure syrups contain no protein or fat Sweet sorghum syrup has high antioxidant activity. It was found four times the antioxidant power of the darkest honey tested. Anti-oxidants are the substances that restrict body damaging free radicals which are responsible for aging.

Tamarind (*Tamarindus indica L.*) is a multipurpose tropical fruit tree used primarily for its fruits, which are eaten fresh or processed, used as a seasoning or spice, or the fruits and seeds are processed for non-food uses. The species has a wide geographical distribution in the subtropics and semiarid tropics and is cultivated in numerous regions. Tamarind belongs to the dicotyledonous family Leguminosae which is the third largest family of flowering plants with a total of 727 genera recognized and the number of species is estimated at 19,327

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Table 1: Standardization of recipe for glazed tamarind candy with different levels of Sweet Sorghum syrup.

Sample code	Sweet Sorghum syrup (ml)	Sugarcane jaggery (gm)	Tamarind pulp (gm)
Control	----	50	50
A	10	40	50
B	20	30	50
C	30	20	50
D	40	10	50
E	50	----	50

Table 2: Chemical composition of Sweet Sorghum syrup, sugarcane jaggery and Tamarind pulp.

Parameters	Sweet sorghum syrup	Sugarcane jaggery	Tamarind pulp
Brix	72±0.942	----	-------
Moisture %	21.80±0.047	15.80±2.725	19.9±0.5760
Protein %	0.1±0.0306	0.20±0.0471	3.10±0.0994
Fats %	0.1±0.0047	0.10±0.0047	0.10±0.0094
Ash %	4.80±0.094	4.20±0.188	2.40±0.141
Carbohydrates %	71.2±0.188	77.8±0.282	53.30±2.357
Reducing sugar %	22.80±0.141	10.20±0.0942	---------
Total minerals %	1.00±0.235	0.98±0.037	---------
Calcium (mg/100gm)	140.00±4.714	12.00±3.29	101±1.8856
Phosphorus (mg/100gm)	70.00±9.4283	4.00±0.471	85±4.714
Iron (mg/100gm)	4.00±0.942	11.00±1.414	0.9±0.0942
PH	5.2±0.0471	4.5±0.0942	1.8±0.047
Vit. C (mg/100g)			40±0.942

*Each value is the average of three determinations.

[9]. The most valuable and commonly used part of the tamarind tree is the fruit. It is the richest source of tartaric acid (8-18%) the chief acidulant used preparation of foods in Asian and African countries. The pulp constitutes 30-50 per cent of the ripe fruit [10,11], the shell and fiber account for 11-30% and the seed about 25-40% [11,12]. It is enriched in both nutritional and medicinal values. Therefore tamarind can be used to prepare many value added products such as ready to serve drinks, cordials, chutney and toffees with high taste and need to popularize throughout the country to improve the nutritional status [13]. Tamarind is used in Ayurvedic medicine for gastric and digestion problems. Phytochemical investigation of tamarind has revealed the presence of many active constituents, found throughout the edible portions of the plant [14]. It contains fatty acids like palmitic acid, oleic acid, linoleic acid, and eicosanoic acid, phytochemical constituents like tannins, flavonoids (quercetin and avicularin), alkaloids and several other aromatic compounds [15]. Tamarind health benefits are due to the abundant supply of antioxidants, carotenes, vitamin C, phytochemicals and B-vitamins found in tamarind pulp.

A tamarind candy is a famous product of tamarind pulp. There is a great production and consumption of tamarind candy at home scale. The tamarind candy is prepared by adding sugar/jaggery to the deseeded pulp of tamarind. The mixture is rubbed by hand to prepare small balls/candy of required size [16]. Sometimes these candies are glazed with sugar crystals and wrapped with polyethylene.

Present investigation consists of preparation of Sweet Sorghum based value added product Tamarind candy. Tamarind pulp contain high amount of vitamins, antioxidants and phytochemicals those are lacking in Sweet Sorghum syrup. A combination of Sweet Sorghum syrup with tamarind pulp in the product provides balanced nutritional profile and masks the muddy taste and dark color of syrup. These products are easy to prepare on farm scale with minimum requirements and skilled labor.

Materials and Methods

The present investigation was carried in Department of Food Science and technology, College of Food Technology, VNMKV, Parbhani (MS. India). Sweet sorghum stems (var. CSH22 SS) were obtained from Sorghum Research Station, MAU Parbhani. Sesame seeds and Sugarcane jaggery were procured from local market Parbhani. Chemicals of analytical grade (Thomas Baker chemicals limited, Mumbai) and glassware were obtained from College of Food Technology, VNMKV, Parbhani.

Preparation of glazed Tamarind candy

Tamarind pulp of variety Ajanta was cleaned and made free of fibers and seeds. Finely crushed jaggery was added and mixed well. The mixture was rolled with hand and prepared balls of required size. The candies were coated with fine sugar crystals and packed in polyethylene packs [17].

Standardization of recipe for glazed tamarind candy with different levels of Sweet Sorghum syrup

The data in depicted in Table 1 shows recipe for preparation of glazed tamarind candy with different levels of Sweet Sorghum syrup. All samples contained 50g tamarind pulp in their recipe. Sweet Sorghum syrup was increased in each sample by 10ml and sugarcane jaggery was decreased by 10g. Control sample was made with sugarcane jaggery 50g. Samples A, B, C, D and E contained 10, 20, 30, 40, 50 ml Sweet Sorghum syrup and 40, 30, 20, 10 and 00g sugarcane jaggery respectively.

Analytical Methods

Chemical characteristics

Total soluble solids (TSS) were measured by using hand refractometer (Erma Japan) and reported as ^{O}Bx. The pH was determined by using a digital pH meter (ELICO LI 612). Estimation of moisture, ash, protein, crude fat, total carbohydrates, reducing sugar was done according to AOAC, [18] and Minerals content was estimated by method given by Ranganna [19]. Organoleptic Evaluation of glazed tamarind candy was done with nine point hedonic rating scale. The total energy was calculated theoretically [20]. The cost of food product was calculated by considering the current prices of raw materials from local market including the processing cost and cost was calculated per Kg of formulated food. The analysis of variance of data obtained was done by using Completely Randomized Design (CRD) as per method given by Panse and Sukhatme [21].

Results and Discussion

The results and relevant information obtained during present investigation are presented and discussed in this chapter.

Table 3: Chemical composition of glazed tamarind candy prepared with different levels of Sweet Sorghum syrup.

Samples	Moisture %	Protein (g)	Fats (g)	Ash %	Carbohydrate %	Reducing sugar %	Ca (mg)	P (mg)	I (mg)
Control	22.20	2.66	0.10	3.30	65.50	20.10	56.00	42.00	5.90
A	30.60	2.67	0.12	3.26	64.84	21.36	68.8	48.60	5.80
B	36.80	2.66	0.10	3.32	64.18	22.67	81.60	55.20	4.50
C	41.20	2.67	0.12	3.38	63.52	23.88	94.40	61.80	3.80
D	48.80	2.66	0.10	3.50	62.80	25.14	107.20	68.40	3.70
E	51.20	2.67	0.12	3.50	62.18	27.40	120.00	75.00	2.40
SE	0.587	0.587	0.004	0.0337	0.0337	0.587	1.5147	1.154	0.005
CD at 5%	1.88	1.88	0.012	0.1036	0.1036	1.786	3.552	3.552	0.188

Ca=Calcium; P= Phosphorus; I= Iron; *Each value is the average of three determinations

Chemical composition of Sweet Sorghum syrup

The chemical composition of Sweet Sorghum syrup described in Table 2 shows that the syrup had 72^{O} Brix TSS, 21.80% moisture, 0.1% proteins, 0.1% fat, 4.80% ash, 71.2% carbohydrates, 22.80% Reducing sugar and 1.00% total minerals. The syrup contained 140.00mg calcium, 70.00mg Phosphorus and 4.00mg/100gm Iron. pH of the syrup was 5.2. The chemical composition of Sweet Sorghum syrup is influenced by type of variety, growing season, agroclimetic conditions and stage of maturity. These results were in good agreement with the results reported by Rajvanshi et al., [22] and Reddy et al., [23].

Chemical composition of Sugarcane jaggery

The chemical composition of sugarcane jaggery in Table 2 represents that it contain 15.80% moisture, 0.2% proteins, 0.1% fat, 4.20% ash, 77.8% carbohydrates, 10.20% Reducing sugar and 0.98% total minerals. The mineral content includes 12.00mg/100gm Calcium, 4.00mg/100gm Phosphorus and 11.00mg/100gm Iron. pH of jaggery was 4.5. Seasonal and agroclimetic variations were taken into consideration to compare the results with the results of Rao, et al., [24].

Chemical composition of tamarind pulp

The results obtained for chemical composition of tamarind pulp described in Table 2 reveals that the tamarind pulp contained 19.9% moisture, 3.1% protein, 0.1% fat, 2.4% ash and 53.3% total carbohydrates. The minerals include 101mg calcium, 85mg phosphorus, 0.9mg Iron and 40mg/100g Vitamin C respectively. pH of tamarind pulp was 1.8. The above values were found resembles to the values reported by Cardoso et al., [25].

Chemical composition of tamarind candy prepared with different levels of Sweet Sorghum syrup

The data explained in Table 3 shows chemical composition of various samples of tamarind candy. The moisture, ash, reducing sugars, calcium and phosphorus content of various samples was increased and carbohydrates and iron content decreases with increase in Sweet Sorghum syrup in the samples. The moisture was in the range of 22.20- 51.20% for samples control, A, B, C, D and E respectively which coincides with higher moisture of Sweet Sorghum syrup (21.8%) than sugarcane jaggery (15.8%). The protein and fat content of samples does not show any notable change as the same quantity of raw material tamarind pulp used in the preparation of all samples. It was in the range of 2.66-2.67% and 0.10-0.12% respectively. Ash content was highest in sample E 3.50% and lowest in control sample 3.30% as Sweet Sorghum syrup contained more ash (4.8%) than sugarcane jaggery (4.2%). Sugarcane jaggery contained more carbohydrates (77.8%) than Sweet Sorghum syrup (72.2%) therefore the total carbohydrates of tamarind ball samples decreased from 65.50-62.18% for sample control, A, B, C, D and E respectively. The reducing sugars were 20.10, 21.36, 22.67, 23.88, 25.14 and 27.40% for the samples control, A, B, C, D and E respectively. As the reducing sugar content of Sweet Sorghum syrup was higher than sugarcane jaggery which contributes the reducing sugars of the samples increases with increase in concentration of Sweet Sorghum syrup. There was notable increase in calcium and phosphorus content in the sample which was the result of high level of these minerals in Sweet Sorghum syrup. It was in the range of 56.00-120.00mg/100g and 42.00-75.00mg/100g respectively. The decreasing values of iron content were found with decrease in sugarcane jaggery in the samples. It was found 5.90, 5.80, 4.50, 3.80, 3.70 and 2.40mg/100g of respective samples. This might be due to higher iron content of sugarcane jaggery than Sweet Sorghum syrup. The obtained results

Table 4: Organoleptic evaluation of glazed tamarind candy.

Samples	Color	Texture	Taste	Appearance	Overall acceptability
Control	9	9	9	9	9
A	9	9	9	8	9
B	7	8	8	8	8
C	7	7	7	7	7
D	5	6	6	7	6
E	5	5	4	6	5
SE	0.471	0.471	0.471	0.4714	0.4714
CD at 5%	1.450	1.450	1.4504	1.450	1.450

*Each value is the average of three determinations

Table 5: Theoretical energy value of glazed tamarind candy.

Samples	Constituents			Total energy (Kcal)
	Protein	Carbohydrate	Fat	
Control	2.66	65.5	0.10	273.54
A	2.67	64.84	0.12	271.12
B	2.66	64.18	0.10	268.26
C	2.67	63.52	0.12	265.84
D	2.66	62.8	0.10	262.74
E	2.67	62.18	0.12	260.48

Table 6: Techno-economical feasibility of glazed tamarind candy.

Sr. No.	Ingredients	Rate (Rs./kg)	Cost (Rs.)/100gm					
			Control	A	B	C	D	E
1.	Sweet sorghum syrup	25 Rs/kg	00	0.25	0.50	0.75	1.00	1.25
2.	Sugarcane jaggery	35 Rs/kg	1.75	1.40	1.05	0.70	0.35	00
3.	Tamarind pulp	100Rs/Kg	5.00	5.00	5.00	5.00	5.00	5.00
A) Total cost of raw materials			6.75	6.65	6.55	6.45	6.35	6.25
B) Processing cost			2.00	2.00	2.00	2.00	2.00	2.00
C) Miscellaneous cost			0.20	0.20	0.20	0.20	0.20	0.20
Total cost of production (A+B+C) /100g			8.77	8.85	8.75	8.65	8.55	8.45

were in good agreement with results reported by Singh et al., [17] and Byrappa et al., [26].

Organoleptic evaluation of glazed tamarind candy

The panel of semi- trained judges consisting of 10 members was given samples for organoleptic evaluation of glazed tamarind candy prepared with various combinations of Sweet Sorghum syrup presented in Table 4 reveals that the sensory scores for color, taste, appearance and overall acceptability of samples A, B, C, D and E decreases with increase in concentration of Sweet Sorghum syrup in all the samples. The darkness in the color of tamarind candy increased and thus sensory scores for color decreased from 9-5 in the respective samples with increase in level of Sweet Sorghum syrup this may be due to umber color of raw material Sweet Sorghum syrup. The scores obtained for texture of samples were decreased from 9-5 from samples control, A, B, C, D and E respectively as related to stickiness of sweetener Sweet Sorghum syrup. The sensory scores for taste, appearance and overall acceptability goes on decreasing from 9-4, 9-6 and 9-6 for samples control, A, B, C, D and E respectively as the level of Sorghum syrup increased in the samples this might be related to the muddy taste of Sweet Sorghum syrup.

From the present study it can be concluded that acceptable quality of tamarind candy prepared with 10% (A), 20% (B), and 30% (C) of sweet sorghum syrup was superior over samples 40% (D) and 50% (E). The similar products prepared using tamarind pulp showed coinciding results reported by Cardoso et al., [25] and Joshi et al., [27].

Theoretical energy value of glazed tamarind candy

Theoretical energy value of glazed tamarind candy made with different levels of Sweet sorghum syrup presented in Table 5 states that the control sample yields 273.54Kcal energy. The total energy obtained from Sweet Sorghum syrup was lower than sugarcane jaggery. Therefore the total energy of sample A accounts to 271.12Kcal. The samples B, C, D and E accounted 268.26, 265.84, 262.74 and 260.48Kcal respectively. The sugarcane jaggery contained more carbohydrates than Sweet Sorghum syrup that contributes to the total energy value of the product.

It was concluded from the above experiment that the increase in Sweet Sorghum syrup level in the product decreases its energy value and proven to be best alternative to sweeteners like sugarcane jaggery [27,28].

Techno-economical feasibility of glazed tamarind candy

The techno-economic feasibility of glazed tamarind candy prepared with Sweet Sorghum syrup was determined by calculating the total cost of production for 100g of product presented in Table 6 reveals that the cost of production of tamarind candy prepared with varying concentration of Sweet Sorghum syrup was ranged between 8.85-8.45Rs/100g.

The cost of production of control sample was 8.77 Rs/Kg. It shows that the added Sweet Sorghum syrup decreases the cost of production of tamarind candy in the samples. This was due to lower cost of production of Sweet Sorghum syrup than sugarcane jaggery. It was clear from the above experiment that the use of economic Sweet Sorghum as alternative sweetener in variety of foods reduces the cost of food product.

Conclusion

It may be concluded from present investigation that Sweet Sorghum syrup obtained from stalk juice was rich source of reducing sugars and total minerals. It can be used as ingredient in variety of food formulations. The value addition of Sweet Sorghum syrup as alternative sweetener in foods gives additional income to farmers. The confectionery product glazed tamarind candy prepared form Sweet Sorghum syrup was nutritionally balanced, acceptable to the consumers and rated at par with control samples.

Utilization of economical Sweet Sorghum syrup in these products as alternative sweetener masks the muddy taste and dark color of syrup. These products were easy to prepare on farm scale with minimum requirements and skilled labor and thus ready for commercialization.

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