



ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(7): 2315-2319
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www.thepharmajournal.com
Received: 17-04-2022
Accepted: 05-06-2022

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Development and evaluation of high value products from grape pomace

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Abstract

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. The grapes variety and the processing industry was selected to collect the grapes pomace, were further processed and incorporated in the development of high value products such as jam, squash and RTS. The difference between the developed products and the commercial products is that, these products had highly acceptable sensory qualities specially the mouth feel of the product, which give thatste of the grapes skin and seeds and also the total antioxidant activity of these products were comparatively higher than the ordinary squash and RTS prepared from grape juice.

Keywords: High value products, waste by-product, non-starch polysaccharides and lignin

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.

Recently, there has been an upsurge in the exploitation of the waste materials generated by the wine industry/grapes processing industries. These wastes could be an alternative source for obtaining natural antioxidants, which are considered completely safe in comparison with synthetic antioxidants.

Grape pomace is characterized by high-phenolic contents because of poor extraction during juice/winemaking, making their utilization worthwhile and thus supporting sustainable agricultural production. For this reason, important quantities of phenolic compounds still remain in the by-products and there is great interest in the exploitation of this type of grape

byproducts to obtain potentially bio-active phenolic compounds. The by-products obtained after winery/juice exploitation, either seeds or pomace, constitute a very cheap source for the extraction of antioxidant flavanols, which can be used as dietary supplements, or in the production of phytochemicals, thus providing an important economic advantage. Therefore, there is an urgent need for development of a process that would utilize the grape waste for the production of natural antioxidants and natural color as a replacer for synthetic antioxidants and color. 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, 2014). Grapes pomace collectively includes stems, seeds and skins. (Fontana *et al.*, 2013).

With this background, the following work was taken up on development and evaluation of high value products from grape pomace was attempted.

Methodology

Selection of place

In Tamil Nadu, Theni district accounted for a major share of 78 percent of grape area under cultivation (1886.7 ha) followed by Coimbatore with 9 percent (214.3 ha), Dindugul with 8 percent (197.0 ha) and Krishnagiri with 2 percent (56.3 ha). In terms of production, Theni district accounted for 76 per cent share in the state's total production of grape (29338 T), followed by Coimbatore district, 11 percent (4110T) and Dindugul district 8 percent (3246 T). However, Coimbatore district ranks first in terms of productivity (19.1 tons per ha) followed by Dindugul district with 16.9 tons per ha.

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).

In Tamil Nadu, Muscat (Paneer) variety is extensively grown and hence this variety of grapes is used in the study.

Selection of grape 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. The important variety grown is Muscat (local name is Panner grapes). 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.

KRS organic Farm, Coimbatore			
Variety	Area	Yield/yr	Waste yield/yr
Muscat (Paneer)	15 acres	4T/ha	2.2T/ha

Screening and Characterization of grape waste

After juice extraction from grape fruit, grapes pomace that is

discarded as waste accounted for 55-65 percent of the fruit. The percentage of different components present in grapes pomace is seeds (8 percent), stem (10 percent), skin (25 percent) and pulp (57 percent).

In recent years, this fruit processing waste has received much attention as a potential source of value products and it is inferred from the table 1 which shows that the fresh grapes pomace contain considerable amount of anthocyanin and hence it can be used as a substrate for the solvent extraction of anthocyanin. The Typical composition of the grapes pomace is given in table 1.

Table 1: Proximate analysis of the grapes pomace

Parameters	Values per 100g
Moisture (%)	42.48
Sugar (g)	15.20
Protein (g)	8.50
Fibre (g)	45.65
Total lipids (g)	07.10
Anthocyanin (mg)	143.45
Antioxidant activity (µg/ml)	15.0

From the table it could be seen that, the moisture content of grapes pomace was 42.48g, sugar 15.20g per 100g, protein 8.50g, fibre 45.65g, anthocyanin 143.45mg per 100g and antioxidant activity was 15.0µg/ml.

Standardization of grape pomace incorporated products jam

Jam is prepared by boiling the fruit pulp with sufficient quantity of sugar to a reasonably thick consistency, firm enough to hold the fruit tissues in position. It can be prepared from one kind of fruit or from two or more kinds.

In its preparation about 45% of fruit pulp should be used for every 55% of sugar. The FPO specification of jam is 68.5%, TSS, 45% of fruit pulp and 0.5 - 0.6% of acid (citric acid) per 100 gm of the prepared product. The table shows the development of grape pomace jam along with the standard.

Table 2: Standardization of Grape Pomace Jam

Ingredients	Grape Jam	Grape Pomace Jam	Sugar free grape pomace Jam
Fruit pulp-1 Kg	Grapes pulp	Grape Pomace	Grape pomace
Sugar	750 g	750 g	Fructose-15g
Citric acid	5 g	5 g	5 g
Pectin	5 g	5 g	5 g
Preservative (Sodium Benzoate)	200 ppm of benzoic acid	200 ppm of benzoic acid	200 ppm of benzoic acid

Method

1. The sound, juicy and ripe grapes were selected for preparing standard. The grapes were washed in running water to remove dust and dirt. The stem was removed manually and the berries were collected separately. The grapes were made into pulp using food processor.
2. The grape pomace was used in the place of grape pulp for the preparation of grape pomace products.
3. The pulp/pomace was taken in a vessel along with citric acid, pectin and sugar (required amount) and was heated over fire by stirring continuously, until the final TSS reaches to 68.5⁰ bx.
4. The preservative was added and mixed well.
5. In the preparation of sugar free squash, fructose was used as a sweetener at the final stage of preparation.

- The jam was removed from the fire and packed in sterilized bottle and was stored at room temperature for cooling.
- The bottles were sealed and labeled with suitable information.
- The developed products were subjected to sensory evaluation and also for quality analysis.

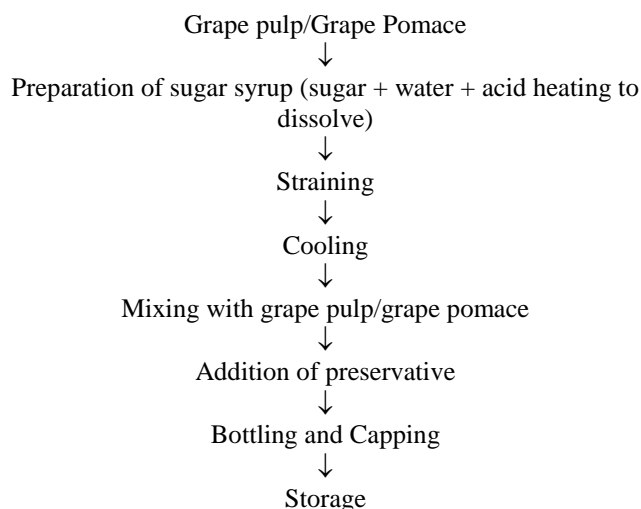
Squash

Squash is nothing but the partially strained fruit juice with considerable amount of cane sugar. The fruits like mango, pineapple, citrus fruits, grapes, pomegranate etc. are used for the preparation of squash for immediate use as well as for future use. The FSSAI (FPO) specification of squash is juice content (25%), acidity (1%), TSS (45° b), preservative (350 ppm of SO₂ (KMS) (or) 600 ppm of benzoic acid (sodium benzoate)). The table shows the development of grape pomace squash along with the standard.

Table 3: Standardization of Grape Pomace Squash

Ingredients	Grape squash	Grape Pomace squash	Sugar free grape pomace squash
Fruit pulp-1 Kg	Grapes pulp	Grape Pomace	Grape pomace
Water	1 litres	1 litres	1 litres
Sugar	1.75 kg	1.75 kg	Fructose-45 g
Citric acid	15 g	15 g	15 g
Preservative (Sodium Benzoate)	600 ppm of benzoic acid	600 ppm of benzoic acid	600 ppm of benzoic acid

Method



- In the preparation of sugar free squash, fructose was used as a sweetener.
- The bottles were sealed and labeled with suitable information.
- The developed products were subjected to sensory evaluation and also for quality analysis.

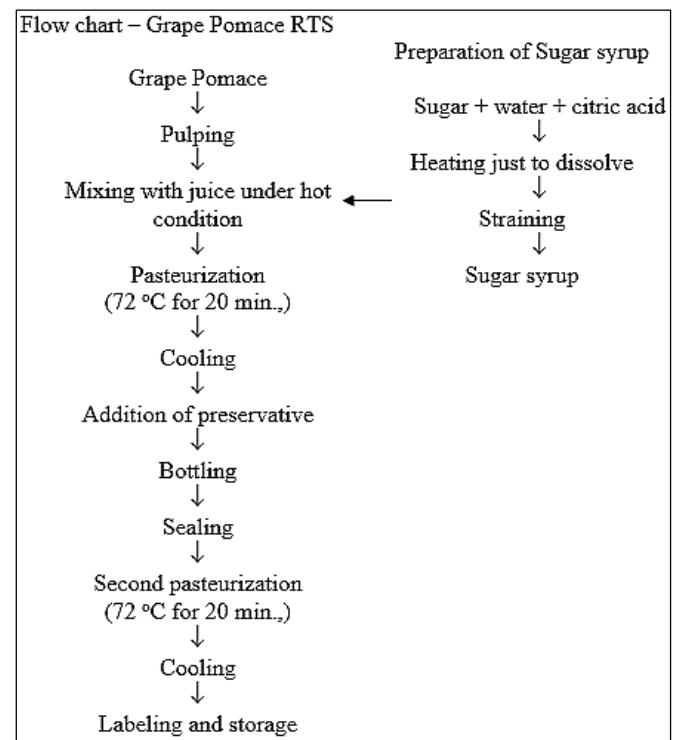
Ready to Serve (RTS)

It is not diluted before serving and hence the name ready to serve (RTS). This product is preserved by the addition of sugar and is supplemented with flavoring, coloring and acidic ingredients and may be stabilized with a preservative and pasteurization process. The FSSAI specification for fruit juice is 10 %, TSS is 10 % and acidity is 0.3 %.

Table 4: Standardization of Grape Pomace RTS

Ingredients	Standard (Grape RTS)	Grape Pomace RTS	Sugar free grape pomace RTS
Fruit pulp-1 Kg	Grapes pulp	Grape Pomace	Grape pomace
Water	8 litres	8 litres	8 litres
Sugar	1.75 kg	1.75 kg	Fructose-45 g
Citric acid	15 g	15 g	15 g
Preservative (Sodium Benzoate)	600 ppm of benzoic acid	600 ppm of benzoic acid	600 ppm of benzoic acid

Method



Products developed using grape juice, which is commercially in vogue for the development of jam, squash and RTS served as control.

Proximate analysis of the developed products

The developed products were analysed for TSS (°B), Titrable acidity, pH, Reducing sugar (%), Total sugar (%), Calories (Kcal), Ascorbic acid (mg), Anthocyanin (mg) and Total antioxidants using AOAC methods.

Sensory quality

The quality parameters like color, flavor, texture, taste and overall acceptability of the fresh and stored samples were organoleptically evaluated using 9-point hedonic scale by a panel of 15 semi trained judges.

Results and Discussion

The nutritional quality of the developed grape pomace jam was analysed and presented in the table below. From the table, it could be inferred that, though the nutritional composition of grape pomace products are comparatively lesser than grape juice products, the anthocyanin and antioxidants were found to be the highest in the grape pomace products. Similarly the results also indicated that sugar free grape pomace jam had the highest nutraceutical properties.

Table 5: Quality Analysis of Grapes Pomace Products

S. No	Name of the Constituents	Grape Jam	Grape pomace Jam	Sugar free grape pomace jam
1.	TSS (°B)	65	63	62.5
2.	Titration acidity	0.82	0.4	0.45
3.	pH	2.8	3.5	3.5
4.	Reducing sugar (%)	14.28	9.35	9.35
5.	Total sugar (%)	62.3	61.4	15
6.	Calories (Kcal)	249	245	60
7.	Ascorbic acid (mg)	12.56	10.56	10.5
8.	Anthocyanin (mg)	20.4	37.5	37.5
9.	Antioxidant (µg/ml)	6.5	12.1	12.1

Grape squash

The developed grape pomace squash were analysed for nutritional and nutraceutical properties and the results showed that the TSS, Acidity and pH did not reveal significant difference, while that of the Anthocyanin (mg/100 g) was 20.4, 39.32 and 39.3 and that of the Total antioxidant activity was (µg/ml) 6.5, 14.83 and 14.80 for grape squash, grape pomace squash and sugarfree grape pomace squash

respectively.

Table 6: Quality Analysis of Grapes Pomace Products

S. No.	Name of the Constituents	Grape Squash	Grape pomace squash	Sugar free grape pomace squash
1.	TSS (°B)	55	54	45
2.	Titration acidity	0.82	1.50	1.50
3.	pH	2.8	4.65	4.65
4.	Reducing sugar (%)	14.28	8.56	8.56
5.	Total sugar (%)	62.3	48	48
6.	Calories (Kcal)	249	192	34
7.	Ascorbic acid (mg)	12.56	10.28	10.2
8.	Anthocyanin (mg)	20.4	39.32	39.3
9.	Antioxidant (µg/ml)	6.5	14.83	14.8

RTS

Table 7 furnishes the results of the nutritional and nutraceutical properties of grape pomace RTS and it also followed the same fashion as that of the other products. There was a retention of the anthocyanin and increased antioxidant level in the grape pomace products irrespective of addition of sugar.

Table 7: Quality Analysis of Grapes Pomace Products

S. No.	Name of the Constituents	Grape RTS	Grape pomace RTS	Sugar free grape pomace RTS
1.	TSS (°B)	55	25	24
2.	Titration acidity	0.82	0.56	0.56
3.	pH	2.8	4.15	4.15
4.	Reducing sugar (%)	14.28	8.54	8.54
5.	Total sugar (%)	18.3	17	12
6.	Calories (Kcal)	249	13.5	7.5
7.	Ascorbic acid (mg)	12.56	15.4	13.0
8.	Anthocyanin (mg)	20.4	30.30	30.3
9.	Antioxidant (µg/ml)	6.5	8.23	8.2

Sensory quality of prepared grape pomace products

The prepared grape pomace products were subjected to sensory analysis by the panel members and the results are furnished below in table. Of the products grape pomace

squash received the highest score, followed by RTS and the jam. Within the products, the grape pomace products obtained the highest score than the control by virtue of the mouth feel of the grape skin and seeds in the products.

Table 8: Sensory Evaluation of Developed Grape Pomace Products

Grape pomace products	Color and Appearance	Flavor	Texture	Taste	Overall Acceptability
Grape squash	8.1±0.37	8.6±0.50	8.5±0.56	8.5±0.56	8.6±0.62
Grape Pomace Squash	8.8±0.40	8.3±0.79	8.6±0.49	8.9±0.54	8.8±0.61
Sugar free grape pomace squash	8.1±0.37	8.6±0.50	8.5±0.56	8.5±0.56	8.6±0.62
Grape RTS	8.2±0.37	8.6±0.50	8.5±0.56	8.5±0.56	8.6±0.62
Grape pomace RTS	8.8±0.40	8.3±0.79	8.6±0.49	8.9±0.54	8.8±0.61
Sugar free RTS	8.1±0.37	8.6±0.50	8.5±0.56	8.5±0.56	8.6±0.62
Grape jam	8.1±0.37	8.6±0.50	8.5±0.56	8.5±0.56	8.6±0.62
Grape pomace jam	8.2±0.37	8.6±0.50	8.5±0.56	8.5±0.56	8.6±0.62
Sugar free grape pomace jam	8.2±0.37	8.6±0.50	8.5±0.56	8.5±0.56	8.6±0.62

Values are mean ± SD

Summary and conclusion

The M/s KRS organic Farm, Coimbatore, has been selected for the present study. There forth after every crush there is a leftover of grapes pomace (2.2T/ha/year) with skins, pulp, seeds and stems. The proximate analysis of the collected grapes pomace was done and the results reflected the amount of anthocyanin present in the grapes pomace as 143.45 mg/100g. The various products have been developed with the help of grapes pomace such as squash, RTS and jam. The

grape pomace products were subjected to sensory analysis and the results proved to be acceptable by the panel members. As people are more conscious about their calorie intake nowadays an attempt was made to develop sugar free grape pomace products such as squash, RTS and jam with the addition of fructose in the place of sugar. The sensory attributes was highly acceptable at 15 per cent incorporation of fructose in the products.



Grape Pomace Syrup

Grape Pomace Squash

Grape Pomace RTS

Grape Pomace Jam

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