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## UNIT 12 FRUIT-BASED ALCOHOLIC BEVERAGES

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### 12.0 OBJECTIVES

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After studying this unit, you should be able to:

- discuss about different varieties of wine produced commercially in different parts of the world;
- know the microorganisms involved in wine fermentation and factors influencing its quality;
- explain the method of wine production and different practices involved before and after fermentation; and
- get information on clarification of fermented juice and maturation of wine.

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### 12.1 INTRODUCTION

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Production and consumption of fermented beverages is an old practice. It has been referred in Vedas. In the previous chapter, how lactic acid from plant constituents is produced to preserve the food along with favourable organoleptic changes are discussed. Similarly many fruits contain very high amounts of free sugars which are readily converted into ethanol and carbon dioxide with the help of yeasts and thus alcoholic beverages are produced.

Wine is normally referred as a by-product of grapes (*Vitis vinifera*). However, wine can be produced from any fruit or flower rich in soluble sugars. Still most of the wines are produced from grapes throughout the world. European, Western World, North America especially colder climate countries are the major producers and consumers of alcoholic beverages. In these countries, 75% of the crop is diverted for wine production. France and Italy are the major producers of quality wine. Due to several reasons including the taboo attached

to consumption of alcoholic beverages, fruit wine and brandy industries have not developed well in India. We meet most of our demand through import although India is the second largest producer of fruits and vegetables.

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## 12.2 TYPES OF WINE

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As stated already, the pressed juice of grapes or any fruit rich in soluble sugars if fermented by yeast/s or spontaneous natural fermentation, it results in the ethanol (wine) production and its distillate is known as “Brandy”. White wine is produced from the grapes usually cultivated whereas the red variety or Bangalore blue grapes having purplish red skin give rise to “Red Wine”.

Different types of commercial wines are listed below:

- *Champagne* is a foaming wine which contains dissolved carbon dioxide.
- *Sparkling* wine is produced by carbonation by injecting carbon dioxide into the wine.
- *Liqueur Wine* is sweet with a higher content of alcohol.
- *Sherry* is a fortified wine with two distinct styles, the first being dry wine (without any sweet taste) consumed as an appetizer before meals and the other being olorosos sweetened wine taken after meals.
- *Port* in which wine is stored in a wooden cask or Hightage ports. During maturation the type of barrel used for aging contributes to quality of wine.
- *Vermouth* is a flavoured wine in which different varieties of herbs and spices are added.
- *Brandy*: It is a distilled wine stored mostly in wooden cooperage or casks.

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## 12.3 FRUITS USED FOR WINE-MAKING

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Sugars present in fruits are responsible for quick fermentation and other constituents contribute to the flavour and aroma of the wine. Grapes, apple, pear, custard-apple, mango, jamun, coconut sap, palm sap, pomegranate, banana, guava, ber, plum, orange, litchi, dates, pineapple, strawberry, raspberry, cherry, grape - fruit etc. can be used for wine making. The technology for grape wine has been developed in the western world and thus quality products are produced commercially. There are many reasons for non-acceptability of non-grape fruits for commercialization. Many of these fruits contain low levels of soluble sugars and their fermentability is poor. Extraction of juice from these fruits poses serious difficulties. Some of these have very high or low concentrations of acidity which influences the quality of wine considerably. Bitterness and some other organoleptic defects of the final product are the other serious problems for commercialization.

## 12.4 IMPORTANT FACTORS INFLUENCING THE QUALITY OF WINE

### i) Fruits and their chemical composition

Grapes are the best fruit for quality wine production. It has been found that the cultivation conditions of grapes influence the quality of wine. Fruit variety, sugar content, additives, pulp or juice yield, yeast strain for fermentation, filtration, maturation and preservation of wine, all affect the final quality of wine. Yeast is the key for alcoholic fermentation or ethanol production and the factors which influence the growth of yeast also affect the quality of the wine. The sugar content of selected fruits is given in Table 12.1.

**Table 12.1: Sugar and acids composition of fruits**

Fruit	Total Sugar (% Fresh Weight)	Acid (% of Tartaric acid)
Apple	8-10	0.9 - 1.4
Banana	18	0.3 - 0.4
Grape	15 - 22	0.4 - 1.3
Orange	9 - 10	0.8 - 1.1
Pear	9 - 11	0.2 - 0.4
Strawberry	5 - 6	0.6 - 1.5

### ii) Temperature

The temperature of must (fruit juice) strongly influence the yeast growth. The yeast normally used for wine fermentation is strain of *Saccharomyces cerevisiae*. The optimum temperature for wine fermentation ranges between 22-27°C. Quality white wine is produced at lower temperature 10-15°C where as red wine needs higher temperature which ranges between 20-30°C.

### iii) Ethanol Content

As we know one mole of glucose gives rise to two moles of ethyl alcohol (ethanol) and two moles of carbon dioxide during the fermentation.



Beyond certain concentrations of sugar in the must/mashes, the yeast growth is stopped. Similarly after 10-12% (v/w) ethanol in the must, the growth of yeast declines considerably. There are a number of methods known to enhance the ethanol tolerance of the selected strain used for fermentation.

### iv) Carbohydrate and Energy Sources

It is apt to think that the wine is produced from the sugar and flavour containing chemicals present in the fruits with the help of yeast/s. It is, therefore, important to know the type of sugars and their quantity present

in the must. Glucose, fructose, sucrose and maltose are easily utilized by the yeast (*Saccharomyces cerevisiae*) for its growth and ethanol and carbon dioxide production. Lactose, pentoses, dextrin, starch or higher molecular weight carbohydrates or poly-saccharides are not utilized by the yeast. Usually 0.8-1.3% of sugar is utilized for the growth and rest is used for ethanol generation. At sugar concentration of 25% and above in the must, the yeast growth is slowed down. Except grapes, due to low concentration of sugars in other fruits, the mash has to be supplemented with sugars.

**v) Carbon dioxide and Pressure**

Carbon dioxide is produced during the fermentation and if higher pressure is built then it inhibits the growth of yeast. However, the sparkling wine is produced under the carbon dioxide pressure in a closed container.

**vi) Sulphur Dioxide (SO<sub>2</sub>) and other Agents**

Sulphur dioxide is added to the must or juice in order to bring down the number of contaminating microorganisms viz., moulds, yeasts and bacteria. The other chemicals tried are salicylic acid, bromoacetic acid, ethylene oxide, benzoic acid and sorbic acid. SO<sub>2</sub> is preferred because it is less toxic to human beings.

**vii) pH and Acids**

Normally the organic acids present in fruits do not interfere with yeast fermentation. Other organic acids such as acetic, butyric, propionic and fatty acids have inhibitory effect on yeasts. If the pH is below 3.0, the alcoholic fermentation is delayed considerably.

**viii) Growth Factors**

Biotin, inositol, nicotinic acid, pantothenic acid, p-aminobenzoic acid, pyridoxine and thiamine are needed for the growth of yeast.

**ix) Minerals and Pesticides**

Iron, copper, zinc and aluminium are present in the final product. Fermentation is not usually affected by the presence of lower concentrations of these metals. They normally come through presses or other equipments used. Pesticides are normally used to control pests which infest trees and fruits. Their residues in the wine is highly objectionable.

**x) Nitrogen Sources**

For the growth of yeast, nitrogenous compounds are needed. The amino nitrogen present in the must supports the growth of yeast. There are many factors e.g. method of juice preparation, ripening of the fruit, variety and several other cultivation parameters, which influence the amounts of these chemicals. Some of the fruits are deficient in them and therefore, supplementation is necessary. The inorganic nitrogenous salts usually used in wineries are: (NH<sub>4</sub>)<sub>2</sub> HPO<sub>4</sub> or (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> upto 0.3 g/l.

Tannin and phenolic compounds are present in the fruit juice. Their concentrations differ from fruit to fruit. Tannin normally does not affect the growth of *Saccharomyces cerevisiae* (yeast).

## xii) Juice Clarification

In recent years, grape and apple juices are being treated with pectinolytic enzymes for better yield and quality of wine. However, in wine manufacture, cloudy or turbid juice is preferred. Bentonite is added to improve the fermentation. However, the fruit pulp of non-grape fruits have to be treated with pectinolytic enzymes. There are many reports that musts which contain insoluble particles ferment quickly. Therefore, insoluble materials such as filter aids or wheatflour is added in the musts.

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## 12.5 MICROORGANISMS INVOLVED IN WINE-MAKING

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### i) Yeasts

The quality of wine depends on the yeast strain used for fermentation. The quick growth of yeast and an efficient conversion of sugar into ethanol decide mostly the quality of wine. *Saccharomyces cerevisiae* is the most important yeast for the juice (must) fermentation. Besides this yeast, there are numerous other species of yeasts which are also present and some times they spoil the wine.

*Saccharomyces cerevisiae* and numerous other yeasts such as *Kloeckera apiculata*, *Hansenula anomala*, *Candida stellata*, *Candida krusei* are also present in grapes. Besides these, *Schizosaccharomyces pombe*, *Saccharomyces bayanus*, *Saccharomyces fermentii* have also been isolated from grapes and various other fruits.

When grapes are crushed, within a few days *Saccharomyces cerevisiae* grows and multiplies to a higher number of cells. In the case of spontaneous fermentation, inoculum is not added and the yeasts present on the substrate and equipments serve as a source of starter culture. In order to maintain the quality and yield of wine, wineries all over the world are using a particular standard strain of *Saccharomyces cerevisiae*. It also provides protection from the 'Killer yeast'. Killer yeasts are infected with a virus that destroys the used strain of yeast for fermentation. Some times an active dry yeast culture about 0.1 g/L is also added to accelerate the fermentation.

It is an important question why wineries prefer *Saccharomyces cerevisiae*? It is tolerant to high levels of sugar of fruit juices, tolerates high ethanol concentration, invariably grows even at low pH, ferments must at low temperature and resistant to sulphur dioxide level which suppresses the growth of bacteria, yeasts and moulds. Apart from these, it induces desirable aroma in the wine. That is the reason it is called as wine yeast.

### Morphology of *Saccharomyces cerevisiae*

It is spherical to ellipsoidal in shape with  $8 \times 7\mu$  of size depending on the growth medium. It multiplies by budding.

Most strains of *Saccharomyces cerevisiae* are capable of producing alcohol upto 16%.

#### ii) Microorganisms other than yeasts in Winemaking

##### Bacteria

###### *Lactic Acid Bacteria*

*Leuconostoc oenos*  
*Pediococcus pentosan*, *Pediococcus*  
*purvislus*, *Lactobacillus plantarum*  
*Lactobacillus fermentum*

Responsible for malo-  
lactic fermentation and  
spoilage

###### Acetic Acid Bacteria

*Acetobacter* and *Glucanobacter* spp.

Responsible for Vinegar  
taste, spoilage and stuck  
fermentation.

*Bacillus* and *Clastridium* spp.

Spoilage

##### Fungi

*Botrytis cinerea*  
*Penicillium* sp.  
*Aspergillus* sp.

Botrytized wine,  
spoilage, corkytaints

*Actinomyces*  
*Actinomyces* spp.  
*Streptomyces* spp.

Earthy and corky taints.

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## 12.6 PREFERMENTATIVE PRACTICES IN WINE- MAKING

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#### i) Stemming, Crushing and Juice Separation

Fruit stalks, seeds and skins (pomace) are removed and then fruits are crushed and macerated. To check initiation of fermentation, white grape juice is chilled to about 10°C. Sulphur dioxide is also added to retard the multiplication of microorganisms. Red grapes are given longer time for maceration at 24-27°C which helps the extraction of pigments and phenolic compounds. Pressing separates the juice from the seeds and skins of the fruit. Large wineries use dejuicers for this purpose.

**ii) Clarification**

If juice is allowed for some hours for settling, the solid materials and suspended particles get separated and a clear juice is obtained. However, in commercial wineries filter aids such as bentonite is used and juice is centrifuged at low speed or passed through filter press.

**iii) Juice/Must Adjustment**

Total acidity of must is important for the final quality of wine. If acidity is less than the desired concentration, citric or tartaric acid is added appropriately. Higher level of acidity is retarded by the supplementation of calcium or potassium salts. Sugar is added in the must when sugar content is too low in the fruits. It is known as chaptalization in wine making. The other techniques followed for increasing sugar concentration are reverse-osmosis, cryoextraction and entropic concentration.

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**12.7 FERMENTATION**


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Fermentation is an energy releasing metabolism in which the electron donor and electron acceptor are organic compounds. In wine fermentation, glucose and fructose are the electron donors and ethanol is the acceptor. Glycerol, acetic acid, acetaldehyde and succinic acid are also electron acceptors which are produced in the must along with traces of diacetyl and fusel (higher alcohols).

Fermentation is done in a vat (open top) or tanks (sealed top). As stated earlier, both spontaneous and starter (inoculum) addition fermentation is practiced for wine making. During the initial stages, aerobic yeasts *Hansenula anomala* and *Klockera apiculata* are active. Subsequently they are taken over by the *Saccharomyces cerevisiae*. *S. cerevisiae* multiplies at a fast rate within 3 to 4 days and then ethanol production follows rising its level gradually and steadily.

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**12.8 SPOILAGE OF FERMENTATION AND WINE**


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Due to over clarification of juice/must and the presence of high number of wild yeasts having killer viruses and some other reasons some times fermentation does not proceed well. It is referred as the 'Stuck Fermentation'. Several species of lactic acid bacteria e.g. *Leuconostoc oenos*, *Lactobacillus* and *Pediococcus* spp. grow in the must and convert malic acid into lactic acid. Malic and tartaric acids are the major constituents of grape juice. They spoil the taste of wine. The wine and cider are spoiled by the acetic acid producing bacteria. They grow on the surface and oxidize ethanol to acetic acid. Similarly wild yeasts grow on the surface of stored wine and spoil the product. The sugar present in wine is converted into lactic acid by several spoilage microorganisms. Butyric acid bacteria, slime producing bacteria and moulds spoil the final stored product. Changes in colour of wine take place due to oxidation. It is, therefore, necessary to take care while carrying out the fermentation and during the maturation and storage of wine.

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## 12.9 POST-FERMENTATION PRACTICES

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### i) Clarification and Stabilisation

Clarification refers to methods adopted for clear wine for bottling while stabilization assures that wine remains clear after bottling. Fermented must is allowed to settle for clarification. Dying yeast cells, grape cell remains, precipitated tannins and crystallized salts are removed. Clarification of wine is sometimes achieved by centrifugation.

### ii) Fining

To remove colloidal materials, fining is practiced using filter aids bentonite, kiesselghur, silicondioxide, gelatin, albumin and isinglass.

### iii) Centrifugation

It is done to remove fine particles.

### iv) Filtration

Sometimes filtration is done with a courser filter but membrane filters are used to remove fine particles and live cells of microorganisms.

### v) Crystallization

Crystallization of potassium and calcium tartrate salts occurs in wines. It has to be removed by the cold filtration adding salt at low temperature ( $-5^{\circ}\text{C}$ ). Crystallization is undesirable for expensive wines.

### vi) Haze formation

Normally soluble proteins and tannins precipitate in the must and lead to haze formation. The judicious addition of pectinase,  $\beta$ -glucanase or mixture of Kieselghur and gelatin prevents the haze formation.

### vii) Adjustment of Factors

Adjustment of acidity, pH, sweetness, alcohol content and decolouration of wines are practiced based on the requirement of the product in the market. Blending is done all over the world in order to get the desired fragrance.

### viii) Maturation

Freshly prepared wine is always found to be harsh with yeasty flavour. Maturation develops the mellowed wine taste with fruity and desired flavour. The quality of wines depend on the maturation and ageing. The maturation period extends upto 6 to 12 months. There are several methods used for maturation. The oldest and traditional method is to allow maturation of wine in the same barrel in which fermentation occurred. The other method is to employ oak wood barrels which results in the best quality of wine. Long oak strips or chips are dipped in the filtered wine and



maturation is allowed to take place for more than a 6 months. Several chemical changes take place during this process.

### **Bottling**

Dark amber colour glass bottles with a distinctive neck are commercially used. Usually oak cork are used as a closure conventionally.

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### **Check Your Progress Exercise 1**



**Note:** a) Use the space below for your answer.

b) Compare your answers with those given at the end of the unit.

1. Define wine and give examples of different varieties of wine used all over the world.

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2. Explain, how wine is produced from fruits.

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3. What is 'MUST', name some yeasts involved in wine fermentation?

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4. What does the 'Killer yeast' indicate?

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5. Why does winery prefer *Saccharomyces cerevisiae*?

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6. What are prefermentative practices in wine making?

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7. What do you understand by the 'Stuck fermentation', Provide information about post-fermentation practices?

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## 12.10 WINE FROM DIFFERENT VARIETIES OF FRUITS

### i) Apples

Cider and wine is produced from apple. Cider is a low alcoholic drink, contains alcohol between 4 to 6%. The apple varieties should have moderate amounts of phenolics. The higher juice containing varieties are preferred for cider fermentation. Apple juice or concentrate is used for wine fermentation. The alcohol content in apple wine ranges between 11 to 14%. Before fermentation apple juice is supplemented with cane sugar. Sometimes ammonium chloride or phosphate are also supplemented in the juice for fermentation.

### ii) Custard apple

*Annona squamosa* is a tropical fruit. Since it is rich in fermentable sugars and delicate flavour, its pulp after the removal of seeds and skin can be used for wine making. The juice obtained is ameliorated to 23° brix and acidity 0.7%, phosphate 0.05% and 125 ppm SO<sub>2</sub> and nitrogenous salts. The must (juice) is inoculated with *Saccharomyces cerevisiae* and fermentation is carried out.

**iii) Pear wine**

Perry or pear wine of good quality is prepared from pears with high tannin contents. Since it is deficient in nitrogen, an exogenous addition of nitrogen is necessary. Perry fermentation is carried out at temperature of 20-22°C.

**iv) Mango wine**

Mangoes (*Mangifera indica* Linn.) is a tropical fruit extensively cultivated in India. Mango fruits and several processed preparations are exported to different countries. It contains high amounts of total solids, vitamins and minerals. Among the numerous varieties 'Safaida, Dashehari, Langra, Chausa of U.P., Alphonso of Ratangiri, Badami of Mysore, Raspuri and Mulgoa of Tamilnadu and Karnataka are rich in total soluble solids and also in fermentable sugars (glucose, fructose and other sugars). In majority of mangoes, juice extraction is a problem and therefore pectinolytic enzymes are suitably added and the sugar level is raised to 20° brix using cane sugar. Fermentation is done at 22°C with 100 ppm of SO<sub>2</sub>. Different varieties of mangoes results in products having varied taste and body.

**v) Jamun wine**

Jamun fruit is also native to Indian fruit and grown in every part of the country. Jamun fruits have therapeutic properties especially in diabetes and its products have wide acceptability everywhere. This fruit is also deficient in nitrogen, rich in pectin and hence amelioration with sugar (23°Brix) diammonium hydrogen phosphate (0.2%), 0.25% pectinolytic enzyme and 150 ppm of SO<sub>2</sub> is required. The other factors remain the same as with other fruits (grapes etc.) Popularization of the product is needed for indigenous and export purposes.

**vi) Coconut and Palm wine or Toddy**

Toddy is an alcoholic beverage produced from the sap of palm trees (*Acrocomia mexicana*) and coconut inflorescence sap. It is consumed in several parts of the country. The sap is collected in clay pots. The middle aged (fully grown) tree is selected and triangular or rectangular cut is made on the top of the tree and the earthen pot is hanged. The foamy sap flows and collects in the pot in the morning and evening. Freshly collected sap is sweet, relishing and invigorating. The fermentation starts as soon as sap starts collecting in the pot. The palm sap contains 10-12% sugar whereas coconut sap generally has about 15-18% sugars. Mostly toddy contains about 6-7% of ethanol. Natural fermentation takes place by the microorganisms present in the earthen pot. *Saccharomyces cerevisiae* is mostly present along with *Lactobacillus plantarum* and *Leuconostoc mesenteroides*. If fermented sap "toddy" is stored for longer time, acetic acid production ensues resulting in the spoilage of the product.

**vii) Pomegranate and other fruit wines**

Pomegranate (*Punica grantum*) fruits are pressed as such to get astringency in the wine. Sugar is ameliorated in the pressed juice getting brix around 22-23°B. Potassium metabisulphite is added to the must and it

is inoculated with the starter culture (*Saccharomyces cerevisiae*) at the rate of 5%. Wine is produced in the California belt of the United States of America.

Litchi, Apricot, Pineapple, Date, Red Raspberry, Strawberry, Kiwi fruit, peach, Kinnow fruits, grape fruit, orange and plum, ber, guava and banana fruits can be used for wine production with certain modifications in the method of preparation. Majority of these fruits require enzymatic treatment to release the sugars and supplementation of juice with cane sugar and nitrogenous salts. The other steps remain the same as followed for production of grape wine.

#### viii) Mead

Mead is a wine prepared from honey. The procedure followed for mead is the same which is employed for wine making from different types of fruits. Light coloured honey is preferred for this purpose. Honey is diluted to 22-23°Brix, it is boiled and cooled and appropriately tannin, acid and diammonium hydrogen phosphate and SO<sub>2</sub> added to it. The must is inoculated with the active starter culture of *Saccharomyces cerevisiae* and fermentation is carried out at low temperatures. Mead is relished in European countries and several other parts of the world.

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## 12.11 CHEMICAL COMPOSITION OF WINE

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The chemical composition of the wine relates to its quality. There are several factors which influence the quality of wine. The most important factors affecting the quality have already been highlighted earlier. The typical wine contains ethyl alcohol, sugars, acids, higher alcohols, tannins, aldehydes, esters, amino acids, minerals, vitamins, anthocyanins, fatty acids, flavouring compounds and traces of methanol.



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### Check Your Progress Exercise 2

**Note:** a) Use the space below for your answer.  
b) Compare your answers with those given at the end of the unit.

1. Explain how wine is produced from these fruits: apples, custard apples, pear, mango and jamun.

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2. Define toddy and explain its preparation.

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3. What do you know about mead?

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4. Do you know the typical chemical composition of wine?

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## 12.12 LET US SUM UP

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Alcoholic beverages have been consumed all over the world since time-immemorial. Their (wine, beer, brandy, whisky, rum) consumption is gradually and steadily increasing in developed and developing countries equally inspite of several restrictions. Wine and beer if taken moderately, have health giving properties. When fruit juices (grapes, apple, pear etc.,) are allowed to spontaneous alcoholic fermentation or with addition of yeast culture, the sugar present in these get converted into ethanol and carbon dioxide and thus wine, cider, perry and if distilled, brandy are produced. The yeast, *Saccharomyces cerevisiae* or *Saccharomyces cerevisiae* var. *ellipsoideus* are primarily responsible for good alcoholic fermentation. The fermentation of fruit juices

initially requires some oxygen for the growth of yeast and after its exclusion, ethanol and carbon dioxide are produced anaerobically. Several prefermentative and post fermentative practices are followed and when fermentation is complete, it is clarified with bentonite or gelatin. Maturation of wine (clarified and filtered fermented juice) is carried out in oak wood barrels and finally it is bottled in dark amber colour glass bottles. Apples, grapes, pears, mango, pomegranate, jamun can be utilized for wine production. Honey is used for mead production. Toddy another alcoholic beverage of India, has good invigorating and relishing effect if taken directly from the tree without any storage.

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### 12.13 KEY WORDS

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<b>Wine</b>	:	Alcoholic fermented juice of fruits
<b>Cider</b>	:	Wine from apples
<b>Perry</b>	:	Wine from pears
<b>Mead</b>	:	Wine from honey
<b>Brandy</b>	:	Distilled wine
<b>Rum</b>	:	From fermented molasses or canesugar
<b>Whisky</b>	:	Distillation of mash of malted grains
<b>Beer</b>	:	From malted barley
<b>Toddy</b>	:	Palm trees sap or coconut inflorescence sap



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### 12.14 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

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#### Check Your Progress Exercise 1

1. Your answer should include the following points:

- The juice of grapes or any other fruits if allowed to ferment by natural fermentation or by addition of starter culture viz., yeast for some time and the resultant product after fermentation is wine.
- Types of Wines are:
  - Champagne: foaming containing dissolved oxygen.
  - Sparkling wine: produced by injecting carbon dioxide into the wine.
  - Liqueur Wine: Sweet with higher content of alcohol.
  - Sherry: Fortified wine.
  - Port: Wine is stored in a wooden cask.
  - Vermouth: Flavoured wine
  - Brandy: Distilled wine
  - Cider: Produced from apple.
  - Perry: Produced from pears.

2. Your answer should include the following points:

- The juice of grapes or some fruits contain high amounts of sugar mainly glucose and fructose sometimes 20-25%. The wine yeast present in the juice or added separately grows profusely and convert sugars into ethanol.
- One mole of glucose gives rise two moles of ethanol and two moles of carbondioxide.
- Usually 8-10% ethanol is obtained after fermentation.

3. Your answer should include the following points:

- Grape juice or any other fruit juice.
- The commercially used yeast strains for wine *Saccharomyces cerevisiae*, *Saccharomyces cerevisiae* var. *ellipsoideus*.

4. Your answer should include the following points:

- Killer yeast/s infected with a virus that kills the wine yeast.

5. Your answer should include the following points:

- *Saccharomyces cerevisiae* strains tolerate high levels of sugars in the fruit juices.
- Tolerate high levels of ethanol.
- Grow even at low pH.
- Ferment fruit juices at low temperature.
- Resistant to sulphur dioxide which checks the growth of bacteria, yeasts, moulds.

6. Your answer should include the following points:

- Stemming, crushing and juice separation → clarification → adjustment of sugar level and acidity → fermentation

7. Your answer should include the following points:

- The growth of wine yeast: *Saccharomyces cerevisiae* is checked due to the presence of Killer viruses and fermentation does not proceed well. A number of metabolites (chemicals) are released causing defective flavour and body of wine (Stuck Fermentation).
- Clarifications and Stabilization, fining, centrifugation, filtration, removal of crystals, avoidance of haze formation maturation and bottling.

**Check Your Progress Exercise 2**

1. Your answer should include the following points:
  - Cider (A low alcoholic 4-6% ethanol) from apples.
  - Custard apple seeds and skin are removed and juice is supplemented with sugar and fermented.
  - Perry or pear wine from pears prepared by extra addition of nitrogen in the juice.
  - Juice extraction a big problem and therefore pectinolytic enzyme is used for the recovery of juice and which is supplemented with sugar and fermented (mango).
  - Jamun wine has therapeutic properties and good for diabetes patients.
2. Your answer should include the following points:
  - An alcoholic beverage produced from palm and coconut trees.
  - The sap is collected from the trees in the morning.
  - Freshly collected sap is sweet, relishing and invigorating.
3. Your answer should include the following points:
  - Prepared from honey.
  - Honey appropriately diluted and supplemented with tannic acid and phosphate and nitrogenous salts and fermented.
4. Your answer should include the following points:
  - Contains usually ethyl alcohol, sugar, acids, higher alcohols, tannins, aldehydes, esters, amino acids, minerals, vitamins, anthocyanins, fatty acids, flavouring compounds and traces of methanol.

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**12.15 SOME USEFUL BOOKS**

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1. Boulton, R.B., Singleton, V.L., Bisson, L.F., and Kunker, R.E. (1995) Principles and Practices of Wine Making. Chapman and Hall, New York.
2. Jackson, R. (1994) Wine Science: Principles and Applications. Academic Press, San Diego.
3. Zoecklein, B.W., Fuselang, K.C., Gump, B.H., and Nurry, F.S. (1995) Wine Analysis and Production. Chapman Hall, New York.