

## Fruit Wine Production: A Review

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### Abstract

The article presents review on potential of wine production from various fruits, classification of wines and current status of wine industry. Various wine classes such as grape wine, fruit wine, berry wine, vegetable wine, plant wine, raisin wine etc. have been discussed in this paper. Recent updates on wine production from various tropical and a subtropical fruit like mango, banana, and apple cider is also reported.

**Keywords:** Fruit wine, mango wine, banana wine, apple wine.

### Introduction

India is one of the largest producers of fruits in the world. Fruits are among the most important foods of mankind as they are not only nutritive but are also indispensable for the maintenance of health. Fruits both in fresh as well as in processed form not only improve the quality of our diet but also provide essential ingredients like vitamins, minerals, carbohydrates etc. Postharvest loss of fresh fruit is one of the serious problems of tropical countries like India. Due to improper postharvest handling and inadequate processing facilities nearly 35 to 40 per cent of horticultural production goes waste. India incurs post-harvest fruits and vegetable losses worth over Rs 2 lakh crore each year largely owing to the absence of food processing units, modern cold storage facilities and a callous attitude towards tackling the grave issue of post-harvest losses. The fruit and vegetable preservation industry in India utilizes less than 2 per cent of the total production of fruit and vegetables for conversion in to products, as against 40 to 50 per cent in advanced countries.

Fermentation is a viable technique in the development of new products with modified physico-chemical and sensory qualities especially flavour and nutritional components. Alcohol, acetic and lactic acid fermentations are important for quality in production. Out of these, alcoholic fermentation is widely employed for the preparation of beverages in which alcohol is major constituent. Fermented beverages have been known to mankind from time immemorial.

An alcoholic beverage is a drink that contains ethanol. These are divided into three general classes for taxation and regulation of production namely beers, wines, and spirits distilled beverages such as whisky, rum, gin, vodka etc. Beer is made by fermentation of starch combining yeast and malted cereal starch, especially barley corn, rye, wheat or blend of several grains and usually flavoured with hops. It contains 4 to 8 per cent alcohol and its energy value ranges between

28 and 73 kcal per 100 mL. Distilled alcoholic beverages are produced by distilling ethanol by fermentation of grains, fruits or vegetables. They are made from sugarcane juice, molasses, fermented mash of cereals and potatoes and fermented malt of barley and rye. The alcohol content in distilled alcoholic beverage ranges between 40 and 60 per cent.

Fruit wines are undistilled alcoholic beverages usually made from grapes or other fruits such as peaches, plums or apricots, banana, elderberry or black current etc. which are nutritive, more tasty and mild stimulants. These fruits undergo a period of fermentation and ageing. They usually have an alcohol content ranging between 5 to 13 percent. Wines made from fruits are often named after the fruits. No other drinks, except water and milk have earned such universal acceptance and esteem throughout the ages as has wine. Wine is a food with a flavour like fresh fruit which could be stored and transported under the existing conditions. Being fruit based fermented and undistilled product, wine contains most of the nutrients present in the original fruit juice. The nutritive value of wine is increased due to release of amino acids and other nutrients from yeast during fermentation. Fruit wines contain 8 to 11 per cent alcohol and 2 to 3 per cent sugar with energy value ranging between 70 and 90 kcal per 100 mL.

### Classification of Wine

A typical wine contains ethyl alcohol, sugar, acids, higher alcohols, tannins, aldehydes, esters, amino acids, minerals, vitamins, anthocyanins, minor constituents like flavouring compounds etc. (Amerine *et al.*, 1980). This product is probably the most ancient fermented beverage and was mentioned in the Bible and in other documents from Asian countries. Depending upon the various attributes such as cultivar, stage of ripening of fruits, chemical composition of juice, use of additives to the must, vinification techniques and ageing of wine, the alcohol and sugar

content, the wines are classified as natural wines (9-14 % alcohol) and dessert and appetizer wines (15-21 % alcohol). Dry wine, sweet table wine, specialty wine, champagne, muscat and burgundy wines are natural wines while sweet wine, cherries, vermouth and port wines are regarded as dessert and appetizer wines (Amerine and Singleton, 1972).

The most famous types of wines are red and white wines, followed by rosé and sparkling wines. There are other wine specialties around the world, such as the Portuguese Port Wine, a very rich flavor, often used by chefs in their signature dishes. Many types of wines can be divided into several groups, which are easy to remember. Depending upon product manufacturing all wines can be classified as grape wine, fruit wine, berry wine, vegetable wine, plant wine, raisin wine etc. Grape wine is made exclusively from grapes and during the production process prohibited from using any other materials (exception is made only for sugar and oak barrels). Fruit wines are fermented alcoholic beverages made from a variety of base ingredients other than grapes; they may also have additional flavors taken from fruits, flowers, and herbs. These types of wines are made from pear, apple, banana, papaya, mango, jackfruit juice etc. Cherry wine is produced from cherries, usually those cherries that provide sufficient acidity to wine. Plant wine is produced from juice of trees like maple, birch, melons, watermelons, and other garden plants such as rhubarb, parsnips and rose petals. Raisin wine is made from dried grapes (raisins). Multisort wine is produced by mixing different kinds of grapes and wine materials.

Depending on the time of fermentation grape varieties and colour fruit wines classified as are in red, white and pink wines. Fig 1 shows the Red wine and white wine.

### Red wine

Red wine is made from red grapes, which are actually closer to black in color. There are many different types of red wines. This is considered to be the most classic in the kingdom of wines, mixing the delicious red grapes with a wide range of aromas, from oak to eucalypti, chocolate or even mint hints. The juice from most black grapes is greenish-white; the red colour comes from anthocyanin pigments present in the skin of the grape. Table 1 gives the characteristics of different types of red wine.

### Major types of red wine

There are six major categories of red wines. Barbera wine is prepared from red Italian grapes variety. It is popular table wine which is low in tannin and high in acidity with rounded fruitiness. This dry red wine pairs well with pizza, pasta with tomato-based sauce, hard cheeses. Merlot wine is very soft, having approachable flavors; descended from the Cabernet Franc grape and related to the Cabernet Sauvignon

grape with a mild mix of plum and blackberry flavors. Merlot pairs well with any dish.

Shiraz wine (Syrah), is available with spicy flavors of blackcurrant and black pepper. It is served with meat dishes for better combination. Cabernet Sauvignon grape wine can be powerful and sharp, but silky and muted as it ages. It is one of the most famous types of wines in the world, especially among the French, Australians, Californians, and Chileans. Cabernet Sauvignon pairs perfectly with meat dishes like Sayrah. This sophisticated French wine is a mix of Cabernet Franc and Merlot, with a full-bodied taste of currant and bell pepper. Malbec wine is a dry red wine known for its dark color and pronounced tannin. Another dry red wine Pinot Noir that made from pinot noir black grapes. Noir is typically a light to medium-bodied red wine that boasts considerable meal pairing versatility. This wine is rare and expensive. Zinfandel wine is produced from Zinfandel red grapes. This type of wine has high alcohol content, strong tannins and slightly spicy flavors.

### White Wine

White wine is not exactly white; it is often yellow, gold or straw coloured, depending on whether it includes the skin of the grape or just the juice. White wine can be made by the alcoholic fermentation of the non-coloured pulp of green or gold coloured grapes or from selected juice of red grapes, produced in Europe, and numerous other places such as Australia, California, New Zealand and South Africa and so on. It is treated so as to maintain a yellow transparent colour in the final product. White wines often taste lighter, crisper and more refreshing than a red wine and so they often gain popularity during warmer months of the year. White wines are typically served alongside white meats and fish. Table 2 gives the characteristics of different types of white wine.



(a) Red Wine (b) White Wine

Fig 1: Different types of Wines (a) Red wine (b) White wine

### Major types of white wine

Chardonnay is a dry white from the Chardonnay grape, which is known for producing some of the finest white wines in the world, and is also used to make

champagne. A dry white from the Sauvignon Blanc grape is light yet acidic taste and as a great pair to salad and poultry dishes. Sauvignon Blanc grapes are often blended with Sémillon grapes to mellow the intensity. Gewurztraminer is a mildly sweet white wine that has a smooth taste and deep aroma, ideal for sensitizing the palate before a meal. Muscat/Moscato wine is prepared from Muscat variety of grapes that smells like grapes, with a fruity, sweet flavor. A dry white made from the Pinot Gris grape, is one of the most delicious types of wine, rich in flavor and slightly spicy is called as Pinot Grigio wine. The taste of this wine varies from light and crisp to full and complex, based on where it is grown.

Reisling wine range from dry to sweet, but the Reisling grape tends to produce softer, fuller, fruitier wines, including ice wine, made from frozen grapes. Reisling wine comes with appetizing flavors of lime, apple and pear.

A dry, sweet white wine that is often blended with a Sauvignon Blanc wine with very opposite flavor for a more rounded, balanced taste. It is called as Sémillon wine also used in fine dessert wines. Viognier wine, a dry white wine made from superior, rare grapes in the Rhône region of France. Viognier wine is best enjoyed before dinner.

### Pink wine

Pink wine having a light pink color, grape skin removed immediately after the start of the fermentation process. These wines are made from a mixture of "black" and "white" grapes, using the technology of producing white wines. Classification of wines by the sugar and alcohol implies their division in dining rooms and fixtures.

- Table wines are dry (sugar and 0.3% alcohol - 9-14%), semi-dry (sugar - up to 0.5-3% alcohol - 12.9%) and sweet (sugar - up to 3-8% alcohol - 12.9%).

Fortified wines are of the following types:

strong (sugar - up to 1-14%, alcohol - 17-20%), dessert sweet (sugar - up to 5-12%, alcohol - 14-16%), sweet (sugar - to 14 - 20% alcohol - 15-17%), liqueur (sugar - up to 21-35%, alcohol - 12-17%), flavors (sugar - up to 6-16%, alcohol - 16-18%).

### Wine Making Technology

Winemaking involves mainly three categories of operations, viz: pre-fermentation, fermentation and post fermentation operations (Iland *et al.*, 2000; Jackson, 2000; Ribéreau-Gayon *et al.*, 2000). In the case of wines made from grapes, pre-fermentation involves crushing the fruit and releasing juice. In case of white wine, juice is separated from the skin whereas in red wine the skins are not separated from the juice. Clarification of juice for white wine is usually achieved by sedimentation or centrifugation. Then yeast is added to the clarified juice to initiate fermentation. In red winemaking, the pulp, skins and seeds of grapes are kept together after crushing and during all or part of the fermentation. This is done to extract colour and flavour. Yeast is added to mashed pulp (must) in red winemaking.

Fermentation involves a reaction that converts the sugars in the juice into alcohol and carbon dioxide. Yeasts utilise the sugars during the fermentation period. A stuck fermentation occurs when yeasts do not completely utilise the available sugar and the rate of fermentation slows down and/or ceases. Clarification may be achieved by racking, filtration and/or centrifugation. Fermentation proceeds under anaerobic conditions and may be boosted with di-ammonium phosphate (DAP) to supplement nitrogen required for yeast growth in non-traditional approach of winemaking. Post fermentation practices are done after fermentation has reached the desired stage or when fermentation is complete. Here, wine is racked off the -

Table 1: Characteristics of different types of red wine

Sr. No	Types of Wine	Common Aromas	Mouth feel	Acidity	Region of Origin
1	Barbera	Blackberry, black cherry, raspberry, plum	Smooth	High	Italy, Argentina, California
2	Cabernet Sauvignon	Dark berries, cassis, cedar wood	Smooth with a coarse finish	High	France, Italy, Australia, California
3	Malbec	Plum, black pepper, blackberry	Full, rich	Medium	France, Argentina
4	Merlot	Plum, cherry, floral aromas	Soft	Medium	France, California, Italy, Washington, Chile
5	Syrah /Shiraz	Black pepper, blackberry	Smooth, round	Medium to high	France, Italy, Australia, California, Washington, South Africa
6	Pinot Noir	Baked cherry, plum, damp earth	Smooth with a crisp finish	High	France, Oregon, California, New Zealand, Australia
7	Zinfandel	Blackberry, boysenberry, plum	Smooth	Medium	California

(Source: [www.foodservicewarehouse.com](http://www.foodservicewarehouse.com))

Table 2: Characteristics of different types of white wine

Sr. No	Types of Wine	Common Aromas	Mouth feel	Acidity	Region of Origin
1	Chardonnay	Tropical fruit, pineapple, apple, lemon, oak	Smooth	High	France, California, Washington, Oregon, New York, Australia, New Zealand, South Africa
2	Gewurztraminer	Tropical fruit and spice	Very smooth	Low to medium	France, Germany, Washington, California, New York
3	Muscat / Moscato	Peach, pear, citrus	Full-bodied, smooth, creamy	High	France, California, Washington, Oregon, New York, Australia, New Zealand, South Africa
4	Pinot Grigio	Grape, pear	Bright, smooth, light	High	Northern Italy, Spain, France, California
5	Reisling	Peach, citrus, apple	Light, round	Low to Very high	France, Germany, Italy, Australia, Idaho, Oregon, New York, California, Washington, New Zealand
6	Sauvignon Blanc	Green fruit, grass, herbs, gooseberry, white asparagus	Crisp	High	France, Oregon, Washington, New York, California, New Zealand, Australia
7	Sémillon	Ripe fruit, nuts, honey, orange peel	Smooth	Medium	France, Washington, Australia
8	Viognier	Apricot, fruit, floral, spice	Smooth	Low	France, Oregon, California

(Source: [www.foodservicewarehouse.com](http://www.foodservicewarehouse.com))

yeast lees, usually in stainless steel vessels or in oak barrels. During the storage period, the wine may be filtered, cold stabilised, fined and/or blended.

Various fining agents such as enzymes, bentonite, diatomaceous earth, egg albumen etc. may be commercially purchased and added to aid in clarification of wines. Wine undergoes continued changes during maturation and at an appropriate stage; the wine is filtered and bottled.

### Wines from tropical and subtropical fruits

Many tropical and subtropical fruits, including grapes, apples, pears, apricots, berries, peaches, cherries, oranges, mangoes, bananas and pineapples yield good amounts of juice on extraction. Upon fermentation, fruit juices can be changed into wines. However, the premium raw material for winemaking has been the grape, although attempts to process other fruit wines are being made. The techniques used for the production of other fruit wines closely resemble those for the production of wines made from white and red grapes. The differences arise from two facts. It is somewhat more difficult to extract the sugar and other soluble materials from the pulp of some fruits than it is from grapes, and secondly the juices obtained from most of the fruits are lower in sugar content and higher in acids than is true for grapes.

As a solution to the above mentioned problems, the use of specialized equipment to thoroughly chop or disintegrate the fruits such as berries, followed by pressing to extract juice from the finely divided pulp, solves the first problem. The second problem is solved by the addition of water to dilute the excess acid and the addition of sugar to correct the sugar deficiency (Amerine *et al.*, 1980).

### Mango wine

Mango, the pride fruit of India, is an important tropical fruit crop occupying about 60% of the total area under cultivation in India. Twenty-five different mango cultivars are available in India, and appreciated for its light to bright yellow colour, its sweet and delicious taste, high nutritive value (high amounts of amino acids, a good source of vitamin A and B6, and low in saturated fat, cholesterol, and sodium), as well as its affordable market price (Spreer *et al.*, 2009). It has a rich luscious, aromatic flavor and delicious taste in which sweetness and acidity delightfully blended. Mango contains a high concentration of sugar (16-18% w/v) and many organic acids and also contains antioxidants like carotene (as Vitamin A, 4,800 IU). Sucrose, glucose and fructose are the main sugars in ripened mango (Anonymous 1962). The unripe fruit contains citric acid, malic acid, oxalic acid, succinic acid and other organic acids. In contrast, in ripe fruits, the main organic acid is malic acid (Giri *et al.*, 1953). Mango juice along with aromatics is recommended as a restorative tonic; as it contains good amount of vitamin A and C which are useful in heat apoplexy. Mangoes with higher initial concentration of  $\alpha$ -carotene are helpful as cancer-preventing agents (Anonymous 1962). Gathambiri (2009) reported a percentage post harvest loss of 45% and the main reason cited was excess fruits in the market during the peak season. Production of wine from mango is one of the alternative ways to use and convert surplus production into a valuable product (Onkarayya, 1984; Reddy, 2005).

Czyhrinciwk (1966) reported the technology involved in mango wine production and suggested that the mango is well suitable fruit for the production of

good-quality white semisweet table wine. Onkarayya and Singh (1984) and Kulkarni *et al.* (1980) screened twenty varieties of mangoes from India for wine production. According to their reports, the mango wine has similar characteristics to grape wine, but they not have details on vinification technique and chemical composition of wine produced from mango. One of the methods of processing and preserving mango is to ferment the juice, which has high carbohydrate content, into wines. Obisanya *et al.* (1987) studied the fermentation of mango juice into wine using locally isolated *Saccharomyces cerevisiae* and *Schizosaccharomyces* species of palm wine and they concluded that *Schizosaccharomyces* yeasts were suitable for the production of sweet, table mango wine and *Saccharomyces* yeasts were suitable for the production of dry mango wine with a higher ethanol level.

For making wine, the fruits must first be pulped. The TSS is raised to 20°Brix by adding cane sugar; usually 100 ppm SO<sub>2</sub> is used, pectinase enzyme (0.5%) is added to the pulp. The most of pulp is fermented using *S. cerevisiae* at a rate of 10% for 7-10 days at 22°C. After racking and filtration, the wine is treated with bentonite and bottled with 100 ppm SO<sub>2</sub> as potassium metabisulphite. A sweet fortified wine, known as 'Dashehari' is made by stopping the fermentation by adding 10% (v/v) mango brandy after 5 days of fermentation. For making sweet wine, cane sugar is added at the rate of 5g/L. The alcohol content of mango wines ranged from 5 to 13% and the wines normally contain low levels of tannins. Acceptable table wine was also prepared (Akingbala *et al.*, 1992) from overripe mango fruit. The chemical properties of mango wine are normally as follows:

pH of around 3.70, ash of 0.27g/100g, extract of 0.41g/100g, soluble solids of 5.0 °Brix, specific gravity at 30°C of 0.98, TA of 0.38% (as citric acid) and 13.82% (v/v) ethanol.

Reddy and Reddy (2005) developed a method of mango juice extraction with pectinase and characterized ethanol and some volatile contents of mango wine. They concluded that the aromatic compounds of mango wine were comparable in concentration to those of grape wine. Reddy and Reddy (2009) studied Production, optimization and characterization of wine from ten mango varieties (*Mangifera indica* Linn.) viz. 'Alphonso', 'Raspuri', 'Banganpalli', 'Totapuri', 'Allampur Banesha', 'Neelam', 'Mulgoa', 'Suvarnarekha', 'Rumani' and 'Jahangir', commonly available and grown south India and it can be concluded that 'Banganpalli', 'Totapuri' and 'Alphonso' cultivars are most suitable for mango wine production on the basis of physico-chemical properties and sensory characteristics.

Musyimi *et al.* (2013) prepared wine from Apple mango variety with varying temperature (20°C, 25°C, 30°C and 35°C) and the yeast concentration (0.0065%, 0.01%, 0.05% and 0.1%). The increase in

temperature and yeast concentration increased the fermentation kinetics significantly. However, at high temperature (35°C) and yeast concentration (0.1%) the sugars were not completely utilized during fermentation. At low temperature (25°C), the alcohol yield was highest (9.44%) relative to high temperature (35°C) that gave the lowest yield (6.93%). Yeast concentration of 0.05% and fermentation temperature of 25°C gave the optimal characteristics for Apple mango wine using wine yeast (*Saccharomyces cerevisiae*). Table 3 gives the physico-chemical composition of mango wine.

### Banana wine

Banana is a tropical fruit belonging to the family Musaceae and genus *Musa* spp. which is grown abundantly in India. Already provided man with food, tools and shelter prior to recorded history. Banana is the fourth most important crop after rice, wheat and maize and international trade in bananas is valued at around US\$5 billion per annum (Sunday Monitor, 2007). Traditional banana juice extraction and its subsequent fermentation to produce beer (*tonto*) is an important social and economic activity among many tribes of East Africa (Stover and Simmonds, 1987).

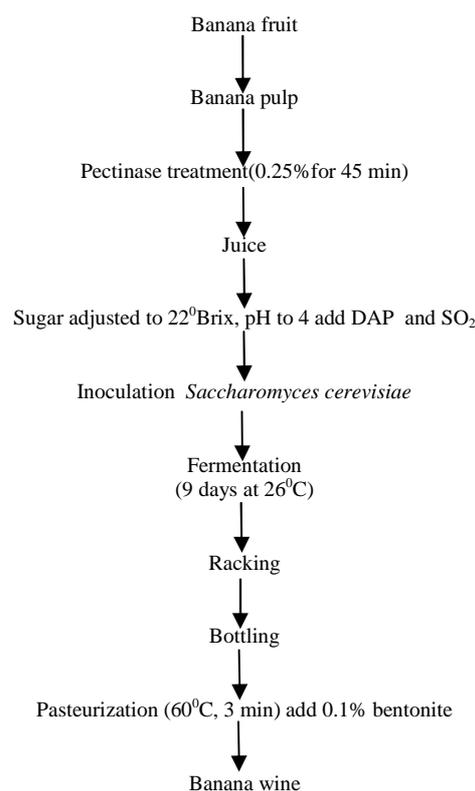


Fig 2: Process flow chart for banana wine making

Bananas contain high nutrition sources of carbohydrates, minerals especially potassium and vitamins such as B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, B<sub>12</sub>, C and E. It can be dried and processed into flour, chips, and dried fruit

(Gopinath, 1995). Cooking bananas are pounded into porridges and also for beer production. The fibre is used for making ropes, sacks and mats. The banana peel is made into sheets of paper and paper board (Obaedo *et al.*, 2009). Banana fruits are sensitive to heat and highly perishable. The consumption of banana wine provides a rich source of vitamins and enhances harnessing of the fruit into useful by-product as banana is available all year round. Banana is a good source of sugars and fibers which make it a good source of energy. When consumed, it can reduce depression, anemia, blood pressure, stroke risk, heartburns, ulcers, stress, constipation and diarrhea. It confers protection for eyesight, healthy bones and kidney malfunctions, morning sickness, itching and swelling, improves nerve functions and is said to help people to quit smoking (Idise *et al.*, 2011). For preparation of banana wine the bananas are cooked, juice is produced, mixed with wine yeast, citric acid, sugar and maize flour and left for 2 days in a pot. Then it is put into a jerry can with an airlock for 14-30 days followed by filtration with a filter siphon into another can. It is kept for some time before consuming.

The technologies used in the traditional approach of processing banana beer in Uganda were based on indigenous knowledge such as the use of spear grass and feet to extract juice from bananas and subsequent addition of sorghum flour as an adjunct upon fermentation of the juice into a banana beer. Banana (*Musa paradisiaca*) fruits can also be converted into wine as procedure given by Kundu *et al.* (1976). They prepared wine from banana juice and pulp (with 1:0, 1:1 and 1:2 dilution) and observed that alcohol and total phenol content of wine is inversely proportional with dilution level where as sugar content is directly proportional.

Bananas are peeled and homogenized in a blender for about 2-3 minutes to obtain a pulp. Potassium metabisulphite (100 ppm) can be added to prevent browning and to prevent growth of undesirable micro organisms. Fermentation is carried out at  $18 \pm 10^\circ\text{C}$ . Kotecha *et al.* (1994) carried out preliminary studies to optimize banana juice extraction by using different levels of pectinase enzymes and different incubation periods at  $28 \pm 2^\circ\text{C}$ . Based on these

studies a 0.2% pectinase addition and a 4 hours incubation time were selected for obtaining the juice from the pulp. The juice was separated by centrifugation and the clear juice was used for preparation of wine (Kundu *et al.*, 1976). The juice recovery from over-ripe bananas was higher (67.6%) than that from normal fruits (60.2%). Good quality wine is obtained from over-ripe banana fruit (Kotecha *et al.*, 1994; Akingbala *et al.*, 1992). The banana (*Musa paradisiaca*) wine chemical composition reported by Kotecha *et al.* (1994) was as follows:

A TSS of  $10.2 \pm 0.2$ , acidity of  $0.88 \pm 0.06\%$ ,  $3.18 \pm 0.16\%$  reducing sugars,  $0.044 \pm 0.002\%$  tannins and alcohol of  $6.06 \pm 0.06\%$  (v/v). Whereas, Akingbala *et al.* (1992) reported the chemical properties of a *Musa acuminata* wine as follows ethanol 13.98% (v/v), TA of 0.33% (as citric acid), specific gravity at  $30^\circ\text{C}$  of 0.9810, soluble solids as 5.2 Brix, an extract of 0.43g/100g and pH of 3.85.

Akubor *et al.* (2003) while studying the production and quality of banana wine ameliorated the juice to 180 Brix and found that during fermentation the T.S.S. decreased and titratable acidity increased with increasing length of fermentation of juice. The produced wine exhibited 4.8 Brix T.S.S. and 0.85 per cent titratable acidity after 14 days of fermentation. Shanmugasundaram *et al.* (2005) studied qualitative changes in banana pulp and juice during wine making process. They observed that T.S.S. must prepared from pulp of Poovan, Rasthali and Robusta varieties decreased from 23 Brix to 8.0, 6.9 and- 5.4 Brix during 28 days of fermentation. Whereas, in case of must prepared from juice of these varieties showed decrease up to 6.5, 4.5 and 3.9 Brix. It was also observed that during first week of fermentation the rate of fermentation was faster also there was no change in T.S.S. of wine prepared from banana cv. Robusta juice and pulp and stored for 90 days at room ( $28 \pm 2^\circ\text{C}$ ) and refrigerated temperatures ( $5^\circ\text{C}$ ).

Sevda *et al.* (2010) prepared wine from ripe banana using pectinase enzyme AND two strains of *Saccharomyces cerevisiae* NCIM 3283 and NCIM 3046 with acceptable qualities in terms of flavor, taste, clarity and overall characteristics.

Table 3: Physico-chemical characteristics of mango wine

Mango cultivar	Ethnaol % (w/v)	T. A % (v/v)	V. A % (v/v)	pH	Residual Sugar % (w/v) (g/l)	Higher alcohols (mg/l)	Total esters (mg/l)	Tannin % (w/v)	Colour OD at 590 mm
Alphonso	7.5	0.650	0.100	3.8	2.1	300	25	0.011	0.22
Raspuri	7.0	0.735	0.210	3.8	2.4	200	29	0.072	0.18
Banganpalli	8.5	0.600	0.181	3.7	2.0	343	35	0.012	0.23
Totapuri	7.0	0.622	0.121	4.0	2.0	320	20	0.012	0.17
A. Banesha	8.0	0.610	0.110	4.0	2.0	320	30	0.013	0.25
Neelam	6.5	0.826	0.234	3.6	2.5	313	15	0.014	0.21
Mulgoa	6.3	0.621	0.109	3.9	3.0	152	18	0.065	0.28
Suvarnarekha	6.8	0.630	0.153	4.1	2.3	175	22	0.025	0.19
Rumani	6.9	0.618	0.125	4.0	2.1	212	15	0.027	0.24
Jahangir	7.1	0.646	0.138	3.8	2.0	256	21	0.042	0.16

T.A = Titrable acidity, V.A = Volatile acidity (Reddy and Reddy, 2009)

The process used for production of banana wine is shown in Fig 2. They found that Fermentation temperature (25 °C), pH (4), di-ammonium phosphate (0.04%) and Sulphur dioxide (100 ppm) gave better good quality of alcohol. Table 4 gives the physico-chemical characteristics of banana wine.

Table 4: Physico-chemical characteristics of banana wine

Sr. No	Properties	Value
1	pH	3.30
2	Titrateable acidity (% tartaric acid)	0.85
3	Soluble solids (°Brix)	4.8
4	Specific gravity	0.9928
5	Fixed acidity	0.63
6	Volatile acidity(% acetic)	0.220
7	Ash (%)	0.2
8	Moisture (%)	92.6
9	Residual sugars (%)	4.00
10	Alcohol (% V/V)	5.0
11	Ascorbic acid (mg/100 ml)	1.4

(Kundu et al., 1976).

### Apple cider and wine

Apple (*Malus domestica*) fruit is used to prepare mild alcoholic beverages which are more nutritious than distilled liquors (Bhutani et al., 1989; Gasteineau et al., 1970; Joshi and Thakur, 1994). The apple fruit is more associated with cider than any other alcoholic beverages (Amerine et al., 1967; Joshi, 1995; Sandhu and Joshi, 1994). Cider is a low alcoholic drink produced by fermentation of apple juice and is believed to have been produced for over 2000 years. Cider is known by different names around the world such as *cidre* (France), *sidre* (Italy), *sidra* (Spain) and *apfel wein* (Germany and Switzerland). Cider can be sweet or dry. Depending upon the alcohol content, cider is categorised into soft cider (1-5%) or hard cider (6-7%) (Downing, 1989; Joshi, 1995). Sparkling ciders contains low sugar levels and CO<sub>2</sub>, usually sweet cider and still cider contain no CO<sub>2</sub>, while dry cider contains little sugar and an alcohol content of about 6-7% (Joshi et al., 2000). The optimum temperature for cider fermentation ranges from 15 to 18 °C. Sulphur dioxide provides a clean fermentation and prevents enzymatic

browning of the juice (Beach, 1957) besides the control of micro-organisms in the must (Amerine et al., 1967) and produce a cider of consistent quality (Poll, 1993). Simultaneous fermentation of apple juice with *Saccharomyces cerevisiae* and *Schizosaccharomyces pombe* produced a cider with acceptable level of alcohol and acidity (O'Reilly and Scot, 1993). Mostly stainless steel tanks are used these days for fermentation of cider (Downing, 1989) though traditionally barrels of oak were used for this purpose. A temperature of 40°C is suitable for bulk storage of ciders. After fermentation, the cider is racked and filtered. During aging, most of the suspended material settles down leaving the rest of the liquid clear which may be clarified with bentonite, casein or gelatin followed by filtration. After aging and clarification ciders needs to be pasteurized at 60°C for about 20-30 minutes or SO<sub>2</sub> can be used (Joshi et al., 2000). Apple wine is another product made from apple juice by alcoholic fermentation and has alcohol content of 11 - 14%. Like cider, apple juice or concentrate is the basic raw material, but as the alcohol content of wine is more than that of cider, amelioration with sugar or juice concentrate is essential (Joshi et al., 2000). Addition of ammonium salts to fermenting solution reduces the higher alcohol production in wine due to non-degradation of amino acids of the must (Reazin et al., 1970). Washing and crushing of the fruits, adding 50 ppm of SO<sub>2</sub> and 10% water in the making of apple wine is recommended (Vogt, 1977). Addition of di-ammonium hydrogen phosphate improved the ferment ability (Joshi and Sandhu, 1996).

### Conclusion

Fruits both in fresh as well as in processed form not only improve the quality of our diet but also provide essential ingredients like vitamins, minerals, carbohydrates etc. Fruit wines are undistilled alcoholic beverages usually made from grapes or other fruits such as peaches, plums or apricots, banana, elder berry or black current etc. which are nutritive, more tasty and mild stimulants. Being fruit based fermented and undistilled product, wine contains most of the nutrients present in the original fruit juice. The nutritive value of wine is increased due to release of amino acids and other nutrients from yeast during fermentation.

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