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## Ashutosh S Dalal

Department of Horticulture,  
School of Agriculture, Lovely  
Professional University,  
Phagwara, Jalandhar, Punjab,  
India

## Sandeep Kumar

Assistant Professor, Department  
of Horticulture, School of  
Agriculture, Lovely Professional  
University, Phagwara,  
Jalandhar, Punjab, India

## A review: potential of wine production from different fruits

Ashutosh S Dalal and Sandeep Kumar

### Abstract

Wine is regarded as a gift from God and has also been described as a divine fluid in Indian mythology from ancient times. In Rigveda we find mention of wine as oldest fermented product known to man. Wine is an alcoholic beverage typically made of fermented juice. The fermentation process of juice into wine is a complex biochemical reaction involving microorganisms. Each gram of alcohol provides 7.1 kcal, and each milliliter provides 5.6 kcal. Alcoholic beverages are worldwide produced and they are most popular around the world for several centuries. Most wines as we know it is made with grapes, but it can technically be made from other fruits, flowers and vegetables too. The article presents review on potential of wine production from various fruits and current status of wine industry. Various wine classes such as fruit wine, blended wine, etc. have been discussed in this paper.

**Keywords:** Fruit wine, blended wine

### Introduction

Wine has a long association with human artistic, cultural and religious activities and is considered as nutritious, safe and healthy drink. With increase in the socioeconomic status, the demand of the health and nutraceutical food is increasing day-by-day. Wine contains a wide variety of the biologically active compounds including antimicrobial compounds (phenolics, acids, alcohols, bioamines, etc.) which possess the numerous health benefits. Wine is a beverage resulting from the fermentation of the juice by yeasts with proper processing and addition. Yeast consumes the sugar in the juice and converts it to ethanol and carbon dioxide, releasing heat in the process. A typical wine contains ethyl alcohol, sugars, acids, higher alcohol, tannins, aldehydes, esters, amino-acid, minerals, vitamins, anthocyanin and minor constituents like flavouring compounds, etc. (Amerine *et al.*, 1980) [3]. Wine is made in many ways from different fruits.

### Present status of wine in India

Wine is defined differently in the laws of different countries, e.g., in China wine is considered to be an alcoholic beverage and it may be translated as appetite wine. In California, it is defined as the fermented juice of various fruits. But wine generally denotes the product produced by fermentation of grape juice. There are varieties of wines and they differ in so many attributes that it is difficult to classify them. According to colour, there are two types, red and white. In making red wines, the grapes are crushed and stemmed but the skin and seeds are left in the must. White wines are made from white or greenish grape or from juice of grapes from which skin have been removed. Wines are of two kinds, dry and sweet. Dry wines are those which contain very little or non-sugar. In sweet wines, the sugar content is high enough. The alcohol content of these two kinds of wines ranges from 7 to 20 per cent. Whines with 7 to 9 percent alcohol are known as "light", those with 9 to 16 per cent "medium" and those with 16 to 21 per cent "strong" (Shrivastava and Kumar, 2002) [50].

India was nowhere on the global wine industry map until the Sula winery of Nashik in Maharashtra caught the attention of wine connoisseurs in recent years and emerged to become the first Asian winery outside China to sell 1 million cases in a year. The country's wine sector is more than a decade old with a total production is nearly 2 crore litres annually and consumption stands at 1.5 crore litres per year. Exports barely account for 10% of the total production; however, going forward the potential for exports look favorable and is likely to grow at a faster pace. There are around 110 wineries in India, including 72 in Maharashtra. While the domestic wine industry has an annual turnover of just Rs 600 crores and now global wine sales were to the tune of \$327 billion in 2018 of which Sula Wines accounts for over

### Corresponding Author:

#### Ashutosh S Dalal

Department of Horticulture,  
School of Agriculture, Lovely  
Professional University,  
Phagwara, Jalandhar, Punjab,  
India

60% of it. Wine production in India is concentrated in the states of Maharashtra (85-90%) and Karnataka (5-10%), while Goa and Himachal Pradesh represent less than 5% of output (Krishnan, 2020) [28].

The Indian wine industry is growing rapidly in terms of area covered under wine grapes, production and export of wines. Major states in the country for wine grapes and wine production are Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Madhya Pradesh, Himachal Pradesh and north-eastern States. The wine market in India is estimated to grow by USD 274.00 million from 2021 to 2026. Wine is now exported to France, Italy, Germany, USA, the UK, Singapore and Belgium. APEDA (Agriculture Processed Food Export Development Authority) and ICAR-NRC-Grapes Pune are monitoring export of Indian grapes and wine.

### Health benefits of wine

Wine is enriched with powerful antioxidants like resveratrol, epicatechin, catechin, and proanthocyanidins and are mainly

responsible for keeping us healthy. Polyphenols, a certain type of antioxidants present in red wines prevent unwanted clotting by keeping the blood vessels flexible. Antioxidants rejuvenate the skin, increase skin elasticity and keep the skin bright and glowing. Wine contains high levels of antioxidants in the form of flavonoids which can combat strongly against viruses. Red wines lower bad cholesterol levels. Resveratrol, the natural compound found in grape skin, controls blood sugar levels in diabetic persons also controls cholesterol levels and systolic blood pressure. The chemical compound piceatannol converted from resveratrol reduces the fat cells in our body and keep us slim. The anti-bacterial nature of red wines helps to treat stomach irritation and other digestive disorders. Wine can protect our teeth against dental plaque by inhibiting the growth of bacteria responsible for the formation of plaque and tooth decay. Regular and moderate consumption of red wine effectively reduces the risks of certain types of cancers such as basal cell, ovarian, colon, prostate carcinoma etc.

**Table 1:** Health benefits of fruit used in preparation of wine.

Sr. No.	Common name	Scientific name	Family	Nutraceutical application	Reference
1	Grape	<i>Vitis vinifera</i>	Vitaceae	antioxidant, anti-inflammatory, anti-cancer and antimicrobial properties	Georgiev <i>et al.</i> , (2014) [17]
	Mango	<i>Mangifera indica</i> L.	Anacardiaceae	Anti-inflammatory, antibacterial, analgesic, antipyretic, antioxidant, anticancer, antiviral, immuno-modulatory, anthelmintic, anti-ageing, anti-diabetic	Jahnavi <i>et al.</i> , 2020; [20] Maksimović and Maksimović 2017 [34];
	Jamun	<i>Yzgium cumini</i>	Myrtaceae	Antidiabetic, hypolipidemic, cardio protective, anti-diarrheal, antiallergic, gastro-protective	Chhikara <i>et al.</i> , 2018 [11]
	Custard apple	<i>Annona squamosa</i> L.	Annonaceae	Antibacterial, anti-diabetic, antimalarial activity, antioxidant, analgesic and anti-inflammatory anti-viral activity	Ahmed and Mariod 2019 [2];
	Banana	<i>Musa sapientum</i> L.	Musaceae	Compete with cholesterol for gut absorption, as well as anti-mutagenic and antitumoral properties.	Sidhu and Zafar 2018
	Apple	<i>Malus domestica</i>	Rosaceae	Increase blood clotting, strengthening the gums and heart muscle	Patocka <i>et al.</i> , 2020 [44]; Maksimović and Maksimović 2017 [34]
	Black berry	<i>Rubus occidentalis</i>	Rosaceae	Antioxidant, anti-inflammatory, and antimicrobial activities	Zorzi <i>et al.</i> , 2020 [56]; Maksimović and Maksimović, 2017 [34]
	Guava	<i>Psidium guajava</i>	Myrtaceae	Anti-viral, anti-nflammatory, anti-mutagenic activities	Naseer <i>et al.</i> , 2018 [37]

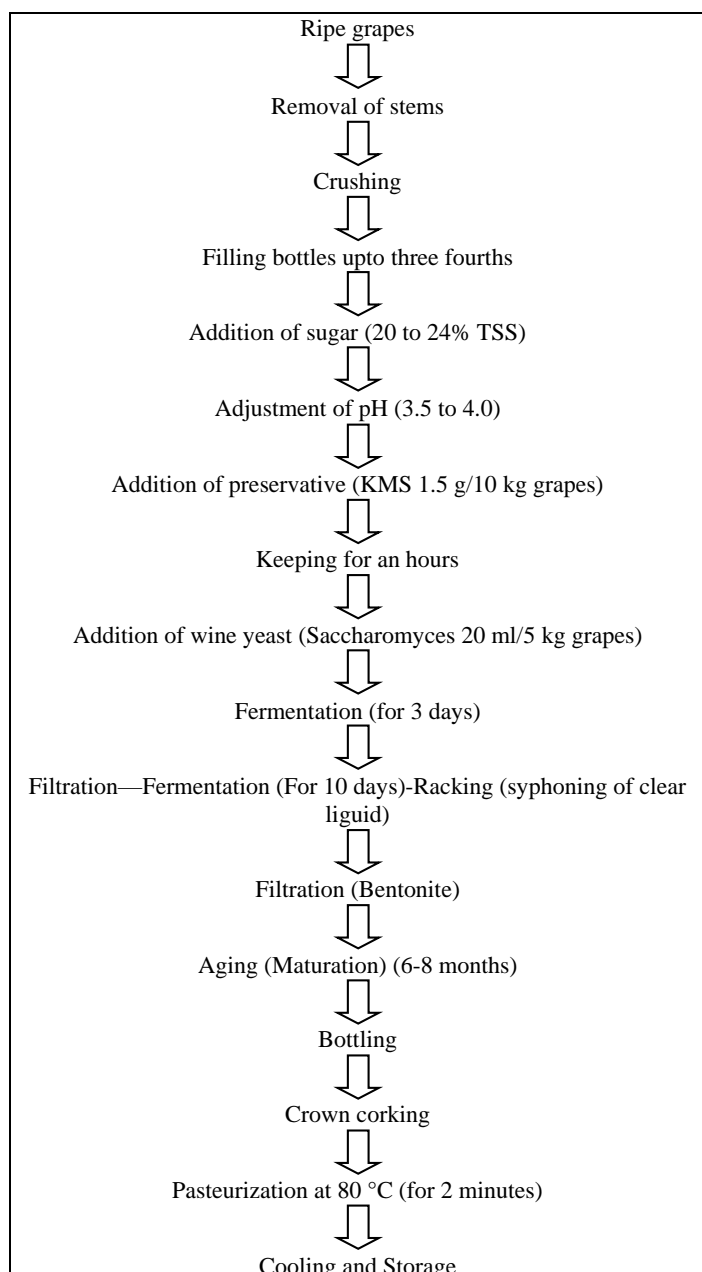
### Fruit Wines

Wine is referred a completely or partially fermented juice of the grape, also fruits other than grapes have also been utilized for the production of wines. In earlier days wine is produced by fermenting grape juice with indigenous bacteria called wild yeast present on grape. Presently, the majority of commercial wine yeasts are strains of *Saccharomyces cerevisiae* because of their superiority of aldehyde production and rate of sugar utilization during fermentation. Fruit wine has wide range of health benefits on human health. It has been used as therapeutic agent and highly acclaimed for its medicinal or therapeutic value.

### Grape

Grapes are conventional and generally preferred for wine production owing to its nutritious and desirable aroma and flavor. Grape wines are made mainly from species

*Vitis vinifera*. This is particularly true in Europe, where the major producers are France and Italy. Phenolic compounds in red wine are derived from the grape skin, seeds, stems and pulp, all of which are important sources of flavanols which are transferred during contact with grape juice in the course of fermentation. In contrast, white wines are produced by fermenting grape juice without contact with grape skins. In addition to the presence of ethanol, red and white wines contain organic acids (Acetic, citric, lactic, malic, succinic and tartaric acid), monomeric and oligomeric flavanols, anthocyanins, proanthocyanidins and low and high degree polymerization condensed tannins (Daglia *et al.*, 2007) [12]. The grape variety for wine making should have higher sugar content of TSS 20<sup>0</sup> B and above, acidity in the range of 0.6-0.8%, and should have typical flavor developed after fermentation and aging (Katyal and Gupta, 1978) [26].



Flow sheet for Processing of Grape Wine

### Mango-

Mango fruit contains carbohydrate (starch and sugar), organic acid, lipid, pigment, and volatiles, phenolics and antioxidants (Maldonado-Celis *et al.*, 2019) <sup>[33]</sup>. Substantial phenolic compounds found in mangoes are mangiferin, quercetin, gallic acid, benzoic acid, kaempferol, anthocyanins, and protocatechuic acid (Palafox-Carlos *et al.*, 2012) <sup>[39]</sup>. These phenolics plays significant role in preventing cardiovascular diseases, atherosclerosis and decreases the risk of cancer (Piers *on et al.*, 2015) <sup>[45]</sup>.

The experiment conducted by Patel *et al.*, (2021) <sup>[43]</sup> on five varieties of mango (Baganpalli, Langra, Dashehari, Alphonso, and Totapuri) for wine production using two different yeast strains namely, *Saccharomyces cerevisiae* MTCC 178 and isolated yeast and found that the physiochemical analysis of wine produced from chosen mango varieties showed that North Indian local mango variety (Dashehari) gave better results in terms of organoleptic and functional attributes.

### Mandarin

Mandarin fruits are popular for their immense nutritive and medicinal values. (Bhatnagar *et al.*, 2012) <sup>[8]</sup> studied seasonal variations in developing fruits of Nagpur mandarin and found that mature fruits of ambia and mrig bahar had 48.80 and 49.58% juice recovery, 8.90 and 10.90<sup>0</sup> B TSS, 0.88 and 0.80% acidity and 47.05 and 51.34 mg/100 mL ascorbic acid, respectively. Fruits are rich source of ascorbic acid (50-60 mg per 100 ml of juice) besides containing fair amount of vitamins and minerals. Mandarin fruits are rich in nutrients especially calcium and potassium. It's fruits, per 100 g contain moisture 82.6-90.2 g, protein 0.61-0.215 g, fat 0.05 - 0.32 g, TSS 6-12%, fibre 0.3 -0.7 g, ash 0.29-0.54 g, calories 32-45 k-cal, calcium 25-46.8 mg, phosphorous 11.7 -23.4 mg, iron 0.17-0.62 mg, sodium 2 mg, potassium 127 mg, vitamin A 420 IU, thiamine 0.048-0.128 mg, riboflavin 0.014-0.041 mg, niacin 0.199-0.38 mg, ascorbic acid 13.3-54.4 mg and carotene 0.013-0.175 mg.

### Carambola

Carambola or star fruit (*Averrhoa carambola*) is a tropical fruit originally from Indonesia and India, being very popular in South-eastern Asia, South Pacific and some regions of Eastern Asia. It belongs to the family Oxalidaceae. Star fruit is rich in vitamins, oxalic acid, polyphenols, dietary fiber, volatile compounds, etc. (Paula *et al.*, 2016) <sup>[15]</sup>.

As most of the Carambola crops are consumed fresh, very few carambolas are processed. The physico-chemical characteristics of carambola fruit juice from unripened and ripened fruits were determined to assess the suitability of the fruit as raw material for wine production. The juice was analysed to determine pH, moisture content, total solids, types of sugars, total sugars and vitamin C content. The fruit had a characteristic soft, fragile and thin skin, relatively few seeds and high water content (88.6 – 91.7%) which made its processing into a fruit juice fairly simple and easy. The analysis of the sugars showed sucrose as the predominant sugar present in both ripened and unripened fruit juice. Vitamin C content was substantially high (28- 40 gm %). The total sugar content and pH were very low. Wine was produced from the ripened and unripened carambola fruit juice. The results indicated that sugar and yeast starter culture helped in increasing the alcohol content (Naphade *et al.*, 2010) <sup>[36]</sup>.

### Bael

The experiment conducted by Rachna (2017) <sup>[47]</sup> for preparation of wine from bael using different levels of yeast (15,20,25 ml per liter), sugar concentration (22, 24, 26 and 28<sup>0</sup> B) and maintained pH 3.5 in the must and reported that the levels of yeast *Saccharomyces cerevisiae var. ellipsoideus* @ 15 ml per liter and 240<sup>0</sup> B of sugar concentration in must was found suitable for preparation of bael wine with respect to TSS, pH, total sugars, reducing sugars, non-reducing sugars, titratable acidity, ascorbic acid and ethanol content of wine, further the taste, colour, flavour and overall acceptability score were increased continuously during maturation with the advancement of time.

### Pineapple

While studying the effect of TSS on quality of pineapple wine, TSS of juice samples were adjusted to 20<sup>0</sup> B, 25<sup>0</sup> B, 30<sup>0</sup> B, 35<sup>0</sup> B and 40<sup>0</sup> B with the addition of powdered sugar. The

highest alcohol content was recorded due to 30<sup>0</sup> B (12.01%), followed by 25<sup>0</sup> B (10.36%). The results of organoleptic evaluation showed that the treatment 30<sup>0</sup> B recorded maximum score, whereas least points were scored by 40<sup>0</sup> B. Thus, the treatment 30<sup>0</sup> B was adjusted superior in most of the characters like colour, appearance, taste, astringency and overall acceptability (Roodagi *et al.*, 2012) [49].

### Sapota

Sapota (*Achras sapota* L.) is one of the important tropical fruits belonging to the family Sapotaceae. Matured sapota pulp is a good source of carbohydrates (21.4 g/100 g), dietary fibres (10.9 g/100 g), tannin (3.16–3.45%), ascorbic acid and minerals like calcium (28 mg/100 g) and phosphorus (27 mg/100 g). It is also rich in bio-iron, required for the formation of haemoglobin and vitamin A. The amino acids present in the fruits are glutamic acid, glycine, alanine, methionine, phenylalanine, proline, hydroxy-proline, threonine, taurine, tyrosine, serine, valine and phosphoethanolamine along with urea (Panda *et al.*, 2014) [40]. In an experiment conducted by Kasture *et al.*, (2018) [25] on preparation of wine from sapota using four sources of sugars (Sucrose, Fructose, Dextrose and Jaggery) and four TSS levels (25, 30, 35 and 40<sup>0</sup> B) it was concluded that, 25<sup>0</sup> B TSS level and sucrose as a source of sugar was optimum conditions for preparation of good quality sapota wine at 3.5 pH.

### Banana

Ezamba *et al.*, (2022) [14] reported that Banana juice can also be applied to wine production. Banana wine has a lot of nutritional benefits, Vitamins including B5, B6, C, A are all present in banana wine and this makes it one of the high ranking beverages over other alcoholic ones. In an experiment Ranjitha *et al.*, (2015) [48] studied the effect of raw material on yield and quality of banana wine by fermentation of different substrates, *viz.*, unpasteurized pulp, unpasteurized juice, unpasteurized juice which was diluted with water in 2:1 and 1:1 ratios and pasteurized juice was carried out using *S. cerevisiae* UCD522. The total soluble solids were adjusted to

22<sup>0</sup> B and acidity to 0.7% with tartaric acid whenever required. As per the results of the experiment, use of unpasteurized juice diluted in 2:1 ratio as the fermentative substrate significantly improved the sensory quality of banana wine as compared to wines from pulp, pasteurized and natural juice

### Aonla

Aonla (*Emblica officinalis*) also called as Amla, In-dian gooseberry, is a rich source of vitamin C, contain 1, 3, 6-trigalloyl glucose, terchebin, corilagin, ellagic, phyllenbolic acids, alkaloids like phyllantidine and phyllantine. This fruit contains as much as 28% tannin compounds of which ellagic acid, gallic acid and corilagin are important ones. Gallic acid acts as an antioxidant, inhibits autooxidation of ascorbic acid (Suresh *et al.*, 2014) [53]. The fruits are the second richest source of vitamin C among fruits after Barbados cherry (*Malpighia glabra* L.) (Singh *et al.*, 2006) [52]. Wine prepared from Aonla by using 28<sup>0</sup> B sugar syrup was best and more acceptable (Lenkannavar *et al.*, 2015) [31].

### Custard apple

Kumar *et al.*, (2011) [29] undertaken the study on preparation and evaluation of custard apple wine: Effect of dilution of pulp on physico-chemical and sensory quality characteristics. In this study attempt was made to prepare wine from custard apple pulp. Pulp was diluted with water *viz.* 1:2, 1:3 and 1:4, were kept with and without 0.1% diammonium hydrogen phosphate (DAHP) as a source of nitrogen. To the must, KMS was added @125 ppm. Fermentation was conducted with *saccharomyces cerevisiae var. ellipsoideus*. Upon fermentation TSS, reducing and total sugars and pH were decreased. Whereas alcohol and titrable acidity increased. The treatment with 1:4 dilution and DAHP recorded higher alcohol content (8.14 v/v), low reducing and total sugars. Treatment with 1:3 dilution without DAHP gave the least fermentation rate. The fermentation efficiency was maximum in 1:3 dilution with DAHP and was minimum in 1:2 dilution without DAHP. It was concluded that custard apple fruit can also be converted into wine of good acceptable quality.

**Table 2:** Micro-organism used in fermentation in fruit crops.

Sr.no.	Common name	Scientific name	Family	Fermentative organism	Reference
1	Mango	<i>Mangifera indica</i> L.	Anacardiaceae	<i>Saccharomyces cerevisiae</i> MTCC 178	Patel <i>et al.</i> , (2021) [43]
2	Bael	<i>Aegle marmelos</i> L.	Rutaceae	<i>Saccharomyces cerevisiae var. ellipsoideus</i>	Rachna (2017) [7]
3	Custard apple	<i>Annona squamosa</i> L.	Annonaceae	<i>Saccharomyces cerevisiae var. ellipsoideus</i> .	Kumar <i>et al.</i> , (2011) [29]
4	Banana	<i>Musa sapientum</i> L.	Musaceae	<i>Saccharomyces cerevisiae</i> UCD522	Ezamba <i>et al.</i> , (2022) [14]
5	Aonla	<i>Emblica officinalis</i>	Phyllanthaceae	<i>Saccharomyces cerevisiae</i>	Lenkannavar <i>et al.</i> , (2015) [31]
6	Sapota	<i>Achras sapota</i> L.	Sapotaceae	<i>Saccharomyces cerevisiae</i>	Panda <i>et al.</i> , (2014) [40]
7	Grape	<i>Vitis vinifera</i>	Vitaceae	<i>Saccharomyces cerevisiae</i>	Katyal and Gupta, (1978) [26]

### Blended Wines

In food processing industry blending is an art to develop different colours, aroma, astringency, body, taste to suit the requirement. Low grade product would be upgraded to product of superior quality by blending of two or more different types of food entities having desired attributes. Thus, end product possessing new, superior or more attractive colour, taste, aroma, flavour and nutritional quality can result from blending.

### Mahua wine blended with Pomegranate

Mahua very rich in fermentable sugars *viz.* glucose, fructose

and maltose (Wealth of India., 1954) [54] and the tribal people prepare country liquor 'mahuli' from these flowers by typical yeast (*Saccharomyces cerevisiae*) fermentation (Bhagmol and Joshi, 2002) [7].

Pomegranate is useful for manufacturing wines rich in bioactive compounds (Mena *et al.*, 2012) [35]. Wine produced from mahua flower extract with pomegranate juice using *S. cerevisiae* (NCIM 3215) and *S. cerevisiae* (NCIM 3206). Two different blends namely A (10:90) and B (20:80) were formulated using different concentrations of mahua flower extract with pomegranate fruit juice. Temperature at 30 °C produced the higher level of alcohol, whereas it was slight



lower at 25 °C and 35 °C among 2 proportions. It was concluded that temperature of 30 °C more suitable for wine production of mahua flower extract and pomegranate fruit juice by using *S. cerevisiae* (NCIM 3215) compared to *S. cerevisiae* (NCIM 3206) (Dushing and Surve, 2019) [13].

### Grape wine blended with Jamun

The grape (*Vitis vinifera* L.) is a non-climacteric fruit belongs to family vitaceae. Wine is the important use of grapes. Grape phytochemical such as resveratrol (polyphenol antioxidant) have been positively linked to inhibiting cancer, heart disease, degenerative nerve disease, viral infection (Janick and Paull, 2008) [21]. Jamun (*Syzygium cumini* L.) of family myrtaceae is an important but underutilised fruit crop of India. Fruits are dark red purple, ovoid in shape, tasty and have pleasant flavour. The fruit is rich source of vitamin C and vitamin A. It comprises glucose and fructose as principle sugar. Jamun has received far more recognition in folk medicine and pharmaceutical trade than other field. Its fruits are known for medicinal value like anti diabetic, astringent, stomachic, carminative, antiscorbutic and diuretic (Patel *et al.*, 2005) [42]. The bright and brilliant purple coloured Jamun juice can, however be successfully used for blended beverage (Gehlot *et al.*, 2008) [16].

In case of red wine prepared by blending of grape and jamun juice in different proportions (100:0, 75:25, 50:50, 25:75, 0:100). The blended juices were inoculated with 7.5% inoculum level of strain *Saccharomyces cerevisiae* 4787 at 25

°C. And observed that, wine blended in 75:25 ratio was more acceptable as compared to the wine blended in other ratios (Choudhary *et al.*, 2014) [10]. but also made the blend acceptable with respect to sensory qualities (Joshi *et al.*, 2014) [57].

### Rhododendron wine blended with Mahua

Kashyap and Deepshikha (2019) [24] prepared a wine by blending of *Rhododendron arboreum* and *Madhuka longifolia* juice in different proportions (90:10, 80:20, 70:30, 60:40, 50:50 and 40:60). The blended juices were boiled in water in the ratio of 1:2. Extract was filtered by using muslin cloth, filled in bottle and stored at 2-4 °C. The results showed that, wine blended in 70:30 ratio was more acceptable as compared to the wine blended in other ratios.

### Nagpur mandarin wine blended with coloured Grape and Pomegranate

Kadge *et al.*, (2021) [22] carried out an experiment with three sugar sources (Cane sugar, Jaggery and Honey) and Nagpur mandarin juice was blended with coloured grape and pomegranate juices in different proportion. From the findings it was observed that Nagpur mandarin wine prepared with Honey as sugar source and blended with mandarin juice and coloured grape juice with 80:20 ratio secured the highest score for colour, flavour, taste, appearance, astringency and overall acceptability as compared to other treatments.

**Table 3:** Chemical composition of different fruit wines (Report by Goriwale *et al.*, 2022) [18]

Sr. No.	Fruit wine	Months after maturation	TSS (°B)	pH	Total Sugar (%)	Reducing Sugar (%)	Non-Reducing Sugar (%)	Titrateable Acidity (%)	Ascorbic acid (mg/ 100ml)	Ethanol (%)
1	Aonla	7	7.30	3.76	2.06	1.67	0.40	0.57	141.68	9.78
2	Pumpkin	7	6.11	3.38	1.09	1.01	0.12	0.27	6.49	9.11
3	Bael	7	6.21	3.49	2.00	1.56	0.19	0.21	6.50	11.74
4	Mahua	7	6.95	3.59	1.15	1.10	0.04	0.50	2.24	12.48
5	Custard Apple	7	6.84	3.55	3.71	1.65	2.00	0.57	2.44	10.90

Horticulture Section, College of Agriculture, Dr. PDKV, Akola (Goriwale *et al.*, 2022) [18] prepared the wines from different fruits *viz.* Aonla, Pumpkin, Bael, Mahua and custard apple and conducted chemical analysis of seven months matured wines and reported that, all the wines had TSS in the range of 6.11 to 7.30 °B, pH (3.38 to 3.76), total sugars (1.09 to 3.71%), titrateable acidity (0.21 to 0.57%) ascorbic acid which was highest in aonla wine (141.68 mg /100ml), however, it was noticed in other fruit wines in the range of 2.24 to 6.49 mg/100ml. Ethanol content was reported to be highest in mahua wine (12.48%), followed by bael wine (11.74%), custard apple wine (10.90%) and minimum ethanol was recorded in pumpkin (9.11%) and aonla wine (9.78%).

### Conclusion

Most of the fruits, contains phytochemicals, essential nutrients, flavonoids, alkaloids, anthocyanin, carotenoids and phenolic compounds for prevention of diseases and promotion of health. The seasonality of some flowers, fruits and vegetables and absence of industrial utilization makes them underutilized. The study includes the utilization of all these in making wine. It gives an opportunity to ferment all these into value-added product such as wine to preserve their nutrients, minerals, aroma and taste and make them available to consumers all year round.

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