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A Comprehensive Review on Classification of Wines and Their Production from Pineapple (*Ananas Comosus*)

Shanu magotra[1] * and Gaurav Rawat[1]
[1]University Institute of Biotechnology, Mohali, Punjab
*Corresponding author

Abstract
Several types of wines are manufactured using a various variety of substrates, however fruit substrates are more preferred due to their flavours and health benefits. Pineapple wine, a fermented beverage prepared with the juice of ripe pineapples *(Ananas comosus*), is gaining popularity due to its distinct flavour profile and potential health advantages. This review explores key factors such as chemical composition, nutritional value, morphological attributes of pineapple suited to be used as a substrate for wine production. The role of *Saccharomyces cerevisiae* and non-*Saccharomyces* yeasts in influencing the physiochemical properties, aroma profiling and quality of pineapple wine have also been discussed. Additionally, factors such as sugar content, acidity and aging processes that affect the sensory characteristics and consumer acceptance have also been analyzed. The potential health benefits, antioxidant properties and bioactive compounds present in pineapple wine have also been highlighted. Basically this review aims to provide comprehensive insights into the production and prospects of pineapple wine, paving the way for future research and innovation in tropical fruit winemaking.

Keywords: Pineapple, *Ananas comosus,* Wine production, antioxidant activity, health benefits.

INTRODUCTION

Wine is contemplated as the most prominent and highly augmented fruit product (Campos et al. 2020). It has been regarded as a therapeutic composition and at the same time considered as a requisite supplement to the human diet(Petzen 2020). It reckons as an undistilled fermented beverage derived from a range of fruits(Desalle, Tattersall, and Wynne 2022). Wine has been valued as a food and the food is defined by the Codex Alimentarius Commission as any material, either processed, semi-processed, or raw, including beverages, that is meant for consumption by humans(Fortin 2023).The process of wine production, known as 'Vinification' and 'Enology' is a scientific discipline concerned with the study of wine.It is one of the oldest human technologies and a significant biotechnological processes today is wine fermentation(Joshi 2021). Production of wine has always been tedious task so as to create a lucrative product, but the proceedings involved in its production are pretty forthright(Buxton and Hughes 2020). Winemaking is termed as a food preservation method that revert to the dawn of mankind(Harutyunyan and Malfeito-Ferreira 2022). In the present era of modernism, wine is observed as the most favored starch fermented and enriched alcoholic beverage, serving as a symbol of social rank(Pilcher 2021). Wine consumption in a moderate way has long been thought to provide many health benefits, like minimizing ageing risks, heart and bone diseases(Hrelia et al. 2022). Wine is proving to be a potential agent that helps in assisting longevity. Majorly the production of wine in India is centralized in the states of Maharashtra (90%) and Karnataka (7%), with Goa and Himachal Pradesh accounting under 3% of total wine production(Pankaj 2023). The majority of wineries and production houses are located in the Nashik region of Maharashtra, which is recognized as the country's wine sector home(Dahake, 2024). According to Wine Intelligence, urban areas such as Mumbai (32%), Delhi (25%), Bangalore (20%), Pune (5%), and Hyderabad (3%) consume the majority of wine in India. Consumers currently prefer red wines, which are accompanied by white, sparkling, and fortified wines. A variety of bioactive compounds, including polyphenols, are bound to undissolved plant molecules in the source materials.

Many of these bioactive ingredients are released into aqueous ethanol solution during the winemaking process, increasing their biological availability for uptake during consumption(Constantin et al. 2024a). Almost every physical, chemical, and biological science—particularly microbiology and biochemistry—contributes to the manufacture of wine, making the process distinct(Joshi and Ray 2021).

A typical wine contains many different components as depicted in Figure1.1

Fruit wines are prepared from many different fruits such as grapes, mango, apple, peach, pear, plum, cashew apple,

pineapple, pomegranate , banana, ber, strawberry, kinnow, etc(Joshi et al. 2017a). Nowadays, people are more conscious about their health because of the common deficiencies of vitamin C, D, especially D3 and B12, minerals and amino acids being observed in the human population(Jan et al. 2019). Individual make their diet in such a way that they get appropriate levels of vitamins,. Ever since the Covid19 pandamic, everyone has been focusing on including antioxidant rich diet which helps in boosting the immunity(Islam et al. 2022). Most common fruits which are a rich source of vitamins and antioxidants are apple, apricot, banana, blueberries, cantaloupe, cashew nut, cherry, dragon-fruit ,grapes, guava, kiwi, mango, oranges, pear, persimmon, peach, plum, pineapple, raspberry and strawberry. Fermented products are one of the optimal solutions due to their appreciable, functional and nutritional properties(Praveen and Brogi 2025). The emergence of brand-new functional products can be premium and strenuous. "Dragon fruit drink" is one of the fermented products established over recent years(Oliveira et al. 2024).
Wines can be classified based on many different attributes: based on color (red and white), basedon nature (table wine, fortified wine, sparkling wine, aromatized wine) and based on taste (sweet, dry) as summarized in Figure 1.2.

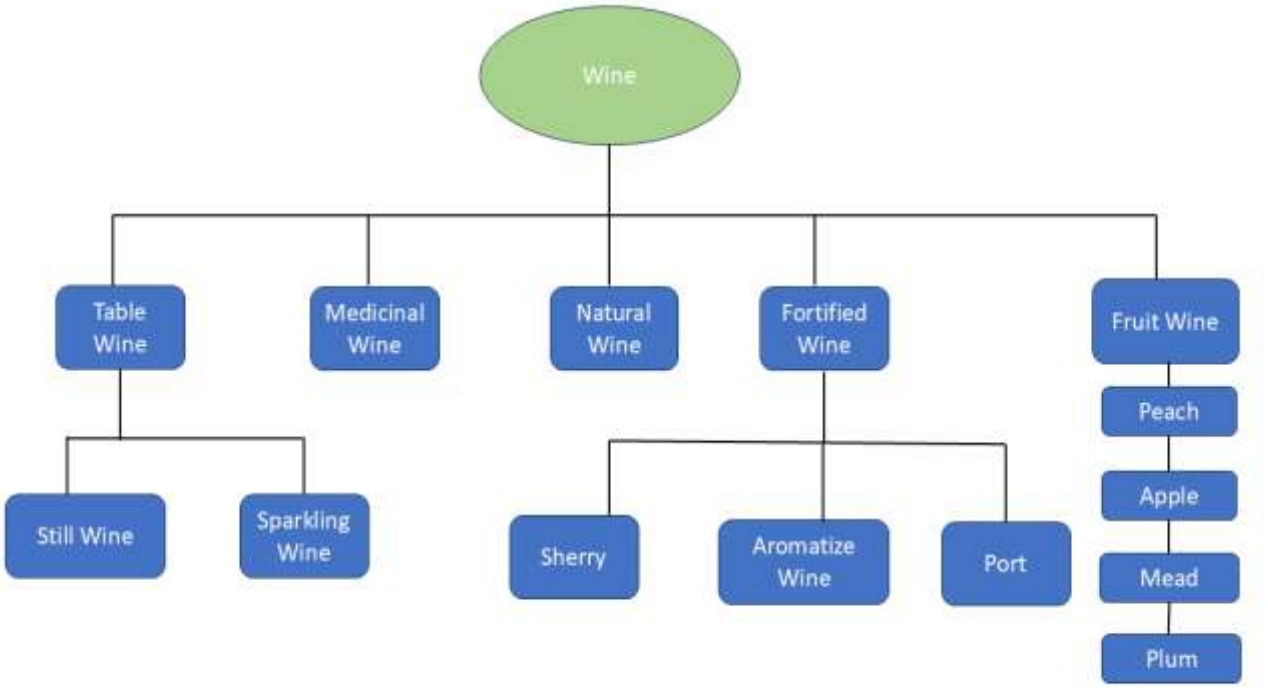

Figure 1.2 Classification of wine based of their characteristics.

Wine can also be categorized on the basis of cultivar, stage of ripening of fruits, different types of fruitsused, geoorigin and fermentation techniques(Cauli 2024).Sparkling wines are those which possess a healthy proportion of CO_2 artificially, as opposed to most of the wines, which are still wines, having a negligible amount of CO_2 produced during fermentation(Just-Borràs et al. 2024). Champagne is the sparkling wine produced in the Champagne region of France. Those wines that possess additional brandy with a 16%- 23% alcohol content are regarded as fortified or dessert wines. They are usually sweet, having 18%-20% alcohol, and can be red or white(Bianchi et al. 2024a). Sweet wines contain 8% sugar, whereas dry wines have a minute sugar content. Table wines contain 10- 11% alcoholic content. On the other hand, dessert wines are regarded as fortified sweet wines(Bianchi et al. 2024b). Fortified wines containing the added distillate of brandy have an alcohol content of 19%-21%. Herbs which are therapeutically dominant and some compounds having a bitter taste, like quinine, are incorporated into medicinal wines. These flavored wines are mildly sweet and contain an elevated amount of alcohol, usually 18%-20%(Sadia et al. 2024). Red and white wines are the most frequently seen types of wines Bickford and coworkers have reviewed the status of Consumption of different types of wines in 2019 which is depicted in Figure 1.3

Red wine and its classification:

Red wine is obtained from red grapes that are basically darker in color than white grapes. There are numerous types of red wines(Xia et al. 2024). This is considered as a delicious vintage in the wine kingdom, combining succulent red grapes with a variety of aromas ranging from chocolate, oak, or even mint scents. Black grapes generate greenish-white juice and the anthocyanin pigment, which is present in the grape skin, provides wine its red colour(Shahrajabian and Sun 2023).

Red wines are classified into five major categories. The accepted table wine having low tannin and an elevated level of acidity is called barber wine(Silva 2024). Itis a red wine that can be appreciated with pasta, hard cheeses, and pizzas. Another popular wine which is served with meat dishes as like Cabernet Sauvignon grape wine (Shiraz wine) for good taste and infused with the spicy flavors of black pepper and blackcurrent. The Cabernet Sauvignon grape wine is the most eminent type of wine, mainly among the Australians, Californians, and French(Roberts and Armitage 2019). Another dry red wine which has a noticeable amount of tannin content and a dark color is known as Malbec wine. Pinot Noir made from black pinot noir grapes is an uncommon and very pricey red wine(McCarthy and Ewing-Mulligan 2019). The red zinfandel grapes are used to make zinfandel wine with a dominant alcoholic content, high tannins, and a mild spicy taste(Martinez, Bressani, and Batista 2024). All the important features of different red wines have been tabulated in table 1.1.

Table 1.1 Features of red wine.

Types of Red Wine	**Mouth feel**	**Acidity**	**Common Aroma**	**Region of Origin**	**References**
Merlot	Soft	Medium	Plum, Cherry and Blackberry.	France, Italy, Chile, California, Washington.	(Pons et al., 2022)
Cabernet Sauvignon	Smooth with a coarse finish	High	Dark Berries, Cedar wood, Cassis.	Italy, France, California, Australia.	(Vercesi et al., 2024)
Pinot Noir	Smooth with crisp finish	Medium to High	Damp earth, Plum and Baked cherry.	Oregon, California, France.	(Kulasiri et al., 2024)
Barbera	Smooth	High	Plum, Black cherry, Blackberry,Raspberry.	Argentina, Italy and California.	(Ahumada et al., 2021)
Malbec	Rich, Full	Medium	Blackberry, plum and Black pepper	Argentina and France	(Morgani et al., 2023)

White wine and its classification:

The color of white wine is gold, straw-colored, and sometimes yellow, but not exactly white. The color depends on whether it encompasses grape skin or only juice(Karki 2019). Grapes having colorless pulp , like gold or green colored grapes or some sort of juice from red grapes, undergoes alcoholic fermentation to produce white wine. They are particularly popular among Australians and Europians. This is fabricated in such a way that the transparent yellow color is retained in the finished product(Uysal-Unalan et al. 2024).

Chardonnay grapes are well known for creating one of the excellent white wines. A dry whitewine produced from these grapes is known as Chardonnay(Jeločnik and Jakšić 2025). These grapes are also used for making champagne. Light acidic flavored dry white wine is induced from Sauvignon Blanc grape that goes well with dishes related to poultry and some salads(Constantin et al. 2024b). Merging of Sauvignon Blanc grape for preparation of the Muscat/Moscato wine that possesses sweet and fruity flavor has also been done.

Riesling grapes are used to for the production of Riesling wine that might be both dry and sweet which can be sweet and dry(Onuma 2024). This type grapes makes the wine fruitier and softer like ice wines originated from frozen grapes. This wine has enticing flavors of pear and apple. Features of white wine as in table 1.2.Table 1.2. Features of white wine.

Types of white Wine	Mouth feel	Acidity	Common Aroma	Region of Origin	References
Moscato	Full bodied, Creamy and Smooth.	High	Peach, Citrus andPear.	New York, Australia, New Zealand, South Africa, France, Washington, California.	(Ferrara et al. 2022)
Riesling	Round and Light	Low to Very High	Citrus, Apple and Peach	Oregon, California, France, New Zealand, Australia	(Song, Fuentes, and Tomasino 2022)
Pinot Girgio	Bright, Smooth and Light.	High	Grape and Pear	Northen Italy, California, Spain and France.	(Michelini et al. 2021)
Viognier	Smooth	Low	Apricot, Fruits and Floral species.	Oregon, California and France.	(Iobbi 2022)
Semillon	Smooth	Medium	Honey, Nuts, Orange peel and Ripe fruits.	Washington, Australia and France.	(J. Wang et al. 2022)
Chardonnay	Smooth	High	Apple, Pineapple, Tropical fruits, Lemon, Oak.	Australia, New Zealand, South Africa, New York, France, California, Washington.	(Alexander 2024)

The quality of wine also depends on several factors and one most important factor is the light (Fracassetti et al. 2021).The University of Zagreb Faculty of Food Technology and Biotechnology Department, in a collaborative project studied the impact of light exposure on the wine taste with respect to the color of the bottle used(Lukić 2022). Two of the red and white wines were streamed into olive green, white, and black colored bottles. A screw cap was used to seal the bottles(Poças, Couto, and Hogg 2022). For one year, tightly sealed bottles were displayed in dazzling light or in absolute darkness for a period of one year. After each six months, quality control was directed through which scientists examined changes in some wine attributes like poly-phenolic content, antioxidant content, wine aroma, and color. For White wine, the project has clearly shown that bottle color highly affects the quality of wine when subjected to a shining light. Black bottles effectively shield the wine in the same way that a dark storage unit does. Nevertheless, white and olive-green colored bottles do not adequately protect the wine from the effects of light. The degradation of many health-benefit components like polyphenols and antioxidants takes place by the impact of light. Along with that, there is considerable loss in wine color as well as aroma(Enaru et al. 2021).

Tropical fruits for wine production:

Selection of fruit is a crucial step in fruit wine production. Must which is prepared from the fruits having low sugar content is balanced by ameliorated sugar or a sugar syrup to establish the proper balance(Matei 2017). The acidity can be maintained to an appropriate level by adding water. Fermentation of grapes produce the wine, however, other soft fruits from temperate and tropical regions having appropriate pigment stability and flavour profiles analogous to the wine grapes which can also be employed for the wine production(Jagtap and Bapat 2015). Fruits from the tropical region can be classified according to their acidity, size of fruit, type of seed, and fruit bearing plants (Figure 1.4). They are classified into four groups based on acidity: alkaline, sub-acidic, acidic, and melons(Aline et al. 2023). While acid fruits have a sour flavor and a higher percentage of citric, malic, and oxalic acids, alkaline fruits have a unique sweet flavor with a high sugar content. Sub-acidic fruits beer flavor that is somewhere between sweet and sour. Melons owns a unique sweet flavor and a high moisture content. Fruit-bearing trees can also be classified in a variety of approaches. Citrus fruits are considered under the tree fruits, while grapes and kiwi are creeping plants(vine trees). Berries come under the class of bushy fruits(Joshi et al. 2017b). Tender fruitsencompass pomegranates, pineapples, and jackfruit, among others, like, jamun, mango, guava, apple, acerola, melon, sapota comes under a class of fleshy fruit called pome fruit, encased bya basic central core of seeds.

Fruits that fall under the tropical subtropical temperate category can be utilized to make wine, not only because of their nutritional value, but also because of the health benefits they provide to consumers(Sarkar et al. 2023). The phenolic compounds which are present in such fruits possess the antioxidant activity that is responsible for such benefits. Some well- known tropicalfruits been employed in the manufacturing of wine have been depicted in Figure 1.5.

Among all fruits, Grapes are widely used for Wine production. But Pineapples are relatively cheap compared to all fruits. Pineapples are juicy and contains good amount of sugars which make them reliable and good for fermentation. Also, Pineapple flesh is sweet, its juice has a very high acid content. Pineapple wine is a distinct tropical spin on typical grape wine, with a naturally lively, sweet-tart flavor and refreshing acidity. Unlike grape wine, which often takes significant age to develop depth, pineapple wine can be consumed early while still providing a rich aroma and balanced flavor. It also contains bromelain, an enzyme recognized for its digestive properties, making it a healthier choice. Additionally, pineapple wine thrives in tropical climes where grapes struggle to grow, making it a sustainable and locally sourced choice in many areas. Its unique flavor, health benefits, and accessibility make it a compelling alternative to grape wine.

Pineapple fruit:Pineapple is a fruit belonging to the Bromeliaceae family, which ranks third in importance worldwide behind citrus and bananas. A tropical pleasure, the pineapple is known for its vivid fusion of sweet and sour flavours. It has a distinctive crown of spiky leaves and golden, textured skin(Gasic, Preece, and Karp 2020). The taxonomic classification of pineapple has been tabulated in Table 1.3. *Ananas comosus*, the pineapple, is said to be native to South America, originating from the region between southern Brazil (14°14’34.492”latitude and 53°11’21.359” longitude) and Paraguay (23°18’59.737”latitude and 58°10’9.64” longitude). Long before pineapples were brought to other parts of the world, indigenous peoples in South America farmed and devoured the fruit(Knorr and Augustin 2025). Brazil, Thailand, the Philippines, Vietnam, Mexico, China, Nigeria, Indonesia, and Columbia are the top producers of pineapples(Yahia 2020). According to Food and Agriculture Organization (FAO) statistics in 2008, Brazil produced 2.5 million tons of pineapples annually, followed by Thailand (2.3 million tons), the Philippines (2.2 million tons), Malaysia (1.2 million tons), Vietnam (0.5 million tons), Mexico (0.5 million tons), China (0.445 million tons), and the United States (0.29 million tons)(Apeksha Rai 2020). Based on morphological traits such as fruit weight, shape, texture, and flavor, as well as length, and form of the leaves, pineapples can be grouped into five groups. Abacaxi, Cayenne, Maipure or Perolera, Queen, and Spanish are these five groups(Ditsawanon 2024). Cayenne Lisse, or Smooth Cayenne, is the most well-known variety in the world of trade, but Queen is well-known in a few, specialized markets for premium, flavorful, and pricey fresh fruit. Although the cultivar Queen is widely available, it is mostly grown for the fresh fruit market in the southern hemisphere, specifically in South Africa and Australia(Vincent et al. 2019)(Takahashi 2024).Every variety of pineapple fruit has different morphological characters such as size, shape and color (Table 1.4). The plant grows to a height of 60 to 80 cm, produces a small fruit with a full golden shell and small, conspicuous eyes, and has short, highly spiky silvery leaves(Dehgan 2022).

Table 1.3 Taxonomical classification of pineapple fruit

KINGDOM	**Plantae**
ORDER	Poales
FAMILY	Bromeliaceae
SUBFAMILY	Bromelioideae
GENUS	Ananas
SPECIES	Ananas comosus

Table 1.4 Morphological attributes of various pineapple fruit varieties

NAME OF PINEAPPLE FRUIT VARIETY	**SIZE & SHAPE OF FRUIT**	**COLOR OF FRUIT SKIN**	**FLAVOR OFFRUIT**	**REFERENCES**
Smooth Cayenne	Medium to large size, cylindrical shape	Golden-yellow	Sweet and slightly tangy	(Bosland and Hamilton 2023)
Queen Victoria	Small to medium, Cylindrical	Yellow with reddish tinge	Sweet and aromatic	(Karp and Gasic 2022)
Red Spanish	Medium to large, Cylindrical shape	Reddish-orange	Sweet-tart	(Elia, Shahrin, and Abdullah 2024)
Sugarloaf	Compact size, cylindrical	Golden-yellow	Sweet with low acidity, crisp texture	(Li et al. 2022)
Pernambuco	Medium to large, Cylindrical	Reddish-orange	Juicy, sweet, distinctive aroma	(de Lira Júnior et al. 2023)

NUTRITIONAL IMPORTANCE OF PINEAPPLE

Among fruits, pineapple is a well-known source of vital nutrients and has been used over generations due to the health benefits it offers(Mukwevho et al. 2025). Several researchers have proved the potential health benefits of consuming pineapple owing to its richness in Vitamin C (78.9 gm of vitamin C in one cup of pineapple)(Thuy Trang and Hong Tu 2024). The human body uses vitamin C to promote growth, wound healing and iron absorption(Love, Bowen, and Fleming 2007). Pineapple lacks saturated fats and is rich in essential vitamins and minerals, while low in calories, therefore helps in weight management(Okwunodulu et al. 2022). Pineapple contains a mixture of enzymes called bromelain, which is commonly used to alleviate digestive problems that will help in treating dyspepsia (Kansakar et al. 2024). Pineapple is rich source of manganese that helps to maintain strong bones. Antioxidants, or chemicals that assist the body Fight inflammation and free radicals, are abundant in pineapple. It also possesses anti-cancer qualities(Mehraj et al. 2024). The nutritional content of pineapple might strengthen immunity.

CHEMICAL COMPOSITION AND NUTRIENT VALUE:

The nutritional quality of pineapple is influenced by several factors such as the nutrient status of the soil and water, the weather, the cultivar, and the pre- and post-harvest technologies(Maia et al. 2020). Sugar content has a significant impact on pineapple flavor attributes and commercial evaluation. The three main sugars found in mature fruit are fructose, glucose, and sucrose(Zhou et al. 2021). The content of sucrose peaks at the full yellow stage and then starts to fall. According to (Boondaeng et al. 2021) during fruit growth, the overall soluble content is modest and mostly made up of glucose and fructose(Shi et al. 2016).

Pineapple contains the three enzymes engaged in sugar metabolism: sucrose synthase, sucrose phosphate synthase, and invertase(Johari et al. 2023). The metabolic rate of sucrose synthase increases in younger pineapples and falls to very low levels six weeks before to harvest, whereas the activity of sucrose phosphate synthase is very low and stays constant throughout fruit growth. The metabolic rate of sucrose synthase increases in younger pineapples and falls to very low levels, six weeks before to harvest, whereas the activity of sucrose phosphate synthase is very low and stays constant throughout fruit growth. Other enzymes found in pineapple include proteinase bromelain, polyphenol oxidase, and peroxidase. These enzymes help in Wine fermentation. Bromelain improves juice extraction and fermentation efficiency. Polyphenol oxidase and peroxidase impacts color, taste and stability.

Pineapple fruit contains three important organic acids: ascorbic acid, citric acid, and malic acid. Following harvest, neither during nor after storage, malic acid levels alter. Malic acid and full ripeness are reached before fruit development peaks, and the amount of citric acid (28–66% of total acid) increases consistently. The amount of ascorbic acid varies greatly between clones and rises in response to rising air temperatures and solar light(Tortosa-Díaz et al. 2025). Fruit ascorbic acid levels have been found to be negatively connected with the intensity of internal browning symptoms associated with post harvest chilling injury at harvest(He et al. 2025). If there is more than 500 µM of ascorbic acid in the fruit, internal browning is a small concern. Chemical composition, nutrient values per 100g flesh fruit is described as Table 2.1. Acids that affect wine's flavor, stability, and aging include tartaric, malic, lactic, and citric acids. Lactic acid softens texture through malolactic fermentation, citric acid improves freshness, malic acid adds sharpness, and tartaric acid gives structure and crispness. A robust taste and the preservation of wine quality are guaranteed by balanced acidity.

Table 2.1 Chemical composition and nutrient value of Pineapple

COMPONENT OF PINEAPPLE	AMOUNT IN PINEAPPLE	COMPONENT OF PINEAPPLE	AMOUNT IN PINEAPPLE (mg)
Non-edible proportion	42%	PantothenicAcid (B5)	0.193
Water(H_2O)	87 g	Thiamine (B1)	0.078
Energy	190 kJ	Riboflavin (B2)	0.029
Carbohydrate	11.82 g	Niacin (B3)	0.470
Sugars	8.29 g	Sodium	1
Dietary fibre	1.4 g	Vitamin C	16.9
Fat composition	0.13 g	Iron	0.25
Protein	0.55 g	Phosphorus	9
Sucrose	4.59 g	Potassium	115
Glucose	1.76 g	Zinc	0.08

Fructose	1.94 g	Magnesium	12
Calcium	13.0 mg	Vitamin K	0.7 µg
Carotene, beta	31µg	Folate (B9)	11 g

Pineapples for winemaking are selected based on juice quality, quantity, and physicochemical properties. Cayenne pineapples contain high sugar and acidity, whilst Queen pineapples have high sugar and moderate acidity. Spanish group pineapples have low sugar and acidity, whilst Pernambuco's 'Pérola' has more total soluble sugar and lower acidity. Red Spanish and Smooth Cayenne pineapple types have been studied for their physical, psychochemical, and biochemical properties. The 'abacaxi' pineapple variety in Benin has the ability to produce wine, and the composition and flavor profile of wine varies depending on the variety.

Pineapple is widely used in winemaking, adding distinct flavors and aromas to fruit wines. The procedure starts with picking ripe pineapples, which are then peeled, cored, and crushed to extract juice. The juice is frequently refined to remove pulp and contaminants, resulting in a clear basis for fermentation. Yeast, commonly *Saccharomyces cerevisiae,* is added to start fermentation, which converts carbohydrates into alcohol and CO_2. Temperature management is essential, with the ideal range being 18-24°C to preserve delicate pineapple flavors. Fermentation takes 1-2 weeks, followed by racking to separate the wine from sediment. Aging, which is frequently done in stainless steel or glass vessels, improves the wine's complexity and stability. Pineapple wine is noted for its tropical, sweet-tart flavor profile, which can be varied by altering sugar levels, mixing with other fruits, or integrating spices. The finished beverage is filtered, bottled, and occasionally carbonated for a sparkling variation. Pineapple wine is a creative alternative to classic grape wines, appealing to consumers looking for unique and exotic flavors. Research into its manufacture continues to improve procedures and enhance its commercial potential.

Role of yeast and temperature in primary fermentation:

Saccharomyces cerevisiae and several other species of *Saccharomyces* are widely used in the brewing and wine making that have been tabulated in table 2.2(Miao et al. 2025). Fermentation which is a complex biochemical process involving yeast, primarily *Saccharomyces cerevisiae,* turns the pineapple juice into wine. Significant compositional changes occur during fermentation when yeast metabolizes sugars in the juice to generate ethanol and carbon dioxide as a by-product as shown as Figure 2.1.

Yeast affects the flavor and character of the wine in addition to fermentation. Numerous organic acids are either degraded or synthesised affecting the wine quality. Various Sulphur compounds can be synthesized by yeast utilizing sulfur, like H_2S, that confer an undesirable aroma(Lorenzo 2021).

Table 2.2 Different *Saccharomyces* species used for different wine production.

Name of fruit wine	***Saccharomyces* yeast**	**References**
Cider	*Saccharomyces cerevisiae* *Saccharomyces pastorianus*	(Y. Wu et al. 2023)
Palm wine	*Saccharomyces sp.*	(Osiebe, Adewale, and Omafuvbe 2023)

Citrus fruits (oranges, grapefruit)	*Saccharomyces uvarum* *Saccharomyces cerevisiae,* *Saccharomyces carlsbergensis*	(Luo et al. 2023)
Masau	*Saccharomyces cerevisiae*	(Tarko and Duda 2024)
Papaya	*Saccharomyces cerevisiae* *Saccharomyces bayanus*	(Patil et al. 2021)

S. cerevisiae possesses unique metabolism that controls the formation of molecules which are aromatic and volatile in nature(D. Ma et al. 2025a). As Saccharomyces cerevisiae is effective at turning carbohydrates into carbon dioxide and alcohol, it is employed. The natural sugars in pineapple juice are broken down by the yeast, which results in ethanol and adds to the wine's alcohol content. By producing secondary metabolites like esters and higher alcohols, which add fruity and aromatic overtones, yeast also affects the flavor profile. To guarantee a seamless fermentation process and avoid off flavors, proper yeast selection and management—including temperature control (18–24°C) and nutritional supplementation—are crucial. In the end, yeast plays a crucial role in turning pineapple juice into a tasty alcoholic beverage. Because of its special qualities—such as its high fermentative metabolism, suitable fermentation kinetics, low acetic acid production, resistance to higher concentrations of sugar,ethanol, and sulfur dioxide, and the generation of pleasant aromatic compounds—*S. cerevisiae* was selected and has been used for century. *S. cerevisiae* has a distinct metabolism that regulates the synthesis of compounds with volatile and aromatic properties(D. Ma et al. 2025b).

In addition to the affect of *Saccharomyces* species there are several sensory and chemical properties of wine that are affected by temperature of fermentation. During primary fermentation, low temperature is favorable because it maintains proper aroma and flavor profile in wine(Gu et al. 2025). During fermentation, *Saccharomyces cerevisiae* emanates different aromatic compounds such as Esters, fatty acids, higher alcohols(Parapouli et al. 2020). Aromatic compounds are low in molecular weight due to the fact that they are easily volatile in nature, which is affected by fermentation temperature. Generation of off flavors mainly sulphur compounds which are volatile
in nature, can be maintained by controlling the temperature(J. Wu et al. 2021). Above 30°C fermentation temperature also has an impact on the process, as it slows down the rate of fermentation and ultimately causes yeast to produce unwanted products. The most frequent chemicals that cause off-flavors (such as rotten eggs and fried cabbage) are mercaptans, also known as thiols and disulfides and H_2S(L. Ma and Li 2021).

Fermentation at a lower temperature has been permitted to improve the purity of the wine. A low temperature is another method for achieving clarity in wine, in addition to cold setting and stabilization racking(Chaudhary and Janmeda 2025). It is possible for yeast cells to release colloids at low temperatures, which improves the clarity of the wine. Yeast and pectin undergo physiochemical modifications to generate aggregates and polysaccharides for the formation of colloids(Zhai et al. 2023). Colloid production reduces the clarity of the wine because they clump together and form polysaccharides following a physicochemical change. This is the reason that fermentation at a lower temperature results in less haziness and cloudiness in the finished wine. Lowering the temperature during fermentation can decrease the

number of microorganisms and their ability to deteriorate the sugars into simple compounds decreases. Specifically, at higher temperatures , some bacteria produce an excessive amount of diacetyl molecules,which give food an unnecessary buttery flavor (Sharma et al. 2020). Besides this, if the temperature is not optimum, some spoilage yeasts like *Pichia membranifaciens, Pichia anomala,* and *Candida* species spoil the wine surfaces, forming undesirable volatile compounds like acetic acid and ethyl acetate(Fernández-Pacheco et al. 2025).

Use of non-*Saccharomyces* yeasts in winemaking:
Many non-*Saccharomyces* yeast are also utilized for wine production which have been enlisted in table 2.6.

Table 2.3 Various non-saccharomyces yeasts used for wine production.

Name of the fruit wine	**Non-*Saccharomyces* yeast strain**	**Reference**
Gabiroba wine	*Candida, Issatchenkia, and Pichia*	(Barbosa, Lima, and Tette 2022)
Palm wine	*Pichia, Schizosaccharomyces saccharomycodes, Schizosaccharomyces pombe*	(Egue et al. 2022; Sukmawati et al. 2023)
Pineapple wine	*Hanseniaspora uvarum; and Pichia guilliermondii*	(Chanprasartsuk and Prakitchaiwattana 2022)
Papaya wine	*Schizosaccharomyces pombe;Zygosaccharomyces*	(N. Wang et al. 2022)

During the process of wine production through non-*Saccharomyces* yeasts some undesirable results have also been reported (Vilela 2020). Elevated proportions of ethyl acetate and methyl butyl acetate produced by species of *Hanseniaspora* confer eastery blemishes
Zygosaccharomyces has been reported to cause refermentation of wine during its storage(Csoma et al. 2023). Some species of non-*saccharomyces*, like *Candida* and *Pichia*,form a film on the wine surface that causes oxidation of wine and results in undesirable changes to wine's flavor,aroma and overall quality. *Saccharomyces cerevisiae* is the prime species which is present at the time of fermentation of fruit wine. Nonetheless, many other Saccharomyces species appeared as like, *Saccharomyces pastorianus, Saccharomyces bayanus*, *Saccharomyces carlsbergens*is and many others(Nya and Etukudo 2023).

Conclusion

On study of Pineapple wine, it is found that it has the potential to be a great substitute for conventional grape-based wines, providing special nutritional, medicinal, and taste advantages. Bioactive substances such as phenolic compounds, antioxidants, organic acids, and vitamins are abundant in pineapple wine and contribute to its unique flavour, fragrance, and health-promoting qualities. With the influence of variables such as yeast strains, fermentation conditions, and

maturation processes, the fermentation process is essential in regulating these biochemical traits.

Advanced analytical methods including chromatography, metabolomics, and spectrophotometry can be used for biochemical makeup and quality standards of pineapple wine. These techniques make it possible to gain a greater understanding of the nutritional value, taste profiles, and possible bioactive effects of the product—all of which are critical for improving marketability, consumer acceptability, and product quality. To find more resilient yeast strains, improve fermentation methods, and investigate how various pineapple cultivars affect wine quality, additional study is required. Furthermore, pineapple wine acceptability in international markets will depend on research on its safety and health advantages.

In summary, pineapple wine has substantial nutritional and financial potential and is a creative and sustainable beverage choice. To realize its full potential and guarantee constant quality for customers throughout the world, biochemical analysis and fermentation technology must continue to progress.

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Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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