Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(2): 610-613
Received: 27-12-2020
Accepted: 12-02-2021

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Development of sugar free grapes products – using grape pomace and assessing its quality and acceptability

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Abstract
An increasing demand for sugar free products are increasing world over including India which results in replacement of sucrose with fructose. Hence there is an urgent need was felt to develop suitable alternatives for sucrose and to enhance nutritional value of developed grapes pomace products. The present study, therefore, aimed to develop sugar free grapes pomace products such as squash, RTS and jam and to assess its quality and acceptability. The grapes variety and the processing industry was selected to collect the grapes pomace, were further processed and incorporated in the development of products. In the preparation of jam, squash and RTS the sugar as a raw material play an important role, so an effort was made to prepare a product with fructose in the place of sugar. The developed product was analyzed for its nutrient content and its sensory quality were also analyzed to ensure the acceptability of the products. In conclusion, it can be said that Grape pomace, a waste by-product can be a good source of value addition for the sugar free products.

Keywords: Grapes pomace, sugar, fructose, pectin, functional foods

Introduction
Grape pomace is the solid remains (waste by-product) of grapes after pressing for juice or oil. Over 60 percent of the grape pomace dry matter is indigestible in vitro. This indigestible fraction is composed of dietary fiber (Non Starch Polysaccharides and lignin) as well as Condensed Tannins and Resistant Proteins. These by- products can also be considered a cheap source for the extraction of antioxidant flavanols (Yu *et al*., 2013) [1].
Pomace also acts as a natural food preservative that possibly interferes with bacterial growth. It, therefore, may be used as a functional food ingredient for promoting human health and extending shelflife of food products (Yadav *et al*., 2015) [2].
People's interest towards functional foods increased for past ten years that resulted in high-quality products development as an important research direction. Nowadays, consumer awareness regarding functional foods and their relationship with health led to an increase of innovations in this field (Bornkessel *et al*., 2014) [3] The increase of food demand at global level requires changes of foods manufacturing processes to make them sustainable by protecting the environment and reducing costs. Vegetables and fruit byproducts are valuable ingredients that can be used to enrich foods, wine industry being one of the fields that produce this kind of waste (Iuga *et al*., 2020) [4]. Hence, considering these benefits, in the present study an attempt was made to develop sugar free products such as jam, squash and RTS to which grape pomace was incorporated in to enhance its nutritive value. Sucrose is the main sugar used in jam, squash and RTS preparation; however excessive consumption of sugar has been related to several diseases; therefore its replacement by alternative sweeteners is an attractive solution. The substitution of sucrose in jam, squash and RTS preparation can cause changes in texture, structure and flavor, making them less attractive to the consumers. Therefore the diet grapes pomace products were standardized to give adequate nutritional profile, maintaining their desire texture for the products developed and flavor characteristics in comparison with the products available in the market. In this study sucrose was replaced by fructose, which in turn resulted in potential low glycemic index, reduced calories and enriched with dietary fiber.

Materials and Methods
a. Selection of Variety
Grapes (*Vitis sp.)* belonging to Family Vitaceae is a commercially important fruit crop of India. About 80% of the production comes from Maharashtra followed by Karnataka and Tamil Nadu.

More than 20 varieties of grapes are cultivated in India and only a dozen are commercially grown and are grouped under four categories such as colored seeded (Bangalore blue and Muscat), colored seedless (Beauty seedless and sharad seedless), white seeded (Anab-e-shahi and Dilkhush) and white seedless (Perlette, pusa seedless, Thompson seedless).
The most important variety grown in Coimbatore district, Tamil Nadu state is Muscat Hamburg (local name is Panner grapes), hence this variety of grapes is used in the study.

b. Selection of Grapes Processing Industry
The industry selected for the study was M/s KRS organic Farm, Coimbatore, one the leading producer of dried grapes, grapes squash, grapes jam and grapes RTS in the city. The grapes are grown in 15 acres of land with a yield of 4T/ha/yr.

c. Collection of Grapes Waste
After juice extraction from grape fruit, grapes pomace that is discarded as waste accounted for 55 – 65% of the fruit. The percentage of different components present in grapes pomace is seeds (8%), stem (10%), skin (25%) and pulp (57%) (*Mirabella et al., 2014*).
The commercial production of grapes juice, squash, jam and RTS are done in M/s KRS Organic Farm, Coimbatore. There forth after every crush there is a leftover of grapes pomace (2.2T/ha/year) with skins, pulp, seeds and stems were collected separately and were further processed for the present study.

d. Preparation of Grapes Pomace Pulp
The collected grapes pomace was boiled for 10 minutes and made into pulp and further used in the preparation of jam, squash and RTS.

e. Preparation of diet grapes pomace jam
The jam was prepared by boiling the grapes pomace pulp with required amount of pectin and citric acid until it reaches to 45^0 bx. The fructose (10g) was added along with color and preservative. The prepared jam was hot filled in the sterilized bottle leaving 1" head space on the top and then sealed tightly. The product was labeled with suitable nutritional information.

f. Preparation of diet grapes pomace squash
The syrup was prepared with required amount of fructose (20g), water, pectin and citric acid. The prepared syrup was filtered and was allowed to cool. The grape pomace pulp was then mixed with cool syrup. The prepared squash was stored in the sterilized bottle leaving 1" head space on the top and then sealed tightly. The product was labeled with suitable nutritional information. The squash is prepared with diluting one part of prepared squash with three parts of water.

g. Preparation of diet grapes pomace RTS
It is not diluted before serving and is supplemented with acidic ingredients and stabilized with a preservative and pasteurization process. The syrup was prepared with required amount of fructose (3g), water and citric acid. The grapes pomace was then mixed with hot syrup. The prepared RTS was hot filled in the sterilized bottle leaving 1" head space on the top and then sealed tightly. The packed juice bottle was pasteurized. The product was labeled with suitable nutritional information.

h. Proximate analysis of the developed grapes pomace products
The grapes pomace products such as jam, squash, RTS were analyzed for the following qualities as furnished in Table 1.

Table 1: Proximate Analysis of the Developed Grapes Pomace Products

S. No	Chemical constituents	Method adopted
1.	Moisture	Hot air oven method
2.	Sugars	Shaffer somogyi method
3.	Protein	Lowry's method
4.	Fibre	Acid and alkali titration
5.	Anthocyanin	Differential assay method
6.	Antioxidant activity	DPPH Test

i. Sensory evaluation of the grapes pomace products
The developed diet grapes pomace products made from fructose were evaluated organoleptically for appearance, flavor, sweetness, taste and overall acceptability by the method as described by Larmond (1977) [6]. The samples were presented to semi trained judges selected from staff and students of Centre for Post Harvest Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. The score card with 9 point hedonic scale was used to evaluate the products, where 1 represents extremely disliked and 9 represent extremely liked.

Results and Discussion
In recent years, this fruit processing waste has received much attention as a potential source of value products and it is inferred from the below table that the developed grapes pomace products contain considerable amount of anthocyanin and the calories were found to be less than 50 kcal.

Table 2: Quality Analysis of Diet Grapes Pomace Products (per 100g)

Name of the Constituents	Diet Squash		Diet RTS		Diet Jam	
	Fresh	Stored	Fresh	Stored	Fresh	Stored
pH	4.65	4.12	4.15	4.00	3.56	3.21
TSS (ºB)	45.0	45.8	8.0	8.5	45.0	45.9
Moisture (%)	78.0	77.2	78.0	77.1	23.6	23.0
Titrable acidity	1.50	1.62	0.56	0.63	0.45	0.60
Reducing sugar (%)	8.56	8.94	8.54	8.85	9.35	9.74
Total sugar (%)	13.4	13.9	13.7	14.1	14.5	15.0
Calories (Kcal)	53.6	55.6	54.8	56.4	58.0	60
Ascorbic acid (mg)	10.2	9.8	10.3	9.9	10.5	9.7

pH
The pH of the diet grapes pomace products was analyzed both in fresh and stored products (3 months). The freshly prepared products of squash, RTS and jam had the pH value of 4.65, 4.15 and 3.56. There was a slight decrease in the pH value of the stored products.
The similar trend was also seen in the study of Torezan (2002) [7] in which mango jam with no sugar was prepared and observed for pH during storage which showed the decreasing trend. In a similar study Ehsan *et al*. (2003) [8] reported a decreasing trend in pH of grape fruit and apple marmalade during storage. It could be inferred that the decrease in pH of the developed products may be due to the formation of free acids and hydrolysis of pectin (Muhammad *et al*., 2008) [9].

Total Soluble Solids (TSS)

It was observed that total soluble solids (TSS) increased during the storage of the diet grapes pomace products. The TSS of the diet grapes pomace products were below the specification of standard value but still the texture of the products were well maintained by the addition of pectin.

In another study Ehsan *et al*., (2002) [8] reported an increase in TSS of watermelon lemon jam from 68.6 to 68.9 and grape fruit marmalade from 70 to 70.8 during 60 days of storage. The increase in TSS contents of the product may be due to the solubilization of jam constituents during storage (Muhammad *et al*., 2008) [9].

Moisture (%)

The moisture content of the grapes pomace products were found to be 78 per cent for diet grapes pomace squash and RTS, 23.6 per cent for diet grapes pomace jam. The moisture content of the developed grapes pomace products were found to be decreased during the storage period.

The similar trend was also seen in the study of Anjum *et al*., (2000) [10] who also observed decreased in per cent of moisture from 79 per cent to 77 per cent after 60 days of storage in dried apricot diet jam.

Titrable acidity

The titrable acidity increased during the storage period of the developed grapes pomace products. The initial titrable acidity for squash was 1.50, RTS 0.56 and jam 0.45.

The results are in agreement with Anjum *et al.,* (2000) [10] observed increased in per cent acidity from 0.65 to 0.70 per cent after 60 days of storage in dried apricot diet jam.

Reducing sugar (%)

The reducing sugar of diet grapes pomace squash as 8.56, grapes pomace RTS as 8.54 and diet grapes pomace jam as 9.35. The slight increase of reducing sugar were seen in the developed products during storage period. Anjum *et al.,* (2000) [10] while working on apricot diet jam observed increase in reducing sugar.

Total Sugar (%)

Sugars are the most important constituents of fruit product and an essential factor for the development of flavour of the food product as well as also act as natural preservative. There is a great demand for food with a reduced sugar content and/or without sugar, but maintaining their sensorial attributes like taste, flavor and texture has been a challenge, this being the case of standardizing the products with low caloric value. The initial total sugar of the grapes pomace products such as squash was in the range of 13.4 per cent, RTS as 13.7 per cent and in jam it was 14.5 per cent. There was a slight increase in the total sugar after a period of 3 months.

The increase in total sugar might be due to the conversion of starch and other insoluble carbohydrates into sugars. The increasing trend of total sugar content during present study agrees with the findings of Muhammad *et al*. (2008) [9] who observed an increase in total sugar content of diet apricot jam from during storage. Vidhya and Narain (2011) [11] also reported an increase in total sugar content of preserved products using wood apple.

Total calories (Kcal)

The jams, squash and RTS prepared with sucrose, contain the higher energy values, in average 278 kcal/100 g for jam, 200 - 220 kcal/100g for squash and RTS. The products that were done with grapes pomace as raw material and with the replacement of sucrose with fructose resulted in decrease of calorie content to less than 60 kcal in all the developed products.

Ascorbic acid (mg)

The ascorbic acid content of the prepared food products were in the range of 10 – 11 mg per 100 g of the sample. During the storage period there was a slight decrease in the ascorbic acid content of the sample.

In a similar research done by Torezan (2002) [7] reported that jam prepared by faster processing techniques retained two fold vitamin C content (14.5mg/100g) than prepared by conventional methods (7.6mg/100g).

Sensory evaluation of the Grapes Pomace Products

Overall acceptability of the developed products plays an important role in product development. Results regarding overall acceptability of the grapes pomace products such as jam, squash and RTS showed that overall acceptability (determine with the average grading of color, flavor, taste and texture) gradually decreased in all samples during storage.

Though the products were developed from the grapes pomace the products had good score for all the sensory attributes.

Table 3: Sensory Attributes of the Diet Grapes Pomace Products

Diet Grapes pomace products	Storage Days	Sensory Attributes				
		Color & Appearance	Flavor	Texture	Taste	Overall Acceptability
Squash	0	8.5±0.3	8.2±0.4	8.1±0.3	8.1±0.3	8.8±0.4
	90	8.0±0.6	8.1±0.4	8.0±0.5	7.8±0.3	8.1±0.3
RTS	0	8.6±0.5	8.5±0.5	8.3±0.7	8.4±0.8	8.6±0.5
	90	8.0±0.2	8.4±0.6	8.0±0.4	8.2±0.5	8.3±0.6
Jam	0	8.5±0.5	8.4±0.4	8.6±0.4	8.5±0.2	8.5±0.5
	90	8.1±0.6	8.1±0.3	8.1±0.4	8.4±0.8	8.3±0.6

Conclusion

During industrial processing of fruits, large quantities of wastes are generated. This has become a serious problem as they exert an influence on environment and need to be managed and/or utilized. Further exploitation of the fruit processing by-products as sources of functional ingredients and possible applications has become a promising field and global requirement due to the increase in the concern towards the environment. Natural functional compounds from fruit processing wastes can be used to replace synthetic additives adding multifunctional concepts by combining health benefits to technological use.

Grape pomace represent the winery`s industry most important by-product. Its valorizing becomes of interest in many industrial fields and medicine. Still, industrials are focusing to integrate the valorization of grape pomace, with cost-effective, eco-friendly techniques, capable to deliver natural value-added products. The seasonal availability of the waste, however, demands judicious handling and proper pre treatment to achieve economic feasibility and efficiency.

By evaluating the sensory quality and consumer acceptance of grapes pomace incorporated products, the present study proves that grapes pomace has a greater potential to serve as a source of functional food ingredient. The combined effort of waste minimization and sustainable utilization of the by-products would substantially reduce the large quantities of fruit wastes accumulated globally.

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