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Review Article

A review on the comparative study of nutraceutically activated fruits and herbs based wines

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Abstract
Nowadays, fruits and herbs wine is a boon for the alcoholic beverage industry since it has a plethora of secondary metabolites (bioactives) with numerous pharmacological properties. The article aims to provide an overview of the possibility of making wine from a variety of nutraceutically active herbs and fruits. The different databases have been used to compile the information. Wine can be made from tropical, subtropical, and temperate fruits that are highly perishable, nutritionally diverse, and underutilised, such as raspberries, pomegranates, sweet potatoes, papaya, pineapples, and kiwi fruit. Herbal wine is beneficial to the alcoholic beverage industry because it has a large number of secondary metabolites (bioactives) with a variety of medicinal properties. Herbal and fruit wine provide biological functions and health benefits such as antioxidants, anti-inflammatory activity, anticancer, anti-aging, and protection against cardiovascular problems, diabetes, obesity, and neurodegenerative disorders. Among herbal and fruit wine constituents, phenolic compounds are important in conferring health benefits. Most significantly, phenolic substances like flavanols, flavanones, flavones, tannins, anthocyanins, hydroxycinnamic acids, hydroxybenzoic acids, and resveratrol can help prevent heart disease, cancer, diabetes, inflammation, and other chronic diseases. This study focuses on the comparative health benefits of the bioactive chemicals which are present in the fruits and herbal wines. Wine includes physiologically active components that have the potential to improve consumer's health. Various herbs and fruits used for wine-making and their medicinal applications have been discussed in this paper.

Keywords: Nutraceutical, Herbal wine, Fruit wine, Secondary metabolites, Flavonoids, Phenols

INTRODUCTION

Wine is an innovative alcoholic beverage produced by the yeast fermentation of grape must consist of the species *Vitis vinifera*. The art of preparation of wine was started back 6000-5000 BC (Fracassetti *et al.*, 2019). It has functional properties which pose many health benefits such as anti-aging effects, improve the lung function, reduce the coronary heart disease, helps in the development of healthier blood vessels in elderly people, act as an antiulcer agent, acting as an antioxidant and also act as anti-carcinogenic (Trivedi *et al.*, 2015). The polyphenolic components of the wine depend on the type of substrate used for its preparation. Many scientists are working to increase the health benefit of the wine by incorporating herbs to increase its medicinal value, which will add functional properties to the product (Chauhan *et al*., 2015). Wine consists of low-level concentrations of various mineral elements, including major and minor elements. A number of macro mineral consists of Ca, K, Mg, Na and Mg, which falls in the range of 10-1000 mg/L and micro mineral include al, Fe, Cu, Mn, Rb, Sr and Zn, which falls in the range of 0.1-10mg/L whereas Ba, Cd, Co, Cr, Li, Ni, Pb and V are the trace elements present in the wine that falls in the range of 0.1-1000 /L (Pérez- Álvarez *et al*., 2019). The flavour of the wine comprises taste, visual attributes and aroma, while aroma contributes in the overall perception of flavour (Belda *et al*., 2017). The techniques for the production of wine were modified with the passing of time; further, development categorized the wine into traditional and modern ones. The process of fermentation of wine is classified into two types, i.e. primary (also known as classic) and secondary (malolactic fermentation) (Milovanovic *et al*., 2019). Various indigenous trees produce fruits and vegetables that ripen in the short passage of time and are edible. Fruits are perishable products used to spoil in a shorter duration of time, leading to the wastage of a large quantity of product. This wastage occurs due to high temperature, fluctuations in humidity levels, improper handling techniques, improper storage conditions, transportation defects and Microbial spoilage. With passing times, various techniques have been developed to increase the products' shelf life. Therefore, wine production contributes in the preservation of fruits by utilizing the juices of surplus ripe and over ripened fruits (Jagtap and Bapat 2015a).Wine can be made from tropical, subtropical, and temperate fruits that are highly perishable, nutritionally diverse, and underutilised, such as raspberries, pomegranates, sweet potatoes, umbu, papaya, pineapples, and kiwi fruit. Herbal wines are alcoholic beverages mostly made from herbs, including amla, aloe vera, holy basil, lemongrass, peppermint, cinnamon, elderberry, and others (Thakur, 2020). Regular but limited use of these herbal wines, which benefit from the extract of herbs, reduces the need for prescription medications to treat various conditions. The health benefits of herbal wine and its formulation are numerous. It fulfils the purpose of functional food. The release of amino acids and other nutrients by the yeast during fermentation has boosted the nutritional value of herbal wine. Herbs were once mostly employed as flavour enhancers, but researchers are now looking at their bioactive properties, which suggest they may aid in the prevention of chronic disease (Bhise and Morya, 2021).The consumption of wine went up and down in past 15 years. Nowadays alternative cheap and easy-drinking wines are appearing in the market for example flavoured wine (black current, peach grapefruit etc.) with alcohol content ranges from 8-10.5% that are obtained by the mixing of fruit juices with the wines with natural or artificial aroma that increases its acceptance (Fracassetti *et al.,* 2019). Wines typically contain 11–16 % alcohol by volume; however, they can be as low as 7%. Fortified or dessert wines have been fortified with brandy or red and white wine and have an alcoholic level ranging from 16 % to 23 %. These wines are usually sweet and have a high alcohol content of 18–20 % (Joshi *et al*., 2017).Wine can be fortified with various types of additives to increase the basic quality of the wine. Addition of extracts from some herbs increases the therapeutic effect and medicinal value of the wine. The presence of antioxidants in the herbs prevents the oxidation of the low density lipoprotein (LDL) (Morya *et al*., 2016). This review article has focused on the comparative study of fruit and herbal wines.

FERMENTATION

Fermentation is the process in which required microorganisms are utilised to produce commercially important products. During industrial fermentation, the selected microorganism is used under the specified condition with adjusted nutrient composition (Saranraj *et al*., 2017). The process of winemaking (Fig 1.) is achieved with three operations: pre-fermentation, fermentation, and post-fermentation operations. Different types of wines require different operations. It includes the conversion of sugar into juice and then into alcohol and carbon dioxide with the help of yeast. This process requires anaerobic conditions. Other operations such as clarification, filtration and centrifugation are achieved by racking (Swami *et al.,* 2014).

The following are the goals of the fermentation process:

- Preservation using acidification/alcohol production
- Changes in the chemical nature and sensory qualities of fruit
- Improvement in the efficacy of some bioactive constituents
- Enrichment of nutritional value of foods and beverages
- Increase in consumption and export of processed fruit products
- Attribution to better transportation and distribution infrastructure
- To reduce post-harvest and production losses
- To generate more income

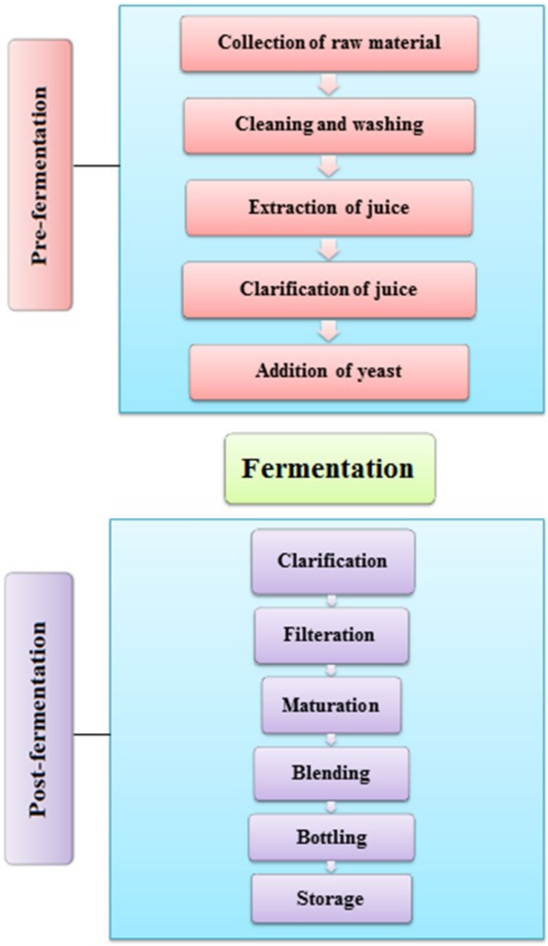

Fig.1. *Steps in wine production*

- Improved cultivation and commercialization
- Promote sustainable use of biomes

CLASSIFICATION OF WINE ON THE BASIS OF FRUIT

Wines can be classified in a variety of ways, including geographical origin, grape variety utilised, fermentation, and maturation technique; however, there is no accepted system of wine classification (Joshi *et al.*, 2017). The broad classification of wine is illustrated in fig 2.

GRAPE WINE

This type of wine comes under the category of table wine and is produced by the fermentation of grapes (black or green) with the help of yeast culture. This category includes red wine, white wine and pink wine.

Red wine

It is basically prepared from black/red grapes. There are various types of red wines that are available in the market. This wine is considered a classic wine. The colour of the grape juice is greenish-white, while the red color of the wine is achieved by the anthocyanin pigment that is present in the skin of the grapefruit. Red wines are classified into six types: Barbera wine, Merlot wine, Shiraz wine, Cabernet wine, Malbec wine, and Nior (Swami *et al*., 2014).There are various flavonoids (catechin, epicatechin, quercetin, anthocyanins, and procyanidins), resveratrol (3,5, 40-trihydroxystilbene), and polymeric tannins are abundant in red wine. In general, red wine is high in polyphenols and can be used as a significant source of polyphenols in the diet (Castaldo *et al*., 2019). These polyphenolic compounds present in red wine help in the reducing cardiovascular diseases and are present in a very limited number of foods. Furthermore, they help reduce arteriosclerosis and heart attacks, reducing the risk of diabetes and hypertension also (Snopek *et al*., 2018).

White wine

White wine is produced with the help of alcoholic fermentation of non coloured pulp of grapefruit, whether they are green or gold coloured grapes. Various types of white wine are chardonnay wine, dry white from sauvignon grapes, gewurztraminer, muscat/moscato wine, dry white from pinot grapes, reisling wine, semillon wine and viognier wine. (Swami *et al*., 2014). White wine isn't usually white; depending on whether it is made from the grape's skin or only the juice, it can be yellow, gold, or straw coloured. White wine can be made from a non-concealed pound of green or gold conditioned grapes, or from plucked red grape juice (Kumar and Singh, 2021). The polyphenolic components of white wine are lesser as compared to red wine (Salucci *et al*., 2017).

Pink wine

Due to its color that is obtained by the immediate removal of grape skin after the start of fermentation pro-

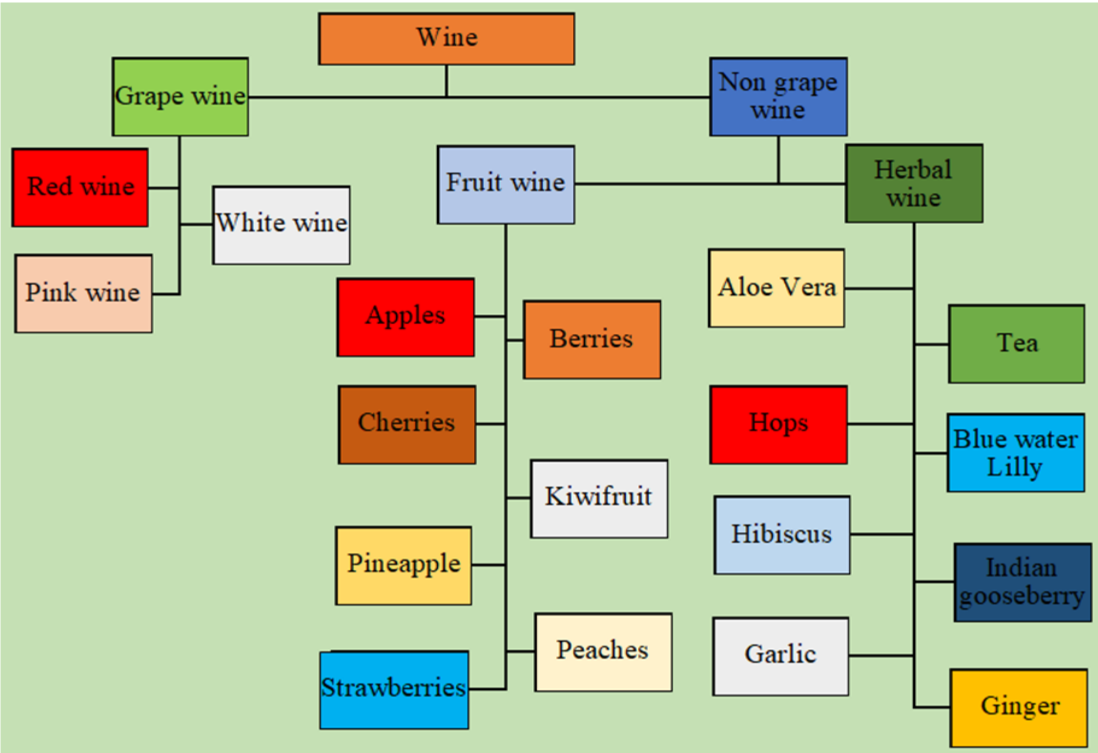

Fig 2. *Classification of wine*

cess, it is called pink wine. These wine are prepared by using technology of white wine production with a mixture of black and white grapes (Swami *et al.,* 2014).

NON-GRAPE WINE

Several fruits are grown in great quantities worldwide for alcohol production during the fermenting process. Fruit wines come in various variety that are based on the technique of production (distillation or not), the raw material utilised, and the vinification practises (Joshi *et al*., 2017). Fruits being a perishable commodity, is more susceptible to spoilage hence fermentation not only increases the shelf life while it also helps in the reduction of wastage from fruits. Wine can be prepared from various types of fruits such as pineapples, apples, oranges, blackberries etc. Cider, or "apple wine," is produced from the fermentation of apples and is one of the most widely manufactured non-grape fruit wines. While working with fruits other than grapes, sugar may be required to speed up the fermentation process if the fruit does not contain enough natural sugar to ferment on its own (Saranraj *et al*., 2017). Herbal wines are wines with therapeutic properties that are typically made with the addition of various herbs and medicinal plants. Anti-cancer, anti-microbial, anti-diabetic, and anti-oxidant effects are all observed in herbal wines. It has numerous health benefits, including ovarian cancer prevention, bone and skeleton strengthening, cancer cell deterioration, heart stroke protection by keeping coronary arteries clear, and improved lung performance (Deshmukh and Deshmukh, 2021).

Herbal wine

Herbal wines are alcoholic beverages prepared mostly from herbs such as amla, aloe vera, holy basil, lemongrass, peppermint, cinnamon, elderberry, and other herbs. The regular use of these herbal wines on a restricted basis tends to lessen the need for prescription medications to treat various health issues. It satisfies the requirements of functional food. The nutritional value of herbal wine has increased due to the yeast's release of amino acids and other nutrients during fermentation. Herbs are widely used to improve flavour, but due to their high bioactive properties, it helps to prevent various chronic diseases (Opara, 2019). People were treated with herbal formulations made from herbs prior to the medical revolution and the rise of modern pharmaceuticals. Because of the solvent capabilities of its alcohol combined with the acidity that often defines wines of a particular terroir, herbal wine is a great vehicle for extracting some of the therapeutic components of plants (Dias *et al*., 2020). Herbs are used as a flavour enhancer, antioxidant, and preservative in wine. Ayurveda expertise has a long history in India, with herbs, herbal powders, and liquid herbal formulations proven useful for conditions ranging from mild ailments to terminal illnesses (Jayasundar, 2010). Anti-carcinogenic, chemo-protective, anti-diabetic, anti-inflammatory effects of these plants can be utilised (Das *et al*., 2021). Herbs have less toxic, anticancer, antitumor, and anti-proliferation compounds than standard plants (Teissedre *et al*., 2018). Because it produces a range of phytochemicals, herbal wine has been utilised as a remedy for a variety of health issues. Herbal wine is also used to treat diabetes, kidney disease, cancer, arthritis, and Alzheimer's disease, among other chronic illnesses (Bhise and Morya, 2021). Herbs and their derived products represent a rich source of bioactive compounds with various nutraceutical properties are mentioned in Table 1.

FRUIT WINE

Wine may be manufactured from a wide variety of fruits as long as the fruit contains enough sugar for the fermentation process to convert it to alcohol. Fruit wines are fermented alcoholic beverages created from other fruits, with comparable manufacture and fermentation methods to grape juice. As a result, nongrape wines are predicted to have similar microbiology to grape wines, although microflora can differ depending on the kind of fruit (Matei and Kosseva, 2017). Fruit wine can be made from a wide range of fruits with enough sugar content. Litchi, apple, plum, pineapple, banana, blueberry, and other fruit wines have been recorded and successfully prepared in the literature (Yang *et al.,* 2020). Fruit wine contains ethyl alcohol, sugar, acids, top alcohols, tannins, aldehydes, esters, amino acids, minerals, vitamins, anthocyanins, and other minor flavouring compounds (Kumar and Singh, 2021). According to European laws fruit wines must be made from the fermentation of juices of fruits other than grapes. The laws also specify the principal classification of fruit wines as still or sparkling and the permitted alcoholic strength of 1.2% to 14% by volume. Except for some differences based on the fruit utilised, grape and fruit winemaking methodology is very similar. Grape juice is naturally suited for winemaking and only requires minor adjustments prior to fermentation, whereas a fruit other than grapes frequently requires changes. Different fruit kinds, such as apples, pears, peaches, or cherries, provide ample juice and a favourable acid-to-sugar ratio, which are essential for effective winemaking (Velic *et al*., 2018) Fruits along with their derived products represent a rich source of bioactive compounds that have various nutraceutical properties have been mentioned in Table 2.

Both herbal as well as fruit wine poses various health benefits and consists a wide range of secondary metab-

Table1. Summary of health benefits of herbs used in wine preparation

Herbs used	Botanical name	Family	Secondary metabolites	Nutraceutical applications	Microorganism used	Alcohol (%)	pH	References
Tea	*Camellia sinensis*	*Theaceae*	Catechins and epicatechins, theaflavins, flavonol glycosides, L-theanine, caffeine, theobromine, linalool and volatile organic substances	Cure cardiovascular illnesses, cancer, digestive problems, and metabolic disorders such as obesity and diabetes	*Saccharomyces cerevisiae* 71B	0.27	-	Samanta, 2022; Wang *et al*., 2020
Hops	*Humulus lupulus*	*Hemp*	Flavonoids isoquercitrin and quercetin	Antioxidant, antibacterial, antifungal, antiviral, anti-inflammatory, and cancer-fighting properties	*S. cerevisiae* var. *ellipsoideus*	-	3.2	Astray *et al*., 2020; Almeida *et al*., 2020; Joshi *et al*., 2014
Blue water lilly	*Nymphaea lotus*	*Nymphaeaceae*	Ellagic and gallic acid and their methyl and ethyl esters and flavonoids as aglycones of quercetin, kaempferol, isokaempferide, apigenin and their glycosides	Antioxidant, Anti-inflammatory, and hepato-protective effects	*S. cerevisiae*	5.14	3.62	Bakr *et al* ., 2017; Yuwa-Amornpitak *et al*., 2012
Purple sweet potato	*Dioscoreaalata*	*Dioscorea*	Discorin, diosgenin and alatanin C	Antioxidant, anti-diabetic and hypoglycemic activity	Dry yeast *S. cerevisiae*	10.55	3	Kanu *et al*., 2018; Zhong-Hua and Jie 2015
Indian gooseberry	*Emblica officinalis*	*Euphorbiaceae*	Gallic acid, ascorbic acid, ellagic acid, rutin, quercetin, catechol, apigenin, chebulinic acid, corilagin, isostrictiniin, methyl gallate, luteolin	Antibacterial, antifungal, antioxidant, antidepressant, immune-modulatory activity, cytotoxic effects, anti-hyperlipidemic, hypolipidemic, and anti-atherogenic actions and many more	*S. cerevisiae*	8.9	6	Chahal *et al*., 2019; Hasan *et al*., 2016; Amaley *et al*., 2016
Aloe vera	*Aloe barbadensis*	*Liliaceae*	Acemannan, aloin, chrysophanol, aloe-emodin, aloesaponarin I & II, aloesin, umbelliferone and esculetin	Anti-inflammatory and immune-modulatory properties, wound and burn healing activities	*S. cerevisiae* MTCC 786	8.5	3.7	Majumder *et al*., 2019; Trivedi *et al*., 2015
Hibiscus	*Hibiscus rosasinensis*	*Malvaceae*	Quercetin, quercetin-3-diglucoside, ß-sitosterol, cyanidin-3,5-diglucoside , cyanidin-3-sophoroside , and luteolin-8-C-glucoside	Hypotensive, antipyretic, anti-inflammatory, anti-cancer, antioxidant, anti-bacterial, anti-diabetic, wound healing, and abortifacient properties are some of the positive benefits	*S. cerevisiae* MTCC 178	11.50	4.62	Missoum, 2018; Tiwari *et al*., 2016
Garlic	*Allium sativum*	*Amaryllidaceae*	Allicin, alliin, diallylsulfide, diallyldisulfide, diallyltrisulfide, ajoene, and S-allyl-cysteine	Antioxidant, anti-inflammatory, antibacterial, antifungal, immune-modulator, cardiovascular, anticancer, hepatoprotective, digestive system protective, anti-diabetic, anti-obesity, neuroprotective, and renal protective activities	*S. cerevisiae*	5.5	-	Shang *et al*., 2019; Bhise and Morya, 2021
Ginger	*Zinziber officinale*	*Zingiberaceae*	Gingerols, shogaols, and paradols	Antioxidant, anti-inflammatory, antimicrobial, anti-cancer, neuroprotective, cardiovascular, respiratory, anti-obesity, antidiabetic, antinausea, and antiemetic properties	*S. cerevisiae*	10-12	3.5 -4	Mao *et al*., 2019; Jangra *et al*., 2018
Lemon grass	*Cymbopogonflexuosus*	*Grasses*	E-citral and Z-citral	Antibacterial, antifungal, antiprotozoal, anti-inflammatory, antioxidant, antitussive, antiseptic, anti-carcinogenic, cardio-protective and anti-rheumatic	*S. cerevisiae*	6	-	Haque *et al*., 2018; Bhise and Morya, 2021
Holy basil	*Oscimum sanctum*	*Laminaceae*	Oleanolic acid, rosmarinic acid, ursolic acid eugenol, linalool, carvacrol, β elemene, β caryophyllene andgermacrene	Used to treat fever, syphilis, ulcers and inflammation, wounds, antimicrobial infection, analgesic, antifungal, arthritis, anticancer, eye disease, anti-fertility, hepatoprotective, chronic fever, and anti-spasmodic	*S. cerevisiae*	11.0	3.71	Panchal and Parvez, 2019; e Dias *et al*., 2020
Peppermint	*Mentha arvensis*	*Lamiaceae*	Menthol, menthone, and menthyl acetate	Antiviral, and antioxidant properties treatstomachache and chest pains.It can be used as a home treatment to help with digestion.	*S. cerevisiae* MTCC 786	9.5	3.67	Brahmi *et al*., 2017; Chauhan *et al*., 2015

Table 2. Summary of health benefits of fruits used in the preparation of wine

Fruit	Botanical name	Family	Secondary metabolites	Nutraceutical applications	Microorganism	Alcohol (%)	pH	References
Apple	*Malusdo-mestica*	*Rosaceae*	Catechin, chlorogenic acid, p-coumaroylquinic acid, epicatechin, cyanidin-3-galactoside, procyanidin, coumaric acid, gallic acid, phloridzin, quercetin-3 galactoside and quercetin-3-rhamnoside	Increase blood clotting, strengthening the gums and heart muscle, useful in reducing sebum production, lowered melanin level, greasiness, and erythema (acne-causing erythema).	*Saccharomyces cerevisiae* strain CCTCCM201022	11–14	4.3	Patocka *et al*., 2020; Maksimović and Maksimović 2017; Jagtap and Bapat, 2015a
Banana	*Musa sapi-entum*	*Musaceae*	Gallic acid, catechin, epicatechin, tannins, and anthocyanins	Compete with cholesterol for gut absorption, amino acid decarboxylation, and amination of aldehydes and ketones, as well as antimutagenic and antitumoral properties.	*S. cerevisiae*	7.2	3.9	Sidhu and Zafar 2018; Jagtap and Bapat, 2015a; Tamrakar *et al*., 2020
Black berry	*Rubusocci-dentalis*	*Rosaceae*	Anthocyanins, chlorogenic acid, procyanidins, polyphenols, benzoic acid, hydroxycinnamicacid, ellagic acid, tannins, ellagitannins, quercetin, and gallic acid	Antioxidant, anti-inflammatory, and antimicrobial activities	*S. cerevisiae*	10–12	3.3-3.6	Zorzi *et al*., 2018; Maksimović and Maksimović, 2017; López-Vidaña et al., 2019
Cagaita	*Eugenia dysenteric*	*Myrtaceae*	Vitamin C, β-Carotene and phenolics	Antioxidant activity	*S. cerevisiae* UFLA CA11	8.6	2.95	Silva *et al*., 2020; Oliveira, et al., 2011
Cherry	*Prunus-cerasus*	*Rosaceae*	Cyanidin, 3-rutinoside, peonidin, 3-glucoside, isorhamnetin, quercetin, ferulic acid, chlorogenic acid and p-coumaric acid	Strong antioxidant, antidiabetic, antiobesitic, antimutagenic, and anticarcinogenic characteristics protect against neurological illnesses, diabetes, obesity, cardiovascular disease, and inflammatory diseases.	*S. cerevisiae*	10–13	3.3-4	Ozen *et al*., 2020; Maksimović and Maksimović 2017; Jagtap and Bapat, 2015a
Custard apple	*An-nonasqua mosa*	*An-nonaceae*	Linalool, borneol, Eugenol, farnesol, geraniol, tannins, phenolic compounds, polyphenols, annotemoyin-1, annotemoyin-2, squamocin and cholesteryl glucopyranoside	Antibacterial, antidiabetic, antimalarial activity, antioxidant, analgesic and anti-inflammatory antiviral activity	*S. cerevisiae* NCIM 3282	11.8	4.5	Ahmed and Mariod 2019; Jagtap and Bapat, 2015b
Elder berry	*Sambu-cusnigra*	*Adox-aceae*	Chlorogenic acid, neochlorogenic acid, cryptochlorogenic acid, rutin, isoquercitrin, kaempferol-3-rutinoside, astragaline, isorhamnetin-3-rutinoside and isorhamnetin-3-glucoside.	Diaphoretic, antipyretic, and diuretic drugs have antibacterial, antiviral, depressive, antitumor, and hypoglycemic characteristics, as well as the ability to lower body fat and lipid levels.	Wine yeast	13.2	3.9	Młynarczyk *et al*., 2018; Schmitzer *et al*., 2010
Guava	*Psidi-umguajava*	*Myrtaceae*	Ascorbic acid, citric acid ,vitamin A, iron, phosphorus and calcium, saponin, oleanolic acid, lyxopyranoside, arabopyranoside, guaijavarin, quercetin and flavonoids	Anti-viral, anti-inflammatory, anti-plaqueposes antinociceptive and anti-mutagenic activities	*S. cerevisiae* MTCC 11815	13.8	3-4	Naseer *et al*., 2018; Nikhanj *et al*., 2015
Jamun	*Syzgium-cumini*	*Myrtaceae*	Anthocyanins, gallic acid, ellagic acid, glucoside, caffeic acid, ascorbic acid, coumaric acid, isoquercetin, myricetin and kaempferol	Antidiabetic, hypolipidemic, cardioprotective, antidiarrheal, antiallergic, antifertility, antipyretic, anticlastogenic, gastroprotective, antidermatophytic, antianemic, carminative, antioxidant, antineoplastic, radioprotective, diuretic, anorexigenic, antiarthritic, aphrodisiac, antiscorbutic and poses cytotoxic activities.	*S. cerevisiae* strain 3304 and 3604	4-6	3.5-4.5	Chhikara *et al*., 2018; Chaudhary *et al*., 2017

Contd…….

Table 2. Contd…….

Jaboticaba	*Myrciariaja-boticaba*	*Myrtaceae*	Cyanidin-3-O-glucoside, delphinidin-3-O-glucoside, gallic acid , ellagic acid, isoquercitrin, quercimeritrin, quercitrin myricitrin, and quercetin	Antioxidant, anti-inflammatory, anti-diabetic, anti-obesity, could be used in the treatment of Chronic Obstructive Pulmonary Disease (COPD).	*S. cerevisiae* UFLA CA1162	5.7	-	Bailão *et al*., 2015; Duarte *et al*., 2010
Kiwi	*Actinidi-aarguta*	*Actinidi-aceae*	Vitamin C, vitamin B8 (myo-inositol), lutein, β-carotene, chlorophylls, enzyme actinidin and antioxidants as well as dietary fibre	Prevention of oxidative stress and inflammation-mediated disorders, such as cardiovascular and neurodegenerative diseases, cancer, diabetes, obesity and premature aging	*S. cerevisiae* WLS21	6-14	3-4	Latocha, 2017; Pinto *et al*., 2020; Huang *et al*., 2021
Lychee	*Litchi chinensis*	*Sapin-daceae*	Epicatechin, Catechin, Gallocatechin, Procyanidin A2, Proanthocyanidin B2 and Cinnamtannin B1	Anti-oxidant, cytotoxicity, anti-viral and antimicrobial	*S.cerevisiae* MERIT.ferm	12	3.8	Upadhyaya *et al*., 2017; Tang *et al*., 2019
Mango	*Man-giferaindica*	*Anacardi-aceae*	Mangiferin, catechins, quercetin, kaempferol, gallic acid and benzoic acid	Anti-inflammatory, antibacterial, analgesic, antipyretic, antioxidant, anticancer, antiviral, immunomodulatory, anthelminthic, anti-ageing, antidiabetic, lipometabolism regulating, cardioprotective, anti-hyperuricemic, neuroprotective and helps in treatment of obesity.	*S. cerevisiae* CFTRI 101	8	3.7	Jahnavi *et al*., 2020; Coelho *et al*., 2019; Maksimović and Maksimović 2017; Jagtap and Bapat, 2015a
Orange	*Citrus sinensis*	*Rutaceae*	Anthocyanins, ascorbic acid, hydroxycinnamic acids, ferulic and p-coumaric acids	Because of their anti-oxidant and anti-inflammatory properties, they reduce the risk of cardiovascular disease, diabetes, arthritis, and cancer.	*S. cerevisiae* var. *ellipsoideus, S. uvarum, S. cerevisiae, S. carlsbergensis*	12.6	3.6	Maksimović and Maksimović, 2017; Matei and Kosseva 2017; Fallico *et al*., 2017
Papaya	*Carica papaya*	*Caricacae*	P-coumaric acid, quercentin, nicotine, kaempferol, ferulicacid and choline.	Treatment of cardiovascular diseases, dengue fever, cancer, malaria, hypoglycemia, hyperlipidemia, anti-inflammatory, fungal diseases and act as a male contraceptive	*S. cerevisiae*	10.11	4.45	Pandey *et al*., 2016; Cholassery *et al*., 2019
Pineapple	*Ananasco-mosus*	*Brome-liaceae*	Alkaloids, flavanoid, tannins and glycosides	Antiscorbutic, cholagogic, diaphoretic, refrigerant, and used in jaundice treatment	Active dry yeast	10.2	3.52	Qi *et al*., 2017; Kalaiselvi *et al*., 2012
Peach	*Prunusper-sica*	*Rosaceae*	Gallic acid, protocatechuic acid, protocatechualdehyde, chlorogenic acid, p-coumaric acid and ferulic acid	Helps in the prevention of diseases such as neurodegenerative diseases, cardiovascular diseases, cancer etc.	*S. cerevisae*	8.1	3.9	Loizzo *et al*., 2015; Maksimović and Maksimović, 2017; Jagtap and Bapat 2015a
Pomegranate	*Punica-granatum*	*Punica-ceae*	Protocatechuic acid,vanillic acid, gallic acid, brevifolin carboxylic acid, phydroxybenzoic acid hexoside, cis- and trans-caffeic acid hexoside, anthocyanin, b-carotene and ascorbic acid	Antioxidant, anti- cardiovascular diseases, anti-osteoporosis, anti-diabetic, anti-inflammatory and poses anticancerous activities	*S. cerevisiae* MTCC-36	10.1	4.0	Fourati *et al*., 2020; O'Grady *et al*., 2014; Samson *and Singh,* 2017
Raspberry	*Raubusi-daeus*	*Rosaceae*	Gallic, p-coumaric and ellagic, and for anthocyanins: cyanidin-3-glucoside and malvinidin-3-glucoside, vitamins C, B1, B2 and B6, provitamin A, pectins, salicylic, caffeic and ferulic acids	Antimutagenic, anti-inflammatory, anti-oxidant and anticancer effects	Activated dry yeast (CY3079)	6.09	2.9	Feng *et al*., 2015; Segantini *et al*., 2015
Sweet potato	*Ipomoea batatas*	*Convolvu-lacee*	Peonidin,cyanidin, luteolin, quinic acid, Chlorogenic,saponin, isochlorogenic, caffeic, cinammic, and hydroxycinammic acids	Treat a variety of illnesses, including oral infections, inflammatory diseases, and diabetes management	*S. cerevisiae*	9.33	3.61	Jagtap and Bapat, 2015a; Ray *et al*., 2011
Strawberry	*Fragari-aananassa*	*Rosaceae*	Anthocyanidins, pelargonidin-3-glucoside,ellagic acid , quercetin and kaempferolglucosides	Poses anti-cancerogenic, anti-inflammatory and anti-neurodegenerative properties	Activated dry yeast (CY3079)	5.99	2.8	Maksimović and Maksimović, 2017; Michalska *et al*., 2017; Feng *et al*., 2015

Table 3. Chemical comparison of fruits and herbal wines

		Herbal wine	**Fruit wine**	**References**
Composition	pH	The pH of herbal wine ranges from 0-4 while for Indian gooseberry it is 6 due to the presence of various acids.	The pH of value ranges from 3-5 for most of the fruit wines.	Chahal *et al*., 2019; Hasan *et al*., 2016; Amaley *et al*., 2016
	Alcohol	Alcohol content of herbal wine is generally less comparatively to fruit wine. It ranges from 0.2-12%. Herbal wine from tea has very less alcohol content that is 0.27%.	Alcohol content of fruit wine ranges from 3-15% that can be due to presence of naturally present sugars. Most of the fruit wines such as apple wine, black berry, cherry, custard apple, elder berry, guava, lychee, orange, papaya, pineapple and pomegranate have alcohol content more than 10%.	Samanta, 2022; Wang *et al*., 2020
	Sugar content	Herbs consist of less natural sugars as major drawback hence frequent adjustments prior to fermentation is usually required that can be generally achieved by the addition of extra sugars into the extracts or must of the herbs.	Grape juice is naturally suited for winemaking and only requires minor adjustments prior to fermentation, whereas a fruit other than grapes requires changes to achieve better results.	Joshi *et al*., 2017; Maksimović and Maksimović, 2017
	Organic acid	Herbal wine made from Indian gooseberry, Hibiscus subdarrifa has high amount of citric, mallic and shikimic acid.	Fruit being rich source of organic acid, the wine prepared from fruits generally have high content of organic acid such as apple wine rich in malic acid, guava and kiwi wine rich in citric and ascorbic acid and so on.	Chahal *et al*., 2019; Hasan *et al*., 2016; Amaley *et al*., 2016; Missoum, 2018; Tiwari *et al*., 2016; Patocka *et al*., 2020; Naseer *et al*., 2018; Pinto *et al*., 2020
	Vitamins	Herbal wine prepared from Indian goose berry, hibiscus and lemon grass are rich source of vitamin C.	Wine contains some minor amount of vitamin B such as thiamine, riboflavin and B12. Fruits wine prepared from fruits of such as apple, cagaita, guava, jamun, kiwi, berries and pineapples are rich source of vitamin A and C.	Chahal *et al*., 2019; Hasan *et al*., 2016; Missoum, 2018; Tiwari *et al*., 2016: Pinto *et al*., 2020; Qi *et al*., 2017; Młynarczyk *et al*., 2018; Jagtap and Bapat 2015a
	Carotenoids	Herbal wines contain a very small amount of carotenoids.	Wine prepared from mango has high amounts of carotenoids.	Maksimović and Maksimović, 2017
Phenolic compounds	Anthocyanin	Herbal wines prepared from hibiscus and purple sweet potato consist of cyanidin. While herbal wines prepared from tea, hops, blue water lilly have very minute amount of anthocyanin.	Berries are the richest source of anthocyanin, and wine made from them also contains a variety of anthocyanin. Blackberry, cherry, elder berry, raspberry, and strawberry consist of cyanidin, pelargonidin, pelargonidin, peonidin and various other anthocyanin.	Młynarczyk *et al*., 2018; Missoum, 2018; Kanu *et al*., 2018; Segantini et al., 2015; Feng *et al*., 2015
	Phenolic acids	The wines prepared from blue water lily consist of gallic acid and their esters. Indian gooseberry is rich source of gallic as well as ellagic acid. Holy basil consists of various phenolic acid such as oleanolic acid and rosamarinic acid. While other herbal wine such as tea wine also consist of various phenolic acid such as catechins and epicatechin.	Major phenolic compounds present in the fruit wine are gallic and ellagic acid. Tannic acid is also present in such wines but they act as the anti-nutritional factors. Apple wine are rich in chlorogenic and p-coumaroylquinic acid. The fruit wine prepared from berries such as blackberry, cherry, elder berry raspberry and strawberry consists of hydroxycinnammic acids.	Bakr *et al* 2017; Chahal *et al*., 2019; Panchal and Parvez 2019; Patocka *et al*., 2020
	Flavonoids	Herbal wines are the rich source for the Flavones, Flavonols, and Flavanones such as wine from tea consist of theaflavins and flavanol. Wine prepared from hops, blue water lilly, indian gooseberry and hibiscus consist of quercetin. Blue water lily also consists of kaempferol and iso kaempferol that is a type of flavonol. Wine prepared from herbs also contains luteolin, catechin, epicatechin, and gallocatechin.	Fruits wine also contain abundant amount of flavonoids. Wine prepared from fruits consists of various flavanoids such as apigenin, chrysin, luteolin kaempferol, myricetin, quercetin, naringin, naringenin, and pinocembrin, catechin, epicatechin, and gallocatechin.	Jagtap, and Bapat, 2015b; Maksimović and Maksimović, 2017

olites, as mentioned in Table 1 and 2, that can benefit human health if utilized properly. Although both wines fulfil the need for a functional fermented beverage, the basic comparison of composition and important phenolic compounds are mentioned in Table 3. Wines manufactured from fruits other than grapes are just as varied, and their cascading array of possibilities opens up a whole new realm to wine enthusiasts.

Conclusion

The present review discusses the health benefits and therapeutic uses of numerous herbs and fruits used in wine production. Wines may now be manufactured from a variety of fruits other than grapes, and the current review includes a collection of studies on the preparation of wine from various fruits and herbs. The primary bioactive chemicals found in fruits and herbs provide many health advantages. Antioxidant and free radical scavenging properties of fruits and herbs as anti-inflammatory activity, anticancer, anti-aging, and protection against cardiovascular problems, diabetes, obesity, and neurodegenerative diseases are just a few of their biological functions and health benefits. The high antioxidant content of herbal wine protects against cardiovascular illnesses and has a free radical scavenging effect. Herbal wine contains all of the health benefits that extend beyond regular nutrition to the host. Consumers who are health-conscious are always on the lookout for foods that are nutritious and provide notable and distinct health benefits. Wine includes physiologically active components that have the potential to improve one's health. Wine contains the majority of the nutrients found in the original fruit juice because it is a fermented and non-distilled product made from fruit. The release of amino acids and other nutrients from yeast during fermentation increases the nutritional value of wine.

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Conflict of interest
The authors declare that they have no conflict of interest.

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