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Review Article

A Review on the Nutritional Value and Health Benefits of Different Parts of Grape (*Vitis vinifera* L.)

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ABSTRACT

Grape, scientifically known as *Vitis vinifera* L. is one of the most popular fruits in the world. Grape seeds, skin, stems, and pomace are some of the by-products that winemaking industries obtain, which are collected in large quantities and often regarded as agricultural waste. Grape and its by-products are nutritionally rich in protein, fat and fatty acids. These are significant sources of various phytochemicals including resveratrol, quercetin, anthocyanins, procyanidins, malvidin-3-glucoside, catechin, kaempferol and isorhamnetin. Numerous pharmacological effects of grapes and its constituents have been identified by many studies, including antioxidant, cardioprotective, antiproliferative, anti-inflammatory, anti-aging, anti-candida, anti-diabetic, anti-obesity, antimicrobial and anti-contraction properties. In addition to being eaten as a fresh fruit, grapes are frequently utilized as a raw ingredient to produce a wide range of products, including wine, grape juice, and raisins. Additionally, grape byproducts such as grape seeds, stems, skin, and pomace have been used in the food industry to make fermented milk and grape jam. The current review focuses on the nutrient and phytochemical composition of grapes and their parts, as well as its applications and health-promoting properties with special attention paid to underlying mechanisms of different parts of grapes. Considerable attention should be paid to grape-based products to alleviate and treat a variety of diseases due to their diverse therapeutic uses. In the future, additional bioactive compounds in grape by-products should be separated and utilized to provide health benefits and enhance farmer's income.

Keywords: Grapes, *Vitis vinifera*, antioxidant properties, biological polyphenols, health benefits

Introduction

The vine *Vitis vinifera* L., or *V. vinifera*, is a member of the Vitaceae family and has been domesticated for over 7500 years. Due to its extensive global cultivation, it is today regarded as one of the most significant fruit crops. More than 67 million tons are produced globally each year, of which 80 percentage are used to make wine.[1] According to the archaeological evidence, cultivation of *Vitis vinifera* subsp. *vinifera* began from the wild progenitor of *Vitis vinifera subsp. vinifera*, around 8000 years ago. Wine grape, European grape, and grapevine are other names for *Vitis vinifera*. The three main applications of grapes are for fresh or table grapes, wine, and dried fruit or raisins. Surprisingly, over 1600 different substances have been found in grapes, including the powerful antioxidants resveratrol, lycopene, quercetin, and melatonin.[2] In the skins, pulp, and seeds of grapes, there are significant amounts of many phenolic chemicals.

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Many of these substances might exhibit advantageous biological action because of their antioxidant qualities. Natural antioxidants generated from plants notably phenolics like quercetin, carnosol, thymol, catechin, and morin have recently attracted more attention because they are highly desirable as food additives or nutritional supplements.[3] *V. vinifera* is a source of raw materials used in the pharmaceutical sector due to its antioxidant, cardioprotective, hepatoprotective, anticancer, antibacterial, and antiviral activities. There have been reports of the use of *V. vinifera* or its active ingredients derived from the plant that serve as antibacterial, anticancer, or environmentally beneficial agents.[4] For many illnesses like cancer, cholera, smallpox, nausea, eye infections, sore throats, liver and kidney problems, dried grapes, grape juice, and unripe grapes have all been employed.[5] Numerous studies have shown that grape variety, edaphic, regional, and weather-related factors all significantly influence the phenolic composition of grapes.[6] Due to the bioactive components and therapeutic qualities of grapes, recent studies addressed in the current review supports their use in the development of functional and therapeutic value-added food products.

Methodology

ScienceDirect, Google Scholar, and PubMed were the main databases used in the literature search and screening for the review article. In order to find relevant publications for the study, the references of articles were looked through. Keywords used for the search were *Vitis*

vinifera, nutritional composition of grapes, pharmacological activity of grapes and application of grapes. The search discovered 45 articles published between 2009 and 2023.

Morphology

Vitis vinifera L. is a vine that climbs and with shoots it can grows up to 35 meters. There is need for the support of young grapevine due to its extremely flexible trunk. It can able to hold on to other structure because of the tendrils and secondary shoots that grew from the original or primary lengthy shoot. Main shoot is covered with bark that is wither brown or grey-brown in color, physical appearance is thick and woody. Grape leaves are simple, broad, lobed, with pentagonal-shape. The leaves were between 5-20cm long. Panicles between 10-20 cm long contain the blooms or flowers. The flower which is tiny and unnoticeable, its calyx is five-sided. there are five petals which when joined together and make a part called corolla. The fruit is a fleshy part which is elliptical in shape, 3cm long. In cultivated grapevine, there are different varieties like white, purple, or red in color. There is pointed tip of the oval or pear-shape seeds. They can grow to a maximum length of 6mm.[4, 7]

Nutritional and phytochemical composition

Phenolic chemicals are secondary metabolites linked to the nutritive, pharmacological, taxonomic, and sensory qualities of food. These substances are extracted during the winemaking process from the seeds and skins of wine grapes, which are significant suppliers of these substances.[6] The proximate composition values of different varieties of *Vitis vinifera* and its parts are given in Table 1. Peels and pulps had the highest moisture levels (83.89 to 88.67%), while seeds had the highest protein and total fat contents (6.53 - 7.71% and 10.84 - 13.72% respectively). Ash content ranged from 0.19- 1.52 %. The pulps included nine fatty acids (FA), the peels contained twelve, and the seeds contained eleven. Linoleic acid (LA, 18:2n-6) and palmitic acid (PA, 16:0) were the two main fatty acids in the pulp and peel of the various grape varietals, whereas LA and oleic acid (OA, 18:1n-9) were the two main fatty acids in the seeds. As a result, the grape seed is a reliable source of oil and may be utilized to extract edible oil.[8]

Additionally, grapes include a variety of chemicals that are good for your health, such as polyphenols, which are most prevalent in red grape varieties and include flavonoids, flavonols, and anthocyanins. More specifically, grape pulp and seeds mostly include proanthocyanidins and non-flavonoid chemicals, while grape skins, leaves contain anthocyanins and flavonols. Various bioactive compounds present in different parts of grapes are shown in Table 2. Total phenolic content (TPC) measurements in the grape samples used in this investigation ranged from 0.44 ± 0.02 to 7.94 ± 0.19 mg gallic acid equivalents/g grape sample. Antioxidant activity ranged from 4.88 ± 0.18 mg/g in red Nerona to 0.32 ± 0.001 mg/g in white table grape variety Sultana. Regarding the possible advantages, the high concentration of flavonols—particularly quercetin derivatives—is significant due to their substantial antioxidant activities, which are known to help lower the risk of developing a number of chronic diseases.

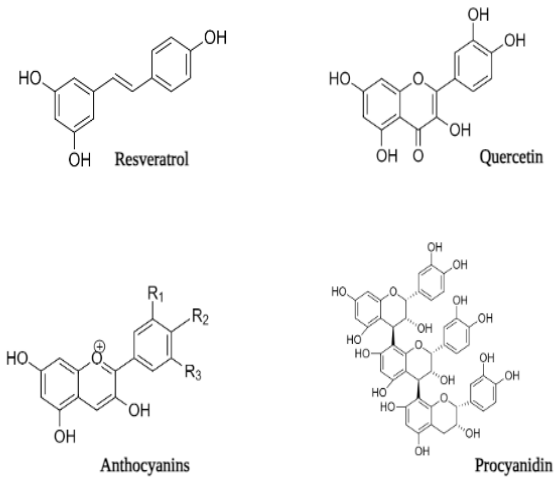

Figure 1: Major phytochemicals found in grape (*Vitis vinifera L.*)

Table 1: Proximate composition of two different varieties of grape (*Vitis vinifera*) and its parts

Part of grape	Variety	Moisture (%)	Protein (%)	Total lipids (%)	Ash (%)	Reference
Peel	*Niagara*	86.08±0.29	0.87±0.02	0.30±0.01	0.77±0.02	[8]
	Brazil	83.89±0.15	0.81±0.02	0.26±0.00	0.71±0.01	
Pulp	*Niagara*	87.40±0.18	0.68±0.02	0.06±0.00	0.28±0.01	[8]
	Brazil	88.67±0.22	0.69±0.02	0.09±0.00	0.21±0.02	
Seed	*Niagara*	8.87±0.07	7.71±0.12	11.53±0.16	1.52±0.03	[8]
	Brazil	10.49±0.17	6.53±0.36	11.90±0.16	1.35±0.02	

Table 2: Bioactive compounds found in different plant *(Vitis vinifera L.)* parts

Part of grapevine	Bioactive compounds present	Pharmacological attributes	References
Grape seeds	Flavan-3-ols (catechin and epicatechin), procyanidins, tannins and gallic acid	Anti-platelet, anti-coagulant, antioxidant, hypo-glycemic, and anti-cancer activity	[10]
Grape skin	Flavan-3-ols, phenolic acids, (+)-catechins, proanthocyanidins, flavonols, and anthocyanins	-	[11]
Grape stem	Gallic acid, catechin, quercetin, quercetin-3-glucoside, malvidin-3-glucoside, malvidin-3-glucoside, resveratrol, and viniferin.	Antimicrobial activity, anti-inflammatory, anti-aging, antioxidant and anticancer properties	[12, 13]
Grape leaves	Glycosylated forms of Myricetin, quercetin, kaempferol and isorhamnetin	Help with the treatment of chronic venous insufficiency hypertension, diarrhea,	[14]

hemorrhage, inflammatory disorders, and hypoglycemia.

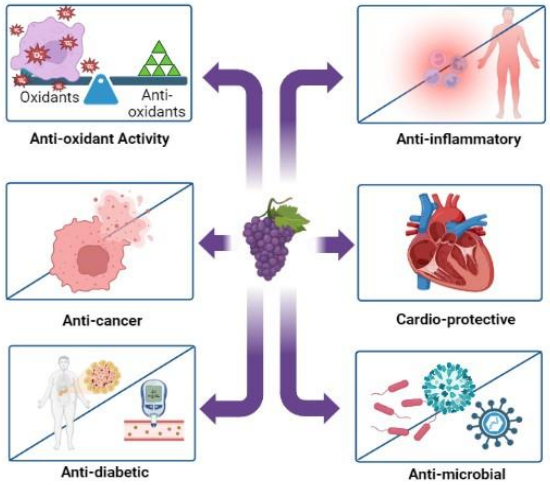

Figure 2: Pharmacological properties of grapes

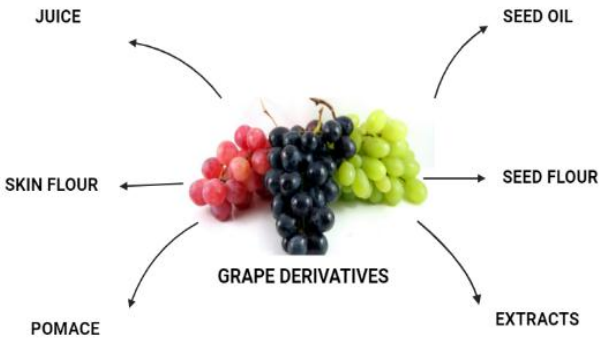

Figure 3: Grape derivatives

By using LC-MS, a total of 25 anthocyanin compounds were discovered, including acetyl, coumaroyl, and caffeoyl esters as well as the 3-O-monoglucosides of delphinidin, cyanidin, petunidin, peonidin, and malvidin and their corresponding conjugates.[9] The four grape varietals' peels and seeds contained trans-resveratrol, but not their pulp. The highest trans-resveratrol concentrations were found in peels, which ranged from 1.17 to 12.96μg g^{-1} wet basis.[8]

Pharmacological properties of grapes

Vitis vinifera contain different phytochemical substances including resveratrol, quercetin, anthocyanins and proanthocyanins (as shown in Figure 1 and Table 3) which possesses antioxidant, antidiabetic, anti-inflammatory properties (as shown in Figure 2).

Anti-inflammatory activity

During inflammation, chemokines, cytokines, cell adhesion molecules, growth factors, antioxidant enzymes are regulated by Nuclear factor kappa B (NF-kB) which is a transcription factors responsible for regulating gene expressions of previously mentioned. Nitric oxide (NO) plays both inflammatory and anti-inflammatory property by these ways: a) At low or non-toxic levels, NO is an effective molecule which is produced by eNOS which stimulate certain pre-inflammatory cytokines namely cyclo-oxygenase 2 (COX-2) and NF-kB. b) At high or toxic levels, NO induces oxidation and nitration. The production of NO was suppressed by flavanols which were highly associated with decreasing the function of iNOS- protein as increased levels of iNOS induces inflammation and damage.[15, 16, 17] It was reported by studies that polyphenols can suppress the activity of NF-kB. Resveratrol belons to stilbenes class found in grapes, is a potent inhibitor of NF-κBactivity. Oxidative stress and inflammation caused by NF-κBwas decreased when the oral supplementation of resveratrol was given to healthy subjects for up to 6 weeks.[18]

Anti-inflammatory activity of *Vitis vinifera* variety named Exalta and Albarossa was found due to the inhibition of Interleukins named IL-8. Due to high levels of anthocyanins in Albarossa skin, flavonols in a variety of Exalta seeds, and procyanidins in both varieties of grapes, both varieties of grapes have anti-inflammatory properties.[19]

Antioxidant activity

Resveratrol found in grapes was found to be antioxidant agent due to following reasons: Regulation and activity of NADPH oxidases was reduced by resveratrol which inhibits reactive oxygen species (ROS) formed by NADPH-oxidases. Resveratrol was observed to prevent various diseases such as degenerative diseases and inflammatory disorders which was caused by increased oxidative stress by increasing antioxidant enzymes namely superoxide dismutase, increases activity of glutathione peroxidise.[20, 21] Intermediates of radicals are removed by grape seed extract as iron-chelating activity of polyphenols present in grapes terminate chain reactions and also inhibits oxidation reactions.[18]

The high contents of flavanols in grapes including quercetin and its derivatives was found to be strong antioxidant agent due to involvement of quercetin in the reduction of risk factors for chronic diseases. Not only quercetin, but also kaempferol and myricetin are capable of scavenging free radicals.[9]

Anti-contraction activity

There are many substances which might cause uterine contractions including PGF2, oxytocin, acetylcholine and calcium channel activators. Grape resveratrol may mimic calcium channel blockers in the plasma membranes thus help to reduce uterine contractions.[22]

Skin-ageing

NF-kB signalling pathway plays a crucial role in inflammation, it is one of the key mediators of ageing and stress occurred in different aspects like genotoxic, oxidative and inflammatory stress are activated by NF-kB.[23] Resveratrol, quercetin, proanthocyanidins, are present in grapes which are linked to their antioxidant and anti-inflammatory property (as shown in Table 2) Anti-ageing activity of grape was accomplished by two distinct pathways: Direct link of decreasing NF-kB by bioactive compounds present in grapes and the other due to decreased mitochondrial damage caused by ROS and act as antioxidant.[24]

Anticancer activity

Antioxidant response mediated by Nrf2 is one of important defence mechanism in cellular level where it provides protection against oxidative stress. ROS and RNS are scavenge by activation of Nrf2. Nrf2 prevent tumorigenesis, maintaining cellular homeostasis which are basic function of Nrf2 at normal physiological conditions.[25]

Grapes contains significant amount of polyphenol resveratrol. Resveratrol inducing certain enzymes which are involved in detoxification such as Phase II detoxifying enzymes, thus preventing the onset and development of carcinogenesis. Nrf2/Keap 1 signalling pathway, which is one of the most crucial cell defence pathways are also activated by resveratrol. Moreover, the apoptotic effects of cytokines, chemotherapeutic drugs and gamma radiations are also enhanced by resveratrol.[26] *In-vitro*, proanthocyanidins in grape seed showed cytotoxicity in cancer cells while in case of normal cells, it has proven non-toxic. The cell death effect in A431 cells was determined,

which was exhibited by *Vitis vinifera* seeds and peel extracts and induce apoptosis.[27]

Antimicrobial activity

Antimicrobial activity of grapes was studied, it has been found that resveratrol showed antiviral effects against virus name polymavirus. Another bioactive compound called Procyanidin in *Vitis vinifera* showed anti-influenza activity by inhibiting the virus replication.[28] DNA synthesis of virus was decreased in two types of cells: Murine fibroblasts and human promyelocytic leukaemia cells by resveratrol and thus showed antiviral activity.[29]

Polyphenols present in grape pomace exhibited antibacterial property, which was found against *E. coli* and *S.aureus*, on Gram-positive bacteria ant bactericidal effects was more as compared to Gram-negative bacteria.[30] There are certain pathogenic microorganisms such as *S.aureus, E. coli, P.aeruginosa and B. cereus* responsible for food spoilage, grape seed extract sowed antimicrobial activity due to presence of fatty acids while grape skin extracts showed no antimicrobial activity against same pathogenic microorganisms.[31]

Anti-obesity activity

Anti-obesity property of grapes was investigated by experiment in which usual and high-fat diets, treated or not treated with grapes seed and skin extract were given to rats for about 6 weeks. It was found that oxidative stress is associated with high levels of triglycerides in case of high-fat diet while on the other hand, fat-induced kidney lipo-toxicity was prevented by grape seed and skin extract.[32] Polyphenols present in grape seed extracts such as procyanidins improve serum and lipid profile, thus reduce fat accumulation.[33] There were some proposed mechanisms found, which showed anti-lipid property of resveratrol, a bioactive compound of grapes. The mechanism including preservation of high-density lipoprotein (HDL) while inhibiting oxidation of low-density lipoprotein (LDL), transfer of cholesterol esters from HDL to VLDL (Very low-density lipoprotein) was reduced.[5] Polyphenolic compound, resveratrol was shown to modulate platelet aggregation, inhibiting the cell proliferation in the smooth muscles, also down-regulating the NF-kB pathway. 3-hydroxy-3-methylglutaryl-coenzyme reductase (HMGCoAR) is enzyme which is involved in the biosynthesis pathway of cholesterol. Resveratrol consumption reduced total serum cholesterol, triglycerides and hepatic HMGCoAR expression.[34]

Table 3: Various pharmacological properties shown by bioactive components present in grape (*Vitis vinifera L.*)

Bioactive components	Pharmacological properties	Description	References
Resveratrol	Anti- inflammatory	Resveratrol supresses the activity of NF-κB activity which is responsible for oxidative stress and causes inflammation	18
	(ii) Antioxidant	Resveratrol reduces the activity of NADPH oxidase activity; thus, it inhibits the formation of Reactive oxygen species (ROS) and increases the activity of certain antioxidant enzymes including glutathione peroxidase	20, 21
	(iii) Anti-contraction	Uterine contraction is reduced by blocking calcium channel blockers	22
	(iv) Skin- ageing	Resveratrol reduces mitochondrial damage, decreases oxidative stress	23, 24
	(v) Anti-cancer	Resveratrol prevents carcinogenesis by involving it in detoxification process	21
	(vi) Antimicrobial	Resveratrol inhibits the virus replication or by decreasing the DNA synthesis of virus	23, 24
	(vii) Anti-obesity	Resveratrol inhibits the oxidation of low-density lipoprotein (LDL), it also modulates the aggregation of platelets, regulates some pathways which are involved in cholesterol biosynthesis	5, 34
	(viii) Anti-candida	Resveratrol prevents vaginal candidiasis	22
Anthocyanins	Anti-inflammatory	Anthocyanins reduces the inflammation by inhibiting the interleukins IL-8	19

Quercetin	(i) Anti-oxidant	Quercetin reduces risk factor of chronic diseases	[9]
	(ii) Skin-ageing	NF-κB activity is reduced by quercetin, also reduces mitochondrial damage thus decreases oxidative stress	[24]
Procyanidin/ proanthocyanidins	(i) Skin-ageing	Procyanidin reduces oxidative stress by decreasing the activity of NF-κB	[24]
	(ii) Anti-cancer	Proanthocyanidins induces apoptosis, it also showed cytotoxicity in cancer cells	[27]
	(iii) Antimicrobial	Procyanidin inhibits the replication of virus and thus showed anti-influenza activity	[28]
	(iv) Anti-obesity	Procyanidin reduces the accumulation of fat and improves lipid profile	[33]
	(v) Anti-diabetic	Glucose uptake is enhanced by procyanidins by modulating the pancreatic beta cells	[5]

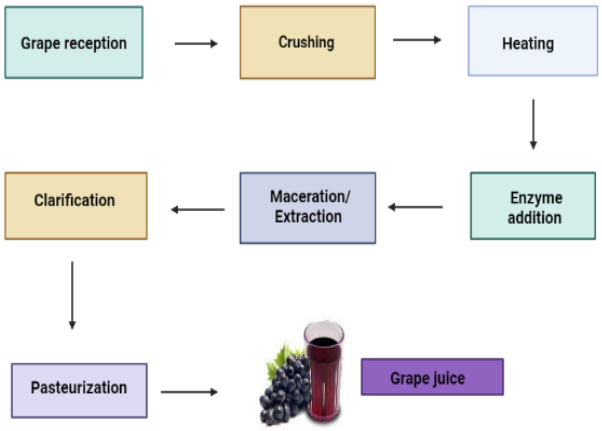

Figure 4: Simplified grape juice flow diagram of hot pressing

Anti-diabetic activity
Phenolic compounds present in grapes possessed insulinotropic property, insulin secretion was increased by 2-8 folds. Pancreatic beta cells are responsible for the secretion of enough insulin to reduce obesity, failure to do so causes high blood glucose levels. Grape procyanidin modulates the proliferation and apoptosis of pancreatic beta cells, that results in the enhancement of glucose uptake under high-glucose concentrations. Grape pomace extract reduces blood glucose levels, showed anti-postprandial hyperglycaemic activity. Moreover, experiment was conducted in which grape-pomace extract was given to diabetic mice (Results of streptozocin) orally, this inhibits the intestinal α-glucosidase and thus showed anti-diabetic effect.[5]
According to the reported literature, *Asparagus adscendens* which is antidiabetic plant showed 19-24% increase in insulin production, which is secreted by pancreatic β cells.[35]

Anti-candida activity
Vaginal candidiasis is a problem faced by women mostly during pregnancy, which can cause preterm labour which can be prevented by resveratrol present in grapes, which act as fungicide agent. High levels of flavonols in grape seed extracts could inhibit candida infections.[22]

Application of grapes in food industry
The yearly global production of grapes is estimated at 75 million tones. In the food business, the majority of grapes are either consumed as fresh fruit or used to make wine, jam, juice, raisins, and other foods (as shown in Fig 3). Winemaking, in particular, uses the majority of grapes. Additionally, due to their significant potential for usage in the food sector, grape by-products including grape pomace and grape seed have attracted growing study interest.[36]

Wine-making
According to reports, one of the most significant agro-industrial sectors in the world uses about 50% of grapes to produce wine. After beer, wine is the alcoholic beverage that is most frequently drank. In 2019, there were 244 million hectoliters of wine consumed globally, according to figures from the International Organization of Vine and Wine.[36] Fresh grapes must be used in the fermentation process to make wine. Yeasts use grape sugars as fuel for the process, which results in the production of ethanol and CO_2 as well as alcohol.[37]
In the processes of wine production, storage, and maturation, a variety of additional substances, including organic acids, polysaccharides, and polyphenols, are also produced or transported from grapes; some of these are accountable for the sensory qualities (such as flavor, color, and taste) and health benefits of wine.[38] Resveratrol, which is mostly present in grape skins and is added to wine during maceration and fermentation, is thought to be responsible for many of the beverage's health benefits. The "French paradox" shows that communities that drink wine moderately and regularly have reduced rates of coronary heart disease, even when they consume high-fat diets on a daily basis. In addition, wine holds great promise for the treatment and prevention of other illnesses like cancer, obesity, and neurological diseases.[39]

Grapes and their derivatives in fermented milk
Fermented milk such as Yoghurt, kefir, and other dairy drinks that make excellent probiotic carriers and are becoming more and more popular worldwide. Due to the presence of live probiotic bacteria, these items are already regarded as nutritious foods. As a result, they have been chosen by numerous researchers as a matrix to which grape derivatives should be added in order to further enhance their functional features. Several kinds of research have been conducted in recent years to assess the effects of adding grape derivatives to fermented milk, particularly yoghurt-based products, such as grape extract, grape skin flour, grape juice, and grape seed or pomace extract.[40]

Raisins
Grapes are currently hand-picked off the vine, placed on clean trays in the spaces between vine rows, and dried in the sun for two to three weeks. The trays are carefully folded into bundles when the moisture level reaches 15% and roasted in the sun for a few additional days. Large stems are then separated, put in sizable wooden bins for moisture equalization, and transported to packing plants after they are loaded onto a conveyor belt. At the packing facility, the raisins are examined for any flaws before being put through a succession of drums, conveyor belts, and chaff- and lightweight fruit-removing devices. Before packaging, the raisins are passed through a laser sorter, which removes any foreign objects with air bursts. Raisins are weighed and packaged in a range of practical sizes following final inspections.[41]

Grape Vinegar
Vinegar is a material made by the alcoholic and subsequent acetous fermentation of liquids or other agricultural products (ethanol, wine, cider, perry, or liquors obtained from grains, such as malted barley. Spirit vinegar, wine vinegar, fruit vinegar, cider vinegar, grain vinegar, and malt vinegar are a few examples of vinegar types. As a raw material, mashes produced by the alcoholic fermentation of liquids containing natural sugar are also used. The type of raw material utilized determines the name of the vinegar. For instance, acetic acid fermentation of grape wine produces wine vinegar, while apple juice fermentation produces cider vinegar, etc.[42]

Grape juice
Grape juice is a clear or hazy liquid that may be produced from grapes using a variety of technical procedures; the most common ones are "Hot press" (HP), "Cold press" (CP), and "Hot Break" (HB). It is a non-fermented, non-alcoholic beverage having a distinctive flavor, color (red, white, or rose), and aroma (typical of the grape type from which the juice was made). One of the oldest fruits consumed by humans was the grape, and regions that grow grapes now employ grape juice as a more affordable alternative.[43]
Any grape variety can be used to make grape juice once it has reached the proper level of maturity. *Vitis vinifera* grape types are used to make grape juice (as shown in Fig 4) in locations that traditionally produce wine; however, Vitis labrusca grape varieties are mostly used to make grape juice in Brazil, where pasteurization preserves the natural flavor. The majority of *Vitis vinifera* grape types lose their unique grape flavor after heat treatment, however American grape cultivars retain this flavor in their juice.[44]

Grape jam
The antioxidant phenolic chemicals flavonoids, specifically, are abundant in grapes, one of the fruits. These substances exhibit a strong ability to absorb free radicals, which can lead to "oxidative stress" and prevent cardiovascular disorders as well as some types of cancer. In addition to other grape derivatives, grape jam is an effective substitute for the commercial exploitation of fruits since it increases the fruit's worth and facilitates year-round access to its healthy components. Additionally, grape juices and jams have a benefit over wine in that they don't contain alcohol, allowing youngsters and those who are infected with certain diseases, such hepatitis, to consume this grape derivative. Fruit jams are frequently used as fillings for cakes, biscuits, and other baked goods. The primary components used to make jam are fruit (in its natural state, in chunks, juice, or pulp), sugar, pectin, and citric acid.[45]

Conclusion

Grape is one of the most produced and consumed fruits in the World, representing a source of polyphenols, especially proanthocyanins, anthocyanins and resveratrol. The different polyphenols significantly support the wide range of biological functions of grapes, including their anti-inflammatory, anti-cancer, anti-diabetic, and anti-microbial properties. As a frequently consumed and healthy fruit, grapes have been utilized as a primary ingredient in a wide range of goods, including wine, grape jam, grape juice, and raisins. The bulk of grapes are used to make wine, which has a number of positive health effects on people. Furthermore, there has been much research done on the use of grape by-products such grape pomace and grape seed, and the food sector has reported improvement in this area. There have been some food products created using these by-products, such capsules containing grape seed extract and grape seed oil. Future research should aim to isolate and characterize more beneficial grape components. It is important to assess their biological activities and learn more about the mechanisms that underlie them. Therefore, greater research on the uses of grape pomace and grape seed extract in food is needed. Additionally, more clinical studies need to be conducted to verify the advantages of grape and its byproducts for human health.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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