DOI: *10.15613/fijrfn/2020/v7i1/203380*
ISSN (Print) : 2349-8897
ISSN (Online) : 2350-1006
***FoodSci*: Indian Journal of Research in Food Science and Nutrition,** *Vol 7(1), 6-14, January-June 2020*

Preparation and Evaluation of a Novel Natural Sweetener

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Abstract

A natural sweeterner using Sapota fruit was formulated with the objective to develop sapota syrup and to analyseits physiochemical characteristics and evaluate the organoleptic acceptance of syrup as a sweetener. Good quality sapota was purchased and syrup was prepared. The percent yield and physicochemical properties of the sapota syrup was determined. Sapota syrup was incorporated into Grape squash, in four different variations (25%, 50%, 75% and 100%) and its sensory attributes were evaluated. Results showed that overall yield of the Sapota syrup was 200 ml/kg of fruit. The TSS, pH, sucrose, titrable acidity, moisture and available waterof sapota syrup was found to be 21%, 5.3, 6.6%, 1.3%, 46% and 0.95 respectively. The amount of non-reducing sugars (Glucose and fructose) was also analyzed and it was found to be 4.2% and 6.6% respectively. Complete replacement of sugar syrup in Grape squash was acceptable without affecting its sensory attributes.

Keywords: Grape Squash, Organoleptic Acceptance, Physio Chemical Characteristics, Sapota Syrup

1. Introduction

"Human desire for sweet taste spans all ages, races, and cultures. Throughout evolution, sweetness has had a role in human nutrition, helping to orient feeding behavior toward foods providing both energy and essential nutrients. Infants and young children in particular base many of their food choices on familiarity and sweet taste"[1]. **"**Humans can distinguish between five basic tastes, including sweet, salty, umami, bitter, and sour"[2]. "Our sense of taste acts as a major determinant for our strong preference for sweet foods and their over consumption. The detection of sweet-tasting compounds provides input on the caloric and macronutrient contents of ingested foods"[3]. "Sweet taste is associated with food reward and energy source in the form of carbohydrate. Excessive sweet consumption is blamed for the prevalence of obesity. However, evidence for the potential of sweet taste to influence food intake and bodyweight regulation in humans remains unclear"[4]. "Sweetness improves the palatability of food. Thus, adding sugar to foods with high nutrient quality may increase the chance that they are consumed. Chocolate milk is an example of increasing the palatability of milk for kids, which provides important nutrients particularly calcium, potassium, and vitamin D"[5]. "Sweetness from sugar can also improve the palatability of foods for the elderly by compensating for the chemosensory losses that the elderly experience"[6].

"Sweet taste is commonly thought to help identify sources of carbohydrate"[7]. "Sucrose, saccharin, sucralose, cyclamate, aspartame, and thaumatin all taste sweet to humans"[8]. "The most commonly understood added sugar is sucrose or table sugar. Sucrose is a simple carbohydrate and occurs naturally in plants because they make sucrose

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via photosynthesis. The highest concentrations of sucrose are found in sugar cane and sugar beets, which are the main sources for making commercial sugar"[9].

"Sugar alcohols are derivatives of monosaccharides, disaccharides, and other oligo saccharides, and they can occur naturally in many fruits and vegetables. Sugar (sucrose) has several functional properties in food and, so far, no other sweetener has been found or developed to duplicate all or even many of them. These functional properties are derived from the sensory and physical properties of sugar and its many reactions and interactions with the other food ingredients present"[6]. "There are several sources and types of sugar such as fruits, fruit juice concentrate, cane sugar, beet sugar, molasses, nectar, honey, corn sweetener, brown sugar, invert sugar"[10].

"The sugars has been suggested as causative factor of many diseases, such as obesity, dental caries, diabetes mellitus, myocardial infarction, dyspepsia and peptic ulceration"[11]. "Also a dramatic rise in the prevalence of insulin resistance and type 2 diabetes mellitus has been paralleled by increasing dietary consumption of sugar"[12]. "Certain food such as added-sugars food may be capable of triggering addictive responses in some individuals, leading at last to compulsive and obsessive overeating"[13]. "Also sucrose sweetened soft drinks and food might increase risk of type 2 diabetes due to their readily absorbable carbohydrates. Cola type soft drinks contain caramel coloring, which are rich in advanced glycation end-products that might increase insulin resistance"[14]. "Sucrose and fructose have a greater effect in raising blood lipids, particularly triacylglycerols, than do other carbohydrates"[15]. "A high sucrose diet acts as a promoter of cancer development and has been demonstrated to cause progression towards malignancy of tumors in the colon"[16]. "Added sugars positively associated with risk of esophageal adenocarcinoma, supplementary fructose associated with risk of small intestinal cancer"[17].

"The demand for new alternative "low calorie" sweeteners for dietetic and diabetic purposes has increased worldwide"[18]. "The demand greatly increased for natural sweetening agents, especially for non-sacchariferous sweetening agents, because they are highly potent, useful, safe and low-calorie sugar alternatives"[19]. "Consumer interest in natural sweeteners has grown spectacularly in recent years because of the rejection of artificial food additives as well as serious health concerns about high sugar intake. Although many natural compounds are sweet in taste, none of them has actually replaced sucrose. The quest for an ideal alternative to sucrose remains open and challenging"[20].

"Replacement of sugars with Non sugar sweeteners bears promise of health benefits primarily by reducing the contribution of sugars to daily calorie intake and thus reducing the risk of unhealthy weight gain"[21]. "The definitions and terminology for Non sugar sweeteners vary. In some cases, the term "artificial sweeteners" is used as a synonym for Non sugar sweeteners, in other cases as a subcategory. In this systematic review, we use the term "Non sugar sweeteners" as a category including both artificial sweeteners and naturally occurring non-caloric sweeteners"[22].

"Artificial sweeteners have gained increasing attention as dietary assessment tools to help combat the obesity epidemic by providing a sweet taste without the extra calories"[23]. "Taste has a significant role in human perception of food quality, contributing to its overall pleasure and enjoyment. To this end, the developments of sweeteners as food additives that mimic the sweet taste of natural sugars suggest promise"[24]. "The search for sugar substitutes from natural sources has led to the discovery of several substances that possess an intensely sweet taste or taste-modifying properties. About 150 plant materials have been found to taste sweet because they contain large amounts of sugars and/or Polyols or other sweet constituents"[25].

"Squash, a ready to drink beverage, is nonalcoholic concentrated syrup that is usually made from fruit juice, water and sugar or sugar substitutes The squash importance is its nutritional content and delicious flavor. The grape squash contains vitamin A, vitamin C and potassium. Wild range of juice varieties belonging to *Vitisvenifera* and *Vitislabrusca* and their hybrids are available. Grapes can be utilized for preparations of squashes and they are in small scales in many parts of the country. But the specific variety is not standardized for specific value added product for its quantity and quality traits after their preparation"[26].

Based on the above discussion the broad objective is to develop a natural sweetener and specific objective is to prepare a syrupout of sapota fruit, to analyse physicochemical parameters and incorporate the syrup into a fruit based product and study its acceptability.

2. Methodology

"Sapota Fruitis the main ingredient chosen for this study.

Figure 1. Sapota fruit.

Sapodilla fruit is mainly consumed fresh as a dessert due to its pleasant sweet flavor and aroma. Sometimes the fruit is chilled prior to eating which improves its flavor. Some people make syrup and vinegar from the sapodilla juice and jams from the flesh"[27] (Figure 1).

2.1 Procurement of the Ingredient

Sapota fruits were purchased from local fruit market. Fresh fully mature and ripen Sapota fruits were chosen. It is a very important initial step as under ripen Sapota tend to have a gummy texture and it will lack in sweetness. Any immature fruit carrying a green tint was excluded. Damaged or insect molded fruits were discarded.

2.2 Preparation of Sapota Syrup

Double washed the sapota fruits in heavy force of running water to remove unwanted debris stuck to the fruits. The skin of the fruits were peeled with minimal loss of fruit pulp and the seeds were removed manually. Then the fruit was sliced and blended thoroughly in a jar. The fruit puree was strained using a muslin cloth and the clear extract thus obtained was boiled to 230^0 F. This thick syrup got is used as an alternative for sugar (Figure 2).

Figure 2 shows the flow diagram of the various steps followed in preparation of sapota syrup.

2.3 Quality Analysis of Sapota Syrup

The yield of sapota syrup was measured by using quantitative method. The sapota syrup was qualitatively analyzed for Total soluble solids, pH, reducing sugar, titrable acidity, non reducing sugars, and moisture and water activity.

2.3.1 Total Soluble Solids (TSS) (°Brix)

Total soluble solids mean theamount of total soluble solid present in the unit volume of solution. Total soluble solids content of a solution is determined by the index of refraction. This is measured using a refractometer, and is referred to as the degrees Brix. Sugar concentration is expressed in degrees Brix. One degree Brix is 1 gram of sucrose in 100 grams of solution and represents the strength of the solution as percentage by mass. Since TSS

Ripe Sapota fruits
↓
Washed and peeled
↓
Made into small pieces
↓
Removed the seeds
↓
Pulp was Blended
↓
Extraction of juice
↓
Strained
↓
Clear Sapota extract is boiled at230˚F.
↓
Made into a syrup

Sapota fruit sliced | Sapota extract | Sapota Syrup

Figure 2. Preparation of sapota syrup.

levels are sensitive to the growing conditions of crops, it is one of the indicators used to judge the quality of fields[34].

2.3.2 pH

The digital pH meter was first calibrated by using 4 pH and 7 pH buffer solution. The electrode was washed with distilled water and blotted with tissue paper. About 10 ml of fruit juice was taken in beaker and the pHwas determined.

2.3.3 Reducing Sugars (RS)(%)

The titrimetric method of Lane and Eynon as described by Ranganna[34] was adopted for the estimation of reducing sugars.

$$\text{Reducing sugar (\%)} = \frac{0.052 \times V \times 100}{T \times W}$$

0.052 – Glucose equivalent
V – Total volume made up
T – Titre value
W – Weight of the sample

2.3.4 Titrable Acidity (Percent)

Titratable acidity of fruit juices is an important parameter in determining fruit maturity and sour taste in citrus fruits.

Total acidity content of the products was estimated in terms of citric acid. It was determined by titrating the sample against 0.1 N Sodium Hydroxide (NaOH) solutions. A few drops of one percent phenolphthalein were used as an indicator.

The titrable acidity was expressed in terms of per cent citric acid equivalent adopting following formula:

$$\text{Titrable acidity (\%)} = \frac{T \times N \times V \times 0.064 \times 100}{V_1 \times W \times 1000}$$

T	=	Titre value,
N	=	Normality of NaOH
V	=	Total volume madeup
0.064	=	Equivalent weight of citric acid
V1	=	Volume taken for estimation
W	=	Weight of the sample

2.3.5 Non-reducing Sugars (NRS)(%)

The value of non-reducing sugars was recorded by the subtracting the value of reducing sugars from total sugar. Reducing sugars are important in many food reactions, such as browned toast, through a reaction called the Maillard reaction.

Sucrose (%) = (% Total sugars – Reducing sugars ordinally present) × 0.95

2.3.6 Moisture Content

"Moisture content is one of the most important and widely used indices in processing and testing foods. Theterms "water content" and "moisture content" have been used interchangeably in literature to designate the amount of water present in foodstuffs and other substances. Becausedry matter content in food is inversely related to its moisture content, moisture content has great economic importance to the food processor and consumer. The amount of moisture is a measure of yield and quantity of food solids, and can be a direct index of economic value, stability, and quality of food products"[29].

2.3.7 Water Activity (a_w)

This is the most important parameter of water in terms of food safety. Water activity or aw is the partial vapor pressure of water in a substance divided by the standard state partial vapor pressure of water.

In the field of food science, the standard state is most often defined as the partial vapor pressure of pure water at the same temperature. Using this particular definition, pure distilled water has a water activity of exactly one.

Water Activity = Relative Humidity of Airspace Over the Food/100.

2.4 Formulation and Standardization of Product

Grape squash was developed by using varying proportions of sapota syrup. Four variations like A, B, C, D were prepared by substitution of sapota syrup as a natural sweetnerat a level of 25, 50, 75 and 100% for sugar syrup respectively. Along with this, the standard Grape squash was also prepared.

The standard and varying levels of sapota syrup incorporated grape squash was subjected to sensory analysis by 30 semi trained panel members using a score card developed based on 5 point hedonic scale.

3. Results and Discussion

3.1 Quality Analysis of Sapota Syrup

3.1.1 Yield of Sapota Syrup

Freshly ripen Sapota was measured in terms of the yield. The amount of Sapota was measured and the overall yield of Sapota syrup obtained after the extraction of it was considered for the preparation of sweetener. One Kg of Sapota yielded 200 ml of sapotasyrup. "Extraction of date syrup from dates usually gives a yield of 60%. It usually extracted by means of pressure or heat extraction (with 2.5 times their weight water)"[35]. Extraction of sapota syrup from sapota gives a yield of 20%.

3.1.2 Compositional Characteristics of Sapota Syrup

Quality analysis is essential for a new product formulation. Since sapota syrup is to be used as a natural sweetener so the syrup was analyzed for its compositional characterisitics. The details regarding the quality of the syrup are given in (Table 1).

The Total Soluble Solids (TSS) of sapota syrup was found to be 21%. It is a known fact that as the fruit matures it becomes less acidic, sweeter fruit. pH of the sapota syrup

Table 1. Quality analysis of sapota syrup

Sl. No.	Parameters	Sapota Syrup
1.	Total soluble solids (TSS)%	21%
2.	pH	5.3
3.	Reducing sugars	
	Glucose	4.2%
	Fructose	5.1%
4.	Non reducing sugar	
	Sucrose	6.6%
5.	Titrable acidity	1.3%
6.	Water activity (a_w)	0.95
7.	Moisture	46%

were analyzed and it was found to be 5.3. Non reducing sugar (Sucrose) content of the syrup was analyzed and found to be 6.6% and the total amount of Reducing sugars were also analyzed in terms of percentage and the glucose content was found to be 4.2% and the fructose content was about 6.6%. The titrable acidity of the syrup was analyzed and found to be 1.3%. The Moisture and Available water of the syrup was also taken into consideration and were analyzed and found to be 46% and 0.95.

The Total Soluble Solids (TSS) and refractive index of the date syrup were higher (84.45% and 1.4885 respectively). This is principle due to the high level of sugars and relatively low moisture content. The pH value recorded 4.91 for date syrups. The optical density of 20% TSS of date syrups at 520 nm was 0.56. Earlier studies[30] reported that, "the prepared date syrup had high acidity 0.69% (as citric acid), therefore the expected storage ability will be high".

"Date flesh obtained from Saidy date (semi dry) variety was analyzed for their constituents and compared with the date syrup extracted by different methods (water bath, rotary evaporator and microwave), which concentrated by rotary and microwave. It was found that the moisture content was 9.75%, while, the moisture content of date syrup concentrated was highest in water bath method, and lowest in microwave method. These differences were due to the type of the used method"[31]. "Significant (p < 0.05) differences were observed in moisture content with all different methods of extraction. These data are in same line with those reported by El-Beltagy, *et al.*"[32]. "The different extraction methods tested no significant (p< 0.05) differences between rotary evaporator and microwave methods in dry matter, total sugars and reducing sugars, dry matter, total sugars and reducing sugars of date flesh were 89.99%, 77.70% and 75.2%, respectively. Reducing sugars were the predominate sugars in the Saidi date variety (75.2%). A considerable amount of non-reducing sugar was found, as their content was 2.50% of its total sugar content in date flesh. Meanwhile, significant (p <0.05) differences were observed in non-reducing sugars. Within each row means that those with the same letter are not significantly different (p<0.05). Sugars were determined with all used methods of extraction"[33].

In comparison with this study it is clear that the date's syrup has the moisture content of 9.75%, whereas it was 46% in sapota syrup. The date syrup contained 2.50% of non-reducing sugars where as sapota syrup has 6.6% of total sugars, which is comparatively higher than date syrup.

3.2 Sensory Analysis

3.2.1 Mean Score for Sapota Syrup Incorporated Grape Squash

The details regarding mean score for standard and varying

Table 2. Mean Score for standard and varying proportions of sapota syrup incorporated grape squash

Sl. No.	Criteria	Maximum Score	Standard Mean ± SD	Sample Mean±SD			
				A(25%)	B(50%)	C(75%)	D(100%)
1.	Appearance	5	4.86±0.33	4.16±0.85	4.16±1.04	4.6±0.98	4.76±0.33
2.	Colour	5	4.8±0.40	4.56±0.91	4.4±0.75	4.56±0.71	4.56±0.49
3.	Consistency	5	4.7±0.45	4.4±0.84	4.33±1.01	3.9±0.70	4.66±0.37
4.	Flavour	5	4.7±0.45	4.26±0.96	4.63±0.70	4.56±0.49	4.83±0.27
5.	Taste	5	4.7±0.44	4.6±0.66	4.43±1.02	4.13±0.99	4.73±0.44

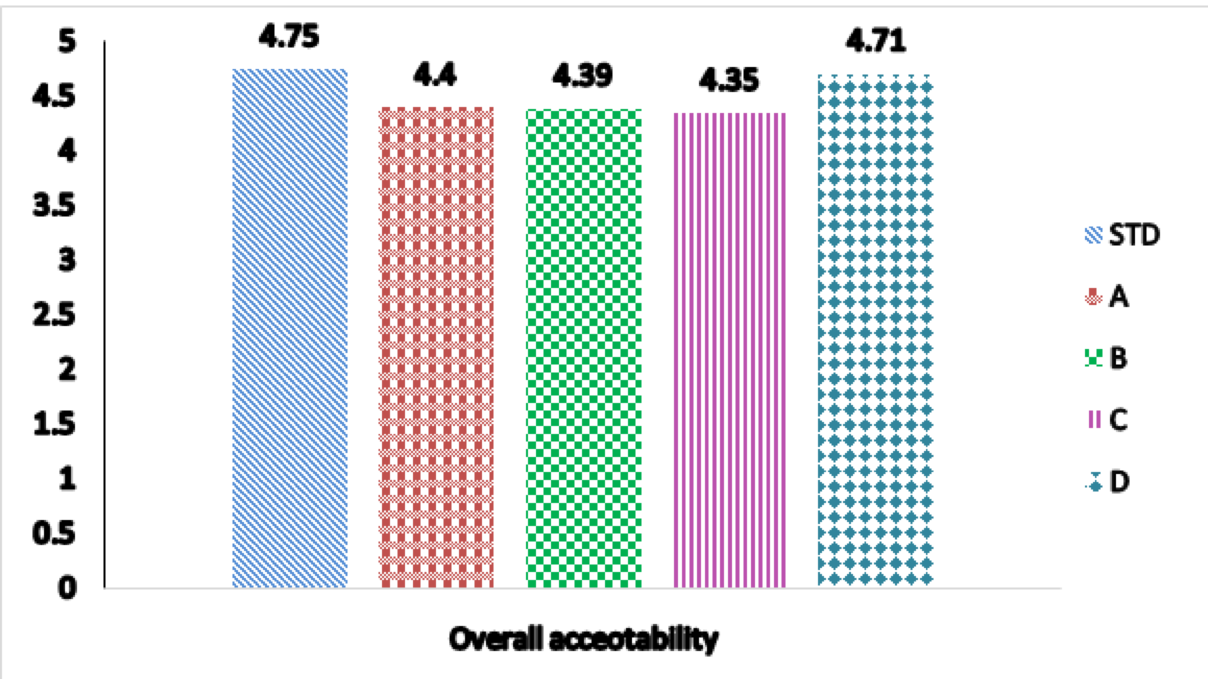

Figure 3. Overall acceptability of sapota syrup.

proportions of sapota syrup incorporated Grape squash is given in Table 2 and (Figure 3).

Figure 3 results show that on incorporation of sapota syrup in grape squash; Sample D had the highest mean score of 4.71 among the other variations. It is observed that the quality of the sapota syrup incorporated Grape squash was acceptable with good sensory qualities.

4. Conclusion

Replacement of sugars with Non sugar sweeteners gives promising health benefits primarily by reducing the contribution of sugars to daily calorie intake and thus reducing the risk of unhealthy weight gain. Sapota syrup was found to be acceptable on complete replacement of sugar in grape squash without affecting the quality attributes.This study provides more scope for use of natural sweeteners in more such fruit squash preparations.

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