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Food Processing and Value Addition in Grapes

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ABSTRACT

Grapes are among the most economically significant fruit crops globally, valued for their diverse uses in fresh and processed forms. However, their high perishability results in considerable post-harvest losses, emphasizing the importance of food processing and value addition. Processing grapes into products such as juice, jam, raisins, and wine enhances shelf life, reduces wastage, and increases profitability. Grape juice production involves steps like extraction, clarification, and pasteurization to maintain quality and safety, while jam-making relies on the proper balance of pectin, sugar, and acid for gel formation. Raisin production, through dehydration techniques like sun drying and mechanical drying, preserves natural sugars and extends usability. Wine production (vinification) transforms grape sugars into alcohol through fermentation, with specific processes for red and white wines. Moreover, grape by-products such as pomace and seeds offer opportunities for valorization through the extraction of phenolics, pectin, and seed oil with nutritional and industrial applications. Emerging technologies, including high-pressure processing, pulsed electric fields, and AI-driven precision viticulture, are revolutionizing grape processing by improving quality, efficiency, and sustainability. Collectively, these advancements contribute to the global grape value chain, supporting economic growth and environmental sustainability in viticulture and food industries.

Keywords: Grapes, Food processing, Juice, Jam, Raisins, Wine

INTRODUCTION

Grape Processing:

Grapes are a significant horticultural crop worldwide, valued for their versatility in fresh consumption and processed forms (Ky, 2024). The global viticulture industry is substantial, with millions of tons of grapes harvested annually (Sharma *et al.*, 2018). However, due to their perishable nature, post-harvest losses can be significant, posing an economic challenge (Casassa and Harbertson, 2021). Food processing and value addition are essential strategies to mitigate these losses, extend shelf life, and enhance profitability for growers and processors (Ky, 2024). By converting grapes into products like juice, jam, raisins, and wine, the industry can create stable, marketable goods that meet diverse consumer demands (Sharma *et al.*, 2018). This process not only preserves the fruit's nutritional value but also transforms it into new products with unique sensory characteristics and applications (Casassa and Harbertson, 2021).

Global and Indian grape production trends between 2015 and 2024 show significant scale and variation in usage patterns. China leads in grape-growing area with 800,000 hectares and a production volume of 14.1 million metric tonnes (MT). Of this, 75% of the grapes are consumed fresh, while 25% go into processing. Italy follows with 700,000 hectares under grape cultivation producing 8.3 million MT, where production is evenly split between fresh use and processing (50% each). India cultivates grapes on 160,000 hectares, yielding 3.4 million

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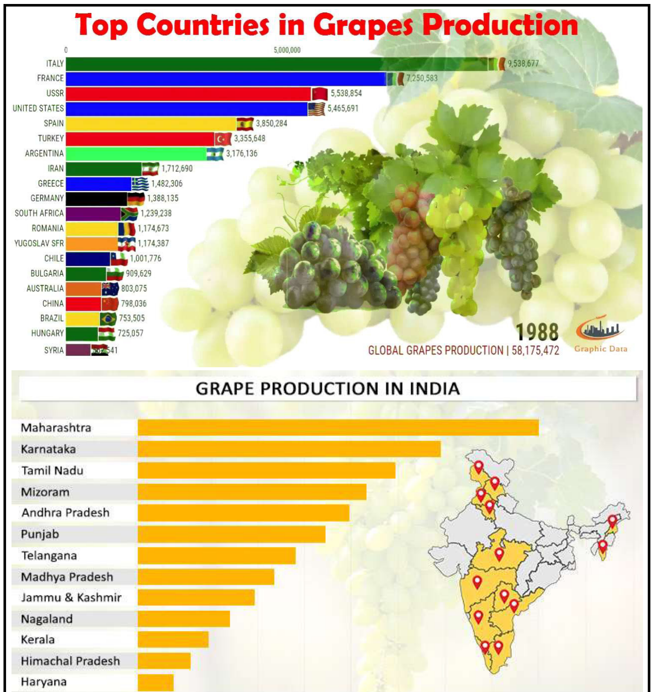

Source: FAO (2023), NHB (2024)

Fig. 1 : Global and Indian Grape Production Trends (2015–2024)

MT; an overwhelming majority (92%) is consumed fresh and only about 8% is processed. The United States covers 360,000 hectares producing 7 million MT with 30% for fresh consumption and 70% destined for processing. These trends indicate regional differences in grape utilization reflective of consumer preferences and industry focus (FAO, 2023) (Fig. 1).

Problem statement:

Grapes are highly perishable; nearly 25–30% post-harvest losses occur due to poor storage and handling (NHB, 2024). Hence, processing and value addition become vital to extend shelf life and enhance farmers' income.

Grape Juice Production:

Grape juice is a widely consumed, non-fermented beverage, and its quality is heavily dependent on the grape variety and processing methods employed (Ky, 2024).

This flowchart (FIg. 2) illustrates the sequential steps in commercial juice processing, starting from raw fruit to finished product ready for sale. The process begins with washing, where fruits are cleaned to remove dirt and contaminants. Next, the clean fruits go through selecting, which involves sorting out any defective or unsuitable pieces. Pulping breaks down the fruit to extract pulp, followed by squeezing to separate the juice from the solid pulp. The extracted juice is then sent for concentrating, which reduces water content to get the desired juice strength and volume. After concentration, the juice moves to allocating, where it is portioned according to product requirements. The next step is sterilizing, which uses heat or chemicals to kill any microbes and ensure product safety and shelf life. Finally, the sterilized juice is sent for filling, where it is packed into bottles or other containers, ready for distribution and consumption as shown by the finished juice bottle image in the diagram.

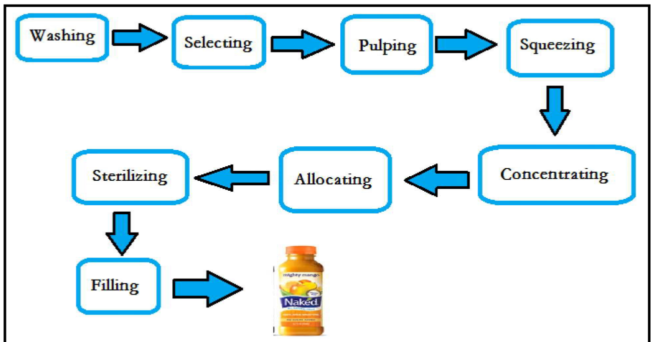

Fig. 2 : Process Flowchart for Grape Juice Production

The process for juice production involves several critical steps with specific parameters to ensure quality and shelf life. Initially, enzyme treatment uses pectinase at a concentration of 0.05 to 0.1% to break down cell walls, facilitating juice extraction (Table 1). Following this, clarification is carried out through centrifugation or filtration, with stabilization at low temperatures between 5 to 10 °C to remove suspended solids and improve clarity. The juice then undergoes pasteurization using High Temperature Short Time (HTST) method at 90 °C, which effectively extends the product's shelf life to 6–8 months while maintaining quality and safety. These steps collectively guarantee stable, clear, and long-lasting juice

Table 1 : Steps and Key Parameters for Juice Processing

Step	Description	Key Parameters
Enzyme treatment	Pectinase used to break cell walls	0.05–0.1% enzyme conc.
Clarification	Centrifugation or filtration	5–10 °C stabilization
Pasteurization	HTST at 90 °C for 30 sec	Shelf life: 6–8 months

Source: Sharma *et al.* (2018); Casassa and Harbertson (2021) suitable for commercial distribution.

Quality and Nutritional Aspects

Processed grape juice retains vitamin C (20–30 mg/ 100 mL) and antioxidants (polyphenols 100–200 mg GAE/ L). Non-thermal technologies like HPP and UV-C improve retention of bioactive compounds (Garde-Cerdán and Ancín-Azpilicueta, 2007).

2.1 Raw Material and Preparation:

The process begins with the selection of suitable grape varieties, followed by inspection, washing, destemming, and crushing to create the "must" (Sharma *et al.*, 2018).

2.2 Juice Extraction:

Two primary methods are used for juice extraction:

– **Hot Pressing**: The must is heated before pressing to increase juice yield and extract more color and flavor compounds, ideal for red and purple juices (Sharma *et al.*, 2018).

– **Cold Pressing**: The must is pressed without heat, often with the aid of pectolytic enzymes to improve extraction, which is common for white grape juice (Ky, 2024).

2.3 Clarification and Stabilization:

Raw juice contains suspended solids and tartrate crystals that need to be removed (Ky, 2024). Clarification involves enzymatic depectinization, the use of fining agents like bentonite, and cold stabilization to precipitate tartrate crystals, which are then removed by filtration (Casassa and Harbertson, 2021).

2.4 Pasteurization and Packaging:

To ensure microbiological stability, the clarified juice is pasteurized, typically using a high-temperature, short-time (HTST) process, before being filled into sterile containers (Ky, 2024).

Grape Jam and Preserves:

Grape jam is a thick, sweet spread made by cooking grape pulp with sugar, pectin, and acid until a gel is formed (Sharma *et al.*, 2018).

The parameters for grape jam and grape jelly differ in several key aspects relevant to their production and quality characteristics. Grape jam utilizes whole pulp as the raw material and requires a low to moderate amount of pectin to achieve the desired set. Its sugar to fruit ratio is typically 1:1, and the total soluble solids (TSS) content is at least 65%. The shelf life of grape jam ranges from 6 to 9 months. In contrast, grape jelly is made from filtered juice, demands a higher pectin content for gel formation, and has a higher sugar to fruit ratio of about 1.2:1. The TSS in grape jelly is also maintained at a minimum of 65%, and it generally has a slightly longer shelf life of 8 to 10 months. These differences reflect the processing and formulation variations necessary for each product's texture, consistency, and storage stability (Table 2).

Table 2 : Comparative Parameters of Grape Jam and Grape Jelly

Parameter	Grape Jam	Grape Jelly
Raw Material	Whole pulp	Filtered juice
Pectin need	Low–moderate	High
Sugar:Fruit ratio	1:1	1.2:1
TSS (%)	≥65	≥65
Shelf Life	6–9 months	8–10 months

Source: Sharma *et al.* (2018); Ky (2024)

3.1 The Chemistry of Jam-Making:

The gelling process depends on the correct balance of pectin, sugar, and acid (Sharma *et al.,* 2018). Pectin forms a gel structure, sugar acts as a preservative and aids setting, and acid provides the optimal pH for the gel to form (Ky, 2024).

3.2 Manufacturing Process:

The process involves cooking grape pulp with sugar and, if needed, added pectin and citric acid until the mixture reaches a Total Soluble Solids (TSS) concentration of over 65% for proper preservation (Sharma *et al.,* 2018). The hot jam is then dispensed into sterilized jars and sealed (Sharma *et al.,* 2018).

Raisin Production (Grape Dehydration):

Raisins are dried grapes, a traditional preservation method that concentrates the fruit's natural sugars (Onkar *et al.,* 2022).

Common drying techniques for raisins vary in temperature, time, characteristics, and limitations. Sun drying operates at 35–40 °C and takes 7–15 days; it is low cost but carries a contamination risk. Shade drying, conducted at 30–35 °C over 15–20 days, offers better color preservation but is slow. Tunnel drying employs temperatures of 55–65 °C for 18–24 hours, providing a uniform product at the expense of high energy costs. Solar hybrid drying, running at 45–55 °C for 20–30 hours, is eco-friendly but requires a higher initial setup cost. Each technique balances factors of quality, efficiency, cost, and environmental impact for raisin production (Table 3).

Table 3 : Common Drying Techniques for Raisins

Method	Temp (°C)	Time	Characteristics	Limitations
Sun drying	35–40	7–15 days	Low cost	Contamination risk
Shade drying	30–35	15–20 days	Better color	Slow
Tunnel drying	55–65	18–24 h	Uniform product	High energy cost
Solar hybrid drying	45–55	20–30 h	Eco-friendly	Initial setup cost

Source: Onkar *et al.* (2022); Liu *et al.* (2024)

This flow diagram (Fig. 3) explains the key steps in the production of currants and raisins from grapes, specifically the seedless variety *Vitis vinifera* L., var. Apyrena. First, grapes are harvested and sorted to remove any defective or unsuitable fruit. After sorting, the grapes may undergo a pre-treatment process, which involves either physical or chemical methods to accelerate drying and improve the final product's quality; however,

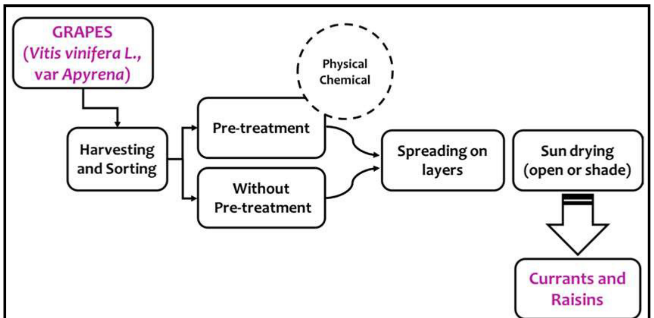

Fig. 3 : Steps in Raisin Production

pre-treatment is optional and some grapes are processed without it. Next, the grapes are spread out in layers, a step that ensures even exposure to drying conditions. The final major step is sun drying, which can be done in open sunlight or under shade depending on the desired characteristics. This process results in two main dried grape products: currants and raisins, which are highly valued for their taste and nutritional content

Table 4 : Nutrient Composition of Raisins

Component	Fresh Grape	Raisin
Moisture (%)	80	15
Total Sugars (%)	16	70–75
Fiber (%)	0.9	3.5
Phenolic content (mg GAE/100g)	120	220

Source: Liu *et al.* (2024)

4.1 Grape Varieties and Pre-treatment:

Seedless varieties are preferred for raisin making (Onkar *et al.*, 2022). To accelerate drying, grapes are often pre-treated by dipping them in an alkaline solution, which removes the waxy cuticle and allows moisture to escape more easily (Onkar *et al.,* 2022).

4.2 Drying Methods

- **Sun Drying**: The traditional, low-cost method where grapes are dried in the sun, though it is slow and presents a risk of contamination (Onkar *et al.*, 2022).
- **Shade Drying**: Grapes are hung in well-ventilated structures, which produces higher-quality raisins but takes longer (Onkar *et al.,* 2022).
- **Mechanical Dehydration**: A modern, faster method using dehydrators with controlled temperature and humidity, resulting in a more hygienic and uniform product (Onkar *et al.*, 2022).

4.3 Post-Drying Processing:

After drying, raisins are cleaned to remove stems and substandard berries, then washed, rehydrated to a specific moisture content, and graded before packaging (Onkar *et al.,* 2022).

Wine Production (Vinification)

Wine is the fermented juice of grapes, and its production, known as vinification, transforms the fruit's sugars into alcohol (Casassa and Harbertson, 2021).

This image (Fig. 4) illustrates the step-by-step process of wine production from grapes to final consumption. The process begins with harvesting grapes, followed by the extraction of juice from the harvested fruit. The juice then undergoes fermentation, where sugars are converted to alcohol under controlled conditions. Once fermentation is complete, the wine is subjected to pressure to separate solids from liquids, and then the liquid is further purified by filtration.

The clarified wine is subsequently transferred into barrels for aging, a stage where the wine develops its flavor and character over time. After sufficient aging, the wine is bottled, ensuring it is ready for commercial distribution and storage. The final step is consumption, where the finished wine is enjoyed. Each stage in this process—from harvesting and juice extraction to fermentation, aging, and bottling—is critical to determining the quality, aroma, and taste of the final wine product.

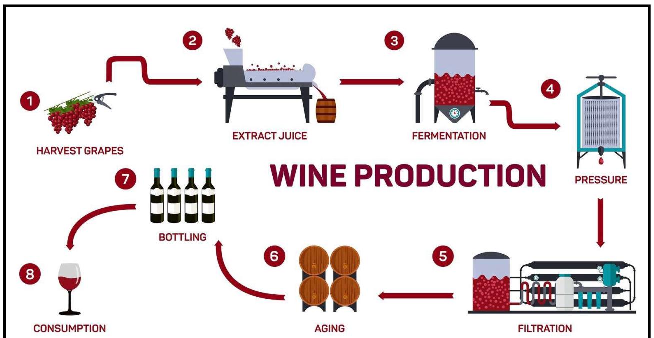

Fig. 4 : Flowchart of Wine Production

Table 5 summarizes the essential fermentation parameters for producing white and red wine, showing how controlled temperature, duration, and chemical composition influence the final product. White wine is fermented at lower temperatures (15–18 °C) for a longer period (10–14 days), resulting in an alcohol content of about 10–12%. These conditions preserve delicate flavors and minimize the extraction of anthocyanins, leading to the characteristic pale color of white wine.

Table 5 : Fermentation Parameters for White and Red Wine

Type	Fermentation Temp (°C)	Duration	Alcohol (%)	Color Compounds
White wine	15–18	10–14 days	10–12	Minimal anthocyanins
Red wine	25–30	7–10 days	12–14	Rich in tannins, anthocyanins

Source: Casassa and Harbertson (2021)

Red wine fermentation is faster (7–10 days) and carried out at higher temperatures (25–30 °C), which enhances the extraction of tannins and anthocyanins, resulting in a deeper color and robust structure. The alcohol content for red wine typically ranges from 12–14%. In summary, the difference in fermentation temperature and time directly impacts not only the alcohol percentage but also the color compounds present in each type of wine, reflecting their flavor profiles and market preferences.

Economic Importance:

Global wine production is ~25 billion liters/year, valued at USD 350 billion (OIV, 2023). India contributes 1.2 million L, mainly from Maharashtra and Karnataka (NHB, 2024).

5.1 The Fermentation Process:

The core of winemaking is the fermentation of glucose and fructose by yeast, primarily *Saccharomyces cerevisiae*, into ethanol and carbon dioxide, a process that is highly temperature-dependent (Casassa and Harbertson, 2021).

5.2 White vs. Red Wine Production:

- **White Wine**: The juice is separated from the skins before fermentation to prevent the extraction of tannins and color, and is fermented at cool temperatures to preserve delicate aromas (Casassa and Harbertson, 2021).
- **Red Wine**: The entire must, including skins and seeds, is fermented together to extract color and tannins, which are crucial for the wine's structure and flavor (Casassa and Harbertson, 2021).

5.3 Aging, Clarification, and Bottling:

Following fermentation, wine is often aged in tanks or barrels to develop complexity (Casassa and Harbertson, 2021). It is then clarified using fining and filtration, stabilized, and finally bottled (Casassa and Harbertson, 2021).

Valorization of Grape By-products:

The processing of grapes generates significant amounts of by-products, primarily grape pomace (Jin *et al.*, 2018). This pomace is now viewed as a valuable resource for extracting high-value compounds (Ferri *et al.,* 2020; Karastergiou *et al.*, 2024).

Table 6 outlines the potential applications of grape processing residues, highlighting the valuable bioactive components and corresponding industrial uses for each by-product. Pomace, which is rich in polyphenols and fiber, is widely used for producing antioxidant supplements that promote health benefits. Grape seeds contain linoleic acid and tocopherols, making them suitable for extraction of edible oil and for applications in cosmetics due to their nourishing properties.

The stems of grapes are a source of resveratrol and tannins, both recognized for their natural preservative

Table 6 : Potential Applications of Grape Processing Residues

By-product	Bioactive Components	Industrial Application
Pomace	Polyphenols, fiber	Antioxidant supplements
Seeds	Linoleic acid, tocopherols	Edible oil, cosmetics
Stems	Resveratrol, tannins	Natural preservatives
Skins	Anthocyanins	Natural colorant

Source: Garavaglia *et al.* (2016); Karastergiou *et al.* (2024)

abilities in food products. Skins are abundant in anthocyanins, which are utilized as natural colorants in various food and beverage industries. Altogether, grape processing residues provide key components for supplement, cosmetic, preservative, and colorant production, maximizing the utility and sustainability of grape by-products.

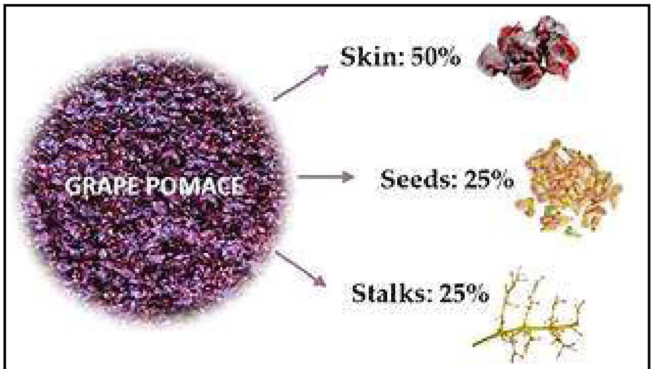

Fig. 5 : Circular Bioeconomy in Grape Processing (Diagram showing conversion of pomace → phenolic extracts, pectin, compost, bioenergy)

Emerging techniques:

– **Supercritical CO_2 extraction** improves antioxidant yield.

– **Enzymatic and ultrasound-assisted extraction** reduces solvent use.

– **Fermentation of pomace** yields organic acids and ethanol (Jin *et al.*, 2018).

Table 7 presents an overview of non-thermal food processing methods, focusing on their operating principles, benefits, and limitations. High Pressure Processing (HPP) uses pressures up to 600 MPa to inactivate microbes, effectively retaining nutrients and freshness in food, but it is costly due to specialized equipment. Pulsed Electric Fields (PEF) apply short bursts of electricity to enhance extraction of valuable food components, yet the method is limited in its application to large-scale processes.

UV-C treatment utilizes light at a wavelength of 254 nm for surface sterilization, making it valuable for microbial safety, though its effectiveness is limited by its

Table 7 : Non-Thermal Methods

Technology	Principle	Benefit	Limitation
HPP	600 MPa pressure	Retains nutrients	Costly
PEF	Pulsed electric fields	Enhances extraction	Limited scale
UV-C	Light at 254 nm	Surface sterilization	Penetration limited
Ozone	Oxidation	Eco-friendly	Potential off-flavors

Source: Hiperbaric (2025); Morata *et al.* (2021)

shallow penetration. Ozone technology relies on oxidation to disinfect and preserve foods; it is eco-friendly but can sometimes impart off-flavors if not controlled properly. Collectively, these non-thermal methods offer nutrient retention and environmentally conscious solutions, but their adoption is often balanced against cost, scale, and specific technical constraints (Hiperbaric, 2025); Morata *et al.,* 2021).

6.1. Extraction of Phenolic Compounds and Antioxidants:

Grape pomace is rich in phenolic compounds like procyanidins, which have strong antioxidant properties and potential health benefits (Karastergiou *et al.*, 2024; Garavaglia *et al.,* 2016). These compounds can be extracted for use in foods, nutraceuticals, and cosmetics (Karastergiou *et al.*, 2025).

6.2. Grape Seed Oil:

Grape seeds contain oil that can be extracted for culinary and cosmetic use (Garavaglia *et al.,* 2016). Methods include cold pressing for high quality, solvent extraction for high yield, and modern subcritical or supercritical extraction techniques (Anderson International Corp, 2023; Best Extraction Machine, n.d.).

6.3. Pectin Extraction

Grape pomace is also a viable source of pectin, a polysaccharide widely used in the food industry as a gelling agent and stabilizer (Megías-Pérez *et al.*, 2023).

Emerging Technologies in Grape Processing:

Innovation in food technology is leading to new methods that improve the quality of grape products.

7.1. Non-Thermal Processing of Grape Juice:
Non-thermal technologies are emerging as alternatives to traditional pasteurization, which can degrade juice quality (Garde-Cerdán and Ancín-Azpilicueta, 2007).

- **High-Pressure Processing (HPP)** uses intense pressure to inactivate microbes while preserving freshness (Hiperbaric, 2025).
- **Ultraviolet (UV-C) Light**, **Pulsed Light**, and **Microfiltration** are other methods that pasteurize juice without heat (Pratap-Singh *et al.,* 2024; Longdom, 2023; Hiperbaric, 2025).
- **Pulsed Electric Field (PEF)** uses electricity to kill microbes and can enhance compound extraction (Morata *et al.,* 2021).

7.2 Innovations in Winemaking:
Technology is transforming winemaking:

- **Precision Viticulture** uses drones and IoT sensors to monitor vineyards (BM Wine Guide, 2023).
- **AI and Machine Learning** help predict harvest times and improve quality control (Halter Ranch, 2025).
- **Advanced Extraction Technologies** like ultrasound and microwaves, along with AI-powered optical sorters, improve efficiency and quality (Morata *et al.*, 2021; BM Wine Guide, 2023).

REFERENCES

Anderson International Corp (2023). *Advances in Seed Oil Extraction Technologies*. Ohio: AIC Publications.

BM Wine Guide (2023). *Precision Viticulture Trends 2023*. Available at: https://bmwineguide.com.

Casassa, L.F. and Harbertson, J.F. (2021). *Grapes and Wine: Biochemistry, Technology, and Quality*. Amsterdam: Elsevier.

FAO (2023). *FAOSTAT: Grape Production Data 2023*. Rome: Food and Agriculture Organization of the United Nations.

Ferri, M., Vannini, M., Ehrnell, M., Eliasson, L., Xanthakis, E. and Sjöholm, I. (2020). Valorization of grape pomace: A sustainable approach. *Food Chemistry*, **326**, 126985.

Garde-Cerdán, T. and Ancín-Azpilicueta, C. (2007). Effect of thermal and non-thermal processing on grape juice composition. *J. Agric. & Food Chem.*, **55**(15) : 6094–6101.

Garavaglia, J., Markoski, M. M., Oliveira, A. and Marcadenti, A. (2016). Grape seed oil: A review. *Food Res. Internat.*, **89** : 435–442.

Halter Ranch (2025). *AI and Machine Learning in Modern Winemaking*. California: Halter Ranch Publications.

Hiperbaric (2025). *High Pressure Processing for Fruit Juices: Technical Review 2025*. Burgos, Spain.

Jin, Q., Xu, Y. and Zhang, J. (2018). Bioconversion of grape pomace for bioethanol and organic acids. *Bioresource Technology*, **247** : 68–75.

Karastergiou, L., Andrikopoulos, N. K. and Komaitis, M. (2024). Recovery of phenolics from grape pomace: New green approaches. *Foods*, **13**(2) : 145.

Ky, C. (2024). *Modern Grape Processing and Enology Advances*. Cham: Springer Nature.

Liu, Y., Chen, X. and Wang, Q. (2024). Effect of pretreatment and drying methods on raisin quality and nutrient retention. *J. Food Processing & Preservation*, **48**(5) : e17962.

Longdom (2023). *Pulsed Light Processing in Fruit Juice Industry: Innovations and Challenges*. London: Longdom Publications.

Megías-Pérez, R., Rodríguez-Gutiérrez, G. and Fernández-Bolaños, J. (2023). Extraction of pectin from grape pomace and other agro-wastes. *Industrial Crops & Products*, **195**, 116389.

Morata, A., Loira, I. and Bañuelos, M. A. (2021). Nonthermal technologies for winemaking: Current status and future trends. *Trends in Food Science & Technol.*, **112** : 67–81.

NHB (2024). *Indian Horticulture Database 2024*. National Horticulture Board, Ministry of Agriculture, Government of India.

Onkar, S., Patil, R. and Jadhav, V. (2022). Optimization of grape drying for raisin production in Maharashtra. *Indian J. Horticulture*, **79**(2) : 223–230.

OIV (2023). *State of the World Viticulture Report 2023*. Organisation Internationale de la Vigne et du Vin, Paris.

Pratap-Singh, A., Thirumdas, R. and Cullen, P. J. (2024). Advances in non-thermal preservation of juices. *Food Engineering Reviews*, **16**(1) : 45–63.

Sharma, R., Chauhan, K. and Mehta, S. (2018). *Fruit and Vegetable Processing Technologies*. New Delhi: CBS Publishers.

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