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Utilization of Grape Pomace as a Raw Material for the Development of Value Added Products

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A B S T R A C T

The wine-making industries produce millions of tons of residues (grape pomace) after fermentation, which represents a waste management issue both ecologically and economically. After juice extraction from grape fruit, grapes pomace collectively includes stems, seeds and skins that is discarded as waste accounted for 55 – 65 per cent of the fruit. 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. A food processing industry in Coimbatore, that produce the leftover of grapes pomace (2.2T/ha/year) was selected. The grapes pomace were collected separately and were further processed for the present study. The proximate analysis of the grapes pomace showed that the moisture content 42.48 per cent, sugar 15.20g per 100g, protein 8.50g, fibre 45.65g, anthocyanin 143.45mg per 100g and antioxidant activity was 15.0µg/ml. The microbial examination of the grapes pomace was also carried out to ensure the safety of the products. The grapes pomace incorporated products such as grape pomace squash, grape pomace RTS and grape pomace jam was standardized and been evaluated for its sensory quality, storage studies and cost analysis has been calculated.

Introduction

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 (*Fontana et al., 2013*). 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 (Beres *et al.,* 2017).

It is noteworthy that the winery / juice extraction residues could be an alternative source for obtaining natural antioxidants, and are considered completely safe in comparison with synthetic antioxidants such as Butylated - Hydroxy Anisole (BHA) and Butylated - Hydroxy Toluene (BHT), compounds now largely used in the food industry with undesirable effects on the enzymes of human organs. Moreover, the color pigment in the grape waste is anthocyanin which also exhibits antioxidant properties, apart from color. This anthocyanin is a potential food color and can be replacer for synthetic food colours.

Grape (Vitis spp.) is one of the most valued conventional fruits in the world (*Lomillo et al., 2017*). It can be consumed raw or can be used in the formulation of products such as wine, jam, juice, jelly, raisins, vinegar and seed oil. According to OIV Statistical Report in 2017, 75.8 million tons of grapes are produced globally and the majority (57%) is used for the production of wine. The wine-making industries produce millions of tons of residues (grape pomace) after fermentation, which represents a waste management issue both ecologically and economically (Fontana *et al.,* 2013). Grapes pomace collectively includes stems, seeds and skins.

In Tamil Nadu, Theni district accounted for a major share of 78% of grape area under cultivation (1886.7 ha) followed by Coimbatore with 9% (214.3 ha), Dindugul with 8% (197.0 ha) and Krishnagiri with 2% (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 % (4110T) and Dindugul district 8 % (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 (Appasmandri *et al., 2017*).

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.

Materials and Methods

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.

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.

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, 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.

Proximate analysis of Grapes Pomace

Increasing consumers` awareness regarding the using and consumption of natural and safer food additives, creates the need for producers to create natural based food additives. To be cost-effective they appeal to low-cost ingredients and this way is created the alternative of using food industry by-products. In addition, more attention is given for the valorising of the bioactive compounds from these by-products. High amounts of polyphenols and dietary pectins are found especially in red grape pomace (*Deng et al., 2011*).

Grape polyphenols are recommended in the literature for their antioxidant, cardioprotective, anticarcinogenic, anti-inflammatory, antiageing and antimicrobial activities (Xia *et al.*, 2010; Vauzour *et al.*, 2010; Giovinazzo and Grieco, 2015).

Resveratrol was proved to improve some symptoms related to Alzheimer's disease (Pasinetti *et al.*, 2015), important cancer protector (Singh *et al.*, 2015) and having metabolic effect (Gambini *et al.*, 2015; Bitterman and Chung, 2015).

Microbiological Examination of the Grapes pomace

The microbial loads of the samples were enumerated by the method described by Istavankiss (1984). Ten gram of the sample was taken in 90ml sterile water blank and thoroughly mixed in a rotary shaker for 10 minutes. From the solution, a series of 10^{-6} dilution were obtained using serial dilution techniques and was used for the estimation of total plate count. From the 10^{-6} dilution, 1.0ml of the sample was poured into a petri plate and rotated clockwise and anticlockwise for the uniform spreading of the sample. Nutrient agar medium was then added and allowed to solidify. After solidification the plates were incubated at room temperature (28±2^{o}C) for 24 to 28 hours and the colonies were counted. The microbiological examination such as initial total plate count, yeast and mold count of the grapes pomace were done to ensure the safety of the product

Product development from Grapes Pomace

Value added products from grapes pomace viz., preparation of grapes pomace squash, grapes pomace RTS and grapes pomace jam has been standardized and prepared. The nutrient content, shelf life and the cost of the developed products has been studied.

Grapes pomace squash

Squash is nothing but the partially strained fruit juice with considerable amount of cane sugar. The grapes pomace squash was done with ingredients such as grapes pomace pulp (1 L), water (1 L), sugar (1.75 kg), citric acid (10g), tonovin (5 ml) and sodium benzoate (3g).

The FSSAI specification for squash is juice (25 per cent), acidity (1 per cent) and total soluble solids (45^{o} brix).

Grapes pomace was collected, boiled for 10 minutes and made into pulp and then used in the preparation of squash. The syrup was prepared with required amount of sugar, water and citric acid. The prepared syrup was filtered and was allowed to cool. The grape pomace pulp was then mixed with cool sugar 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.

Grapes Pomace - Ready to Serve (RTS)

It is not diluted before serving and it is preserved by the addition of sugar and is supplemented with acidic ingredients and stabilized with a preservative and pasteurization process. The FSSAI specification of ready to serve beverage is juice (10 per cent), acidity (0.3 per cent) and total soluble solids (10 per cent). The ingredients such as grapes pomace pulp (1 kg), sugar (1.75 kg), citric acid (25 g) and water (9 L).

Grapes pomace was collected, boiled for 10 minutes and made into pulp and then used in the preparation of RTS. The syrup was prepared with required amount of sugar, water and citric acid. The grapes pomace was then mixed with hot sugar syrup. The prepared RTS was hot filled in the sterilized bottle leaving 1" head space on the top and then sealed tightly. The juice as well as packed juice bottle was pasteurized. The product was labeled with suitable nutritional information.

Grapes Pomace 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. The FSSAI specification for jam is fruit pulp (45 per cent), total soluble solids (68.5 per cent), sugar (55 per cent), and acidity (0.5 – 0.6 per cent). The various ingredients used in the preparation are grapes pomace pulp (1 kg), sugar (0.75 kg), citric acid (5 g) and pectin (5 g).

Grapes pomace was collected, boiled for 10 minutes and made into pulp and then used in the preparation of jam. The jam was prepared by boiling the grapes pomace pulp with required amount of sugar, pectin and citric acid until it reaches to 68.5^0 bx. 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.

Results and Discussion

Proximate analysis of Grapes Pomace

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.

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.

As regards the general composition of the pomace, the humidity varies between 50% and 72% depending on the grape variety used and the degree of ripening. Insoluble residues have a lignin content of between 16.8% and 24.2% and a protein content of less than 4%. In the usual way, peptic substances are the majority polymer-type constituent of the cell walls present in grape pomace, varying from

37% to 54% of the cell wall polysaccharides. On the other hand, cellulose is the second type of polysaccharides found in grape pomace, varying between 27% and 37% (Centeno *et al.*, 2010).

Microbial Examination of Grapes Pomace

Grape pomace, due to its microbial composition and sugar content, is an unstable product which progressively produces a variety of different chemical and microbial profiles during the storage period. The grapes pomace collected from the food processing industry were processed and stored with the addition of 1 per cent sodium benzoate and 1 per cent citric acid in order to extend the shelf life of the grapes pomace.

The microbial examination of the grapes pomace inferred that, there was a minimum total plate count, while the fungi and yeast were below detectable level. This ensured that the product is safe for further utilization.

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

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

S. No	Name of the Constituents	Grapes pomace Squash	Grapes pomace RTS	Grapes pomace Jam
1.	Moisture	78.0	78.0	23.6
2.	TSS (^{o}B)	54	17	45
3.	Titrable acidity	1.50	0.56	0.4
4.	pH	4.65	4.15	3.5
5.	Reducing sugar (%)	8.56	8.54	9.35
6.	Total sugar (%)	48	13.5	12
7.	Calories (Kcal)	192	54	48
8.	Ascorbic acid (mg)	10.28	10.30	10.56
9.	Anthocyanin (mg)	39.32	38.23	37.5
10.	Antioxidant (µg/ml)	14.83	12.42	12.1

Table.3 Sensory analysis of the developed grapes pomace products

S. No	Sensory attributes	Squash	RTS	Jam
1.	Color & appearance	8.5±0.3	8.6±0.5	8.5±0.5
2.	Texture	8.2±0.4	8.5±0.5	8.5±0.5
3.	Flavor	8.1±0.3	8.3±0.7	8.9±0.5
4.	Taste	8.1±0.3	8.4±0.8	8.7±0.2
5.	Overall acceptability	8.8±0.4	8.6±0.5	8.5±0.5

Table.4 Changes in the sensory characteristics on storage of the developed products

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	8.3±0.4	8.2±0.5	8.1±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	8.3±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**

Development of Value Added Products

Quality analysis of the developed grapes pomace products

The quality analysis of the developed grape pomace products are discussed in table 2. From the below table, it is inferred that the moisture content of grapes pomace squash and RTS was found to be 78 percent and in grapes pomace jam it was found to be 23.7 percent. The total soluble solids for the grapes pomace squash and RTS were found to be 54^{o}B and 17^{o}B and for grapes pomace jam it was in the range of 69 ^{o}B. The titrable acidity in all the grapes pomace products were in the range of 0.30 – 1.50 and pH was in the range of 3.15 to 4.65. The anthocyanin content was in the range of 36.12 – 41.2 mg per 100g.

Since the approximately 70 per cent of grape polyphenols remains in the grape pomace (accumulated in the process of winemaking) (Beres *et al.*, 2017), the positive impact could be observed in grape pomace fortified products, it should be emphasized that grape pomace represents an important source of polyphenolic compounds

The addition of grape pomace resulted in increased levels of total antioxidant contents in all fortified final products. The increase of total antioxidant contents also significantly increased the oxidative stability of fortified products and prolongated the shelf life.

Sensory analysis of the developed grapes pomace products

The sensory analysis of the developed grapes pomace products were done by 15 semi trained panelists and the results are discussed in table 3.

The developed grapes pomace products such as grapes pomace squash, RTS and jam had a very good score for the various sensory attributes such as color and appearance, texture, flavor, taste and overall acceptability.

Grape pomace as a byproduct after the juice extraction, has been incorporated in the value added products such as squash, RTS and jam. The present sensory evaluation showed the successful incorporation of grape pomace in different kinds of juice and jam products.

Shelf life studies of the developed product

The shelf life studies of the developed grapes pomace products is displayed in the below table 4. From the above it was inferred that the grapes pomace products had the shelf life of three months and the products were highly acceptable by the panel members.

Cost Analysis of the developed grapes pomace products

Market-focused pricing takes into consideration of consumer trends, purchasing patterns and demand for food products. The price of the developed products has set to be low enough so that the customers has the purchasing capacity, in a similar way it made sure that the industry also earns a profit from its waste (*Babybowna et al., 2012*).

The cost calculation was calculated for the developed grapes pomace products. It was found to be Rs. 200 per kg for grapes pomace squash, Rs. 100 per kg for grapes pomace RTS and Rs. 700 per kg for grapes pomace jam.

In 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, 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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