
UNIT 13 TECHNOLOGICAL ASPECTS OF INDUSTRIAL PRODUCTION OF ALCOHOLIC BEVERAGES AND RELATED PRODUCTS

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13.0 OBJECTIVES

After studying this unit, you should be able to:

- state the necessity of technology in alcoholic beverages production;
- describe the vats and tanks used for industrial production of alcoholic beverages;
- know how different types of beverages are manufactured and various steps involved in their production; and
- describe the method of vinegar production.

13.1 INTRODUCTION

In Unit 10, the industrial significance and necessity of fermentation and its relevance to the society have been highlighted in detail. Fermentation or production of wine, beer, cheese or bread is an art and has been practiced from time immemorial throughout the world. However, to meet the demand of the society, large scale operations are needed for any type of product. Therefore, for all the stages of commercial production, engineering involvement is warranted. The scientific knowledge on production of a product either developed in research laboratories or house-holds or cottage level, has to be developed in the form of a commercial process with the help of engineers, scientists and other experts. There are a number of commercial processes developed for alcoholic beverages and related products, and improvement in the quality and also cost reduction of the final products are made more often.

In brief, various aspects of industrial production of selected wines, distilled alcoholic beverages of fruit origin (Brandy) and vinegar are highlighted here.

13.2 FERMENTERS

In wine production, any non-porous, non-toxic vessel can be used as a fermenter. These are constructed of non-aromatic wood, cement, stainless steel or fiberglass. Only two types of fermenters: Vats and Tanks are employed for fermentation. The size of fermenter differs but most of the wineries use 20000 liters and above capacity vessels either open or closed. Sometimes smaller, barrels are employed in which fermentation and maturation both take place. All these are batch fermentation carried out for certain periods and then again recharged with must and restarted. Hydraulic press, filtration equipments and other machines and equipment are used for commercial production.

13.3 TECHNOLOGY FOR CIDER-MAKING

Cider is a low alcoholic drink prepared from the apple juice. Depending on the ethanol content, it is considered soft cider (1-5%) or hard cider (6-7%). In India, cider is not produced commercially. But the Indian varieties of apple cultivated in Jammu and Kashmir and Himanchal Pradesh e.g., Ambiri-Kashmiri, Red Delicious, Gold Pippin, Maharaji Apples and Golden Delicious can be utilized for cider making. A method for cider manufacture at a commercial scale is shown through flow diagram in Figure 13.1.

13.4 TECHNOLOGY OF SPARKLING CIDER

Sparkling cider is prepared by artificial carbonation. The secondary fermentation is carried out for 3-4 days at 21.0 °C. A protocol for carbonated cider is given in Figure 13.2.

13.5 TECHNOLOGY OF FORTIFIED WINES: VERMOUTH

Wines which are flavoured with herbs and spices and contain ethanol content in the range of 15-21%, are classed under 'Vermouth'. Both dry and sweet vermouth are prepared in European countries and relished in cocktails. It is prepared by making the wine and then extracting the spices and herbs mixture in wine and Brandy and blending with the wine produced and also adjusting the alcohol level. Grapes, apples apricots, mango, plum, even tamarind can also be used for vermouth production. Pear or similar types of fruit which are produced in abundance and commercially do not find much market, can be profitably used for vermouth manufacture. It is schematically illustrated in Figure 13.3.

13.6 TECHNOLOGY FOR BRANDY-MAKING (DISTILLED ALCOHOLIC BEVERAGES)

Brandy is defined as a distilled alcoholic beverage prepared from the distillation of wine or any fermented fruit juice. Usually brandy denotes the distilled wine of grapes whereas for other fruits it is prefixed with the fruit name e.g. apple brandy, plum brandy etc., Sometimes 'Cognac' word is also

used for brandy. Cognac is produced in France. There are many varieties of wines mostly based on their place of manufacture.

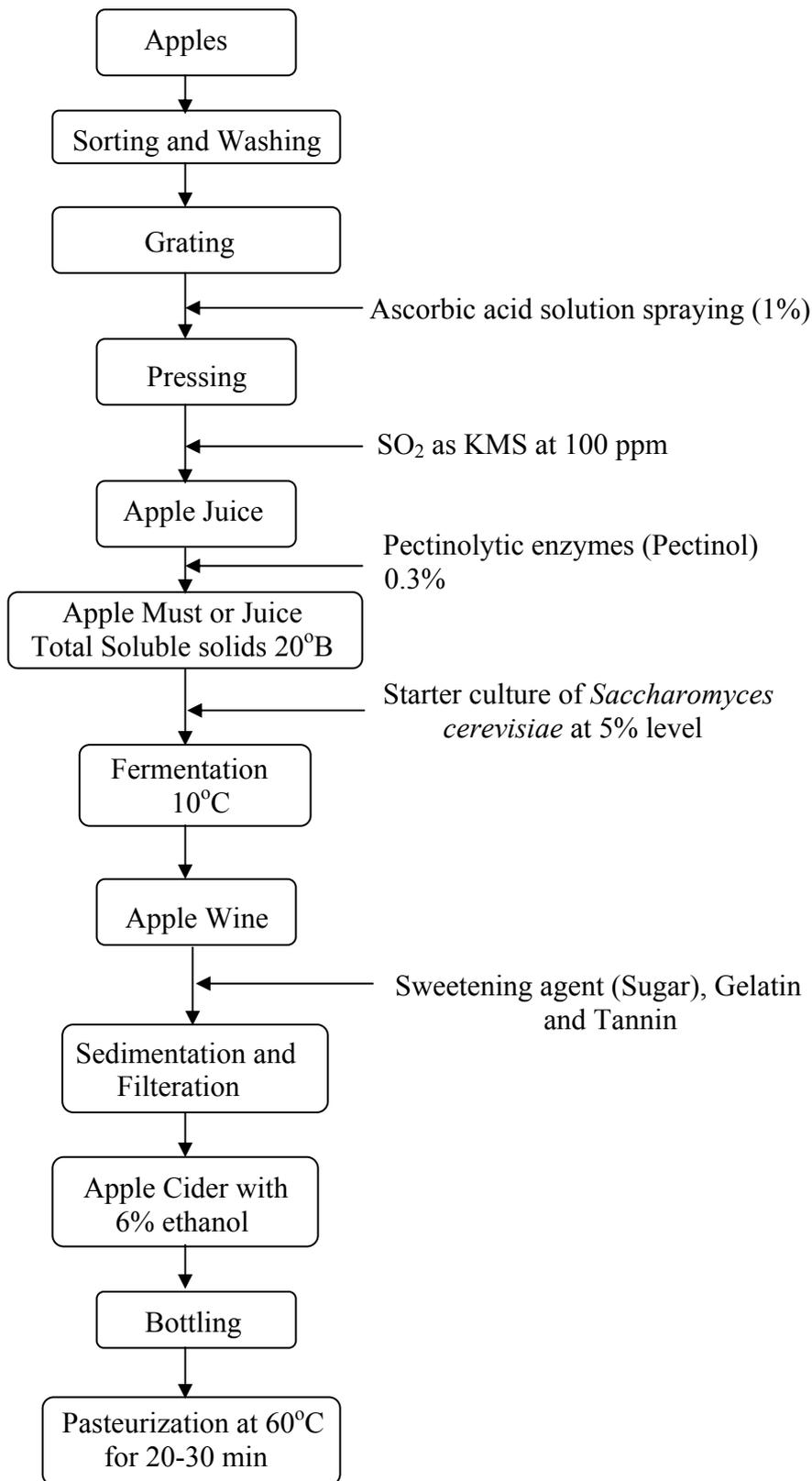


Figure 13.1: A protocol for cider production

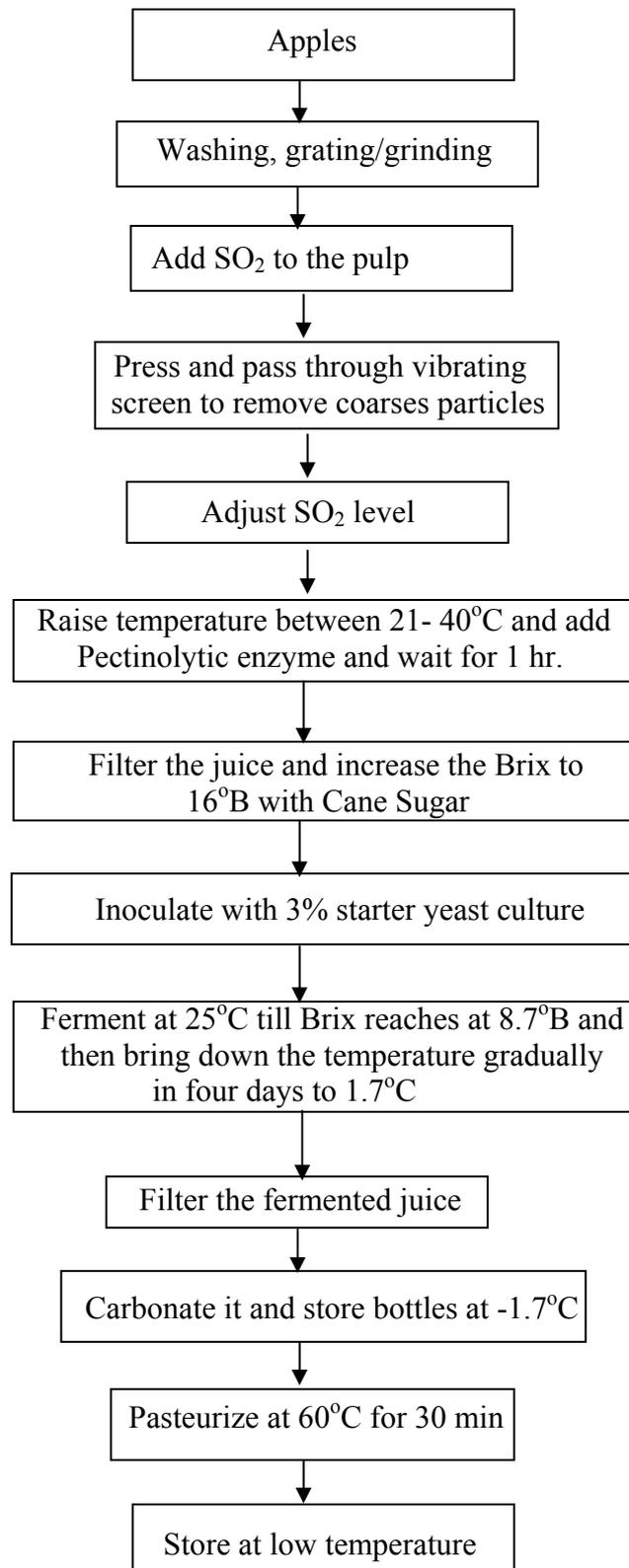


Figure 13.2: A protocol for carbonated cider production

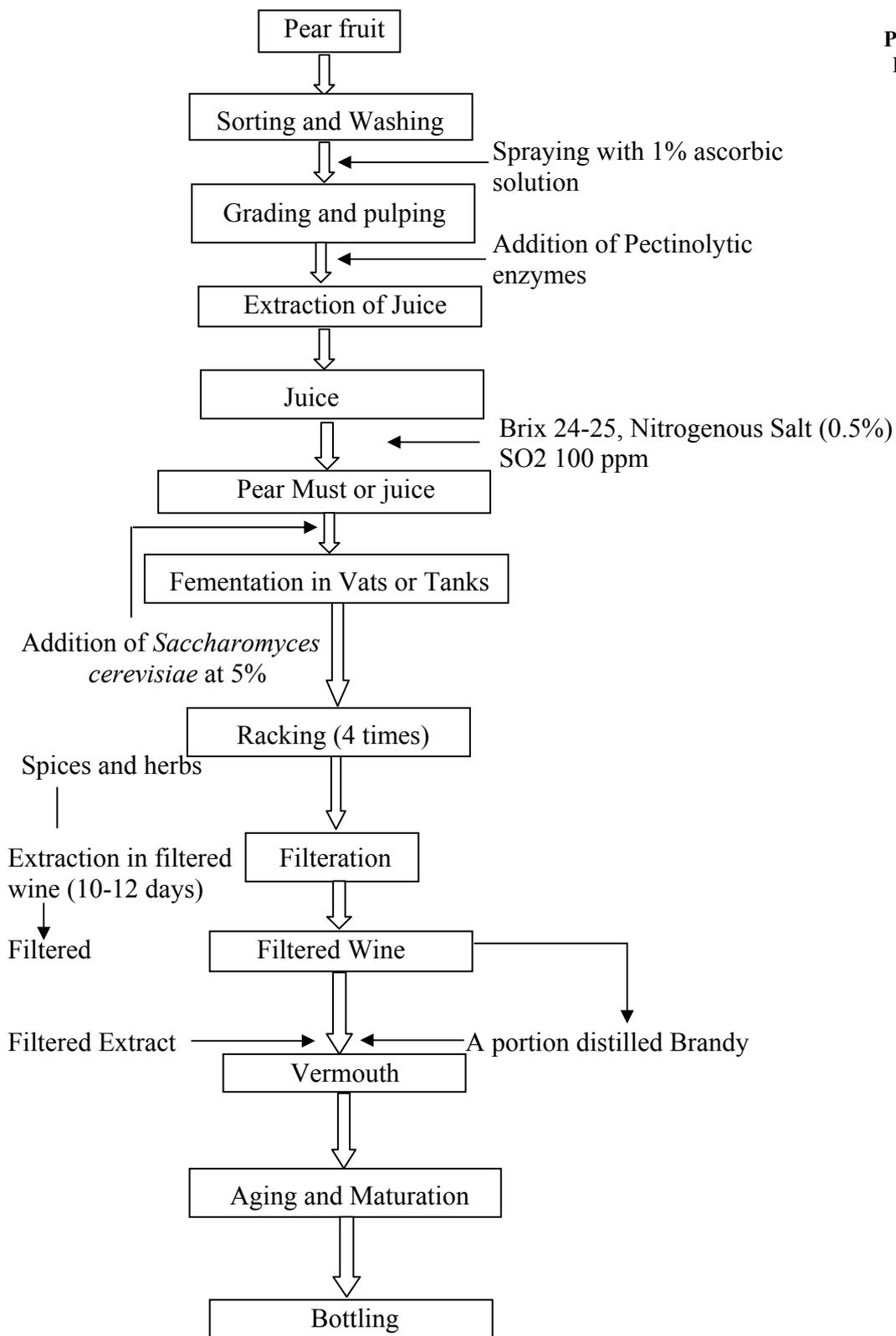


Figure 13.3: Manufacture of vermouth of pears

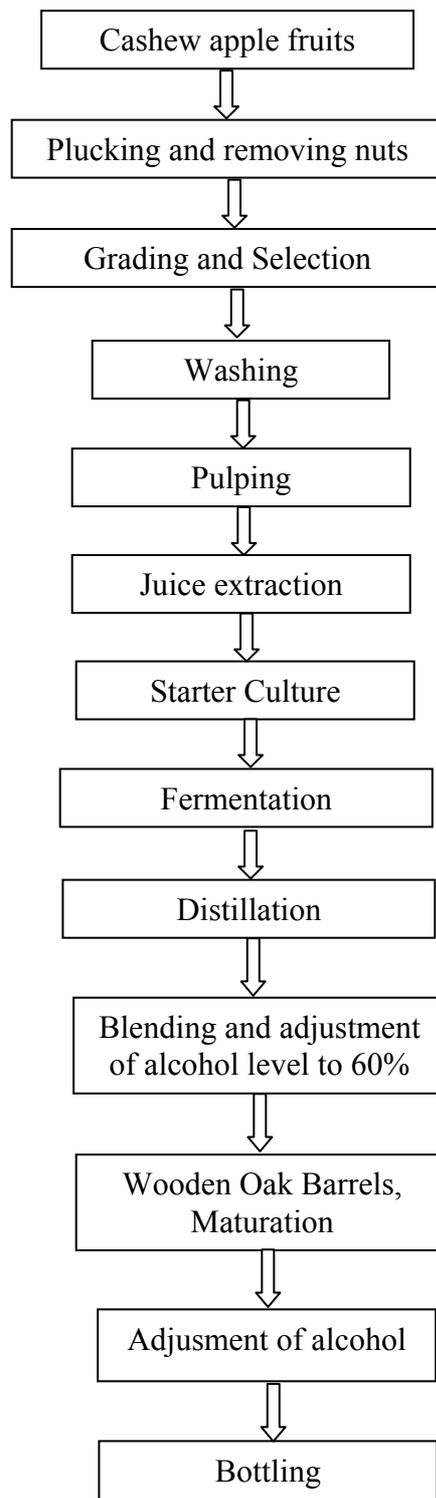


Figure 13.4: Manufacture of Feni from cashew apple

Like wines, brandy also contains many constituents. The major being ethyl alcohol (ethanol) along with fusel oil (higher alcohols e.g. n-propyl alcohol, isobutyl alcohol etc.), traces of aldehydes esters (ethyl acetate) furfural and several other constituents. The method of base wine production for brandy is as employed for other wine manufacturing.

Distillation of fermented wine is carried out mostly in copper pot distillation unit but column stills (a vacuum distillation) is also adopted in some of the

wineries. Distillation is carried out along with some fermented fruit materials and yeast cell biomass (lees). It is done in two steps. The first step results in about 28% of ethyl alcohol in the distillate whereas in the second stage of distillation of the distillate yields 70% of ethanol by volume. Brandy is stored in oak barrels. Some of the products are stored for several years e.g. 15 to 50 years and the quality improves during maturation. The final product has mostly 40-45% of ethyl alcohol by volume.

In the United States of America and several other countries, the strength of alcohol is measured in terms of proof. It denotes usually the twice the percent of ethyl alcohol content of a liquid at 60°F.

13.7 TECHNOLOGY OF FENNY AND BRANDY OF CASHEW APPLE

Cashew apple is grown in large areas of the western coast of Karnataka, Goa and other states for cashew nuts. The nut is attached to the fleshy fruit and while processing, the fruit pulp is mostly wasted or a part is utilized for wine-making. It is rich in fermentable sugars and ascorbic acid. In Goa 'Kaju Feni' is quite popular. In Tanzania, Brazil and several other countries, alcoholic beverages are produced and used as a wine or occasionally distilled and consumed in the form of brandy. The word 'Feni' comes from the Konkani language, which means 'froth'. It is mostly produced at a cottage scale level. However, technical know-hows are available for commercial production of feni and brandy from it.

The cashew apple fruits are crushed and pulped and juice is extracted using extractors. The juice is left as such for spontaneous natural fermentation or inoculum of *Saccharmyces cerevisiae* at 5% is added, stirred and mixed evenly. Normally 2-3 days are taken for the fermentation. The feni is obtained by distilling the fermented juice with Urak* (2:1) containing 60% alcohol. Aging and maturation at 15°C is carried out in oak wood barrels. After aging the product is marketed in bottles adjusting alcohol content to 42-43%.

The process of feni production is illustrated in Figure 13.4.

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. Why is technology necessary for the production of alcoholic beverages?

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* Urak: Distilled feni containing 60% alcohol

2. What special type of fermenters needed for wine production?

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3. What are the important characteristics of sparkling cider and vermouth?

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4. Highlight the importance of brandy among alcoholic beverages.

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5. What do you mean by 'Fenny'? Write its method of production.

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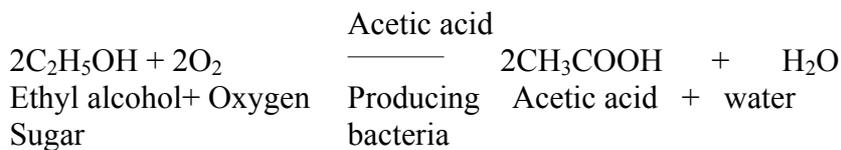
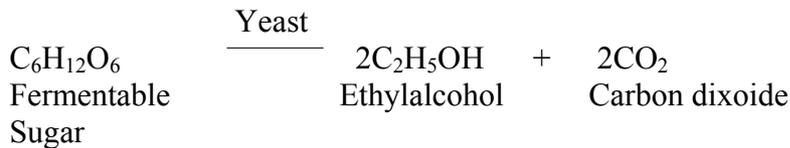
13.8 TECHNOLOGY OF VINEGAR PRODUCTION BY FERMENTATION

Vinegar is consumed in almost every part of the world. Sugars mostly glucose, fructose and sucrose in appropriately diluted concentration are converted to ethyl alcohol by yeast/s and acetic acid producing bacteria convert this alcohol into ethanol by acetification thus producing vinegar. Vinegar contains at least 4% of acetic acid with some other solids. It is made from distilled alcohol prepared from cane molasses or other sugar sources. According to Indian Standards Vinegar should not contain arsenic, mineral acid, lead, copper, or colouring matter except caramel.

i) Method of Vinegar Preparation

Two distinct processes are involved in the preparation of vinegar:

- a) Transformation of sugars of fruits or any sugary materials into alcohol by yeast anaerobically;
- b) conversion by acetic acid producing bacteria of alcohol oxidatively in the presence of air into acetic acid.



ii) Types of Vinegar

Cider Vinegar (apple juice)
 Wine Vinegar (grape juice)
 Spirit Vinegar (Dilute ethylalcohol from molasses)
 Malt Vinegar (barley malt)
 Orange, pineapple, banana, pear, peach, apricot, onion vinegars

iii) Process of Vinegar Preparation

There are a number of processes commercially used for vinegar production. The most commonly used are:

- a) *Slow process*: The juice or sugary solution is filled into barrels and allowed to undergo alcoholic fermentation and acitification slowly. The mouth of the barrel or container is covered with a piece of cloth and placed in a damp and warm place. In about 5 to 6 months, the sugar solution turn into vinegar. This process is time-taking.
- b) *Oreleans Slow Process*: The barrel used is filled three-fourth with the juice and two holes above the juice level on the either side of barrel are made in addition to top hole or mouth. These holes are tightly covered with cheese cloth to protect from insects and flies. The filled barrel is placed in a warm place (21-27°C) and fermentation is allowed to take place. It takes about 3 months for complete fermentation. About three fourth of the fermented liquid (Vinegar) is withdrawn without making any hole in the top thick film of *Acetobacter* and again filled with the fresh juice.
- c) *Quick Process*: It is known as the ‘Generator’ or the ‘German’ process. The generator is in the form of a cylinder 3.6 to 4.2 meters high and 1.2 to 1.5 meters in diameter. It has a false bottom and head, vent holes and sparge for discharging the liquor. It has three compartments. The

central compartment is filled with beech wood shavings, corn cobs, pumice stone, straw to increase the surface area for the growth of acetic acid producing bacteria. The other distribution compartment is above 30 centimeters of the central compartment. It is separated by a partition perforated plate having a number of holes. A revolving sprinkler or a fitting trough is fitted in order to allow liquid to trickle slowly over the shavings of the Central Compartment. The third compartment is the bottom compartment separated from the central compartment by a perforated partition above 1.5 Meters the bottom of the generator.

Initially beech wood shavings are wetted with unpasteurized vinegar and then two parts of alcoholic juice and one part of vinegar is charged slowly to allow bacteria to colonize the shavings. When the generator becomes ready then alcoholic juice or liquid is passed through the generator on the top and acetified liquid (Vinegar) is collected having 3 to 4% acetic acid (volume). The air passage is cleaned from time to time. The optimum temperature is around 27-30°C for this operation.

- d) *Fringe Process*: The quick process has been improved by the addition of forced aeration and temperature control of trickling generators.
- e) *Submerged Culture Process*: It has been tried for Vinegar production but *Acetobacter aceti* is quite sensitive to oxygen. Therefore, the aeration of the liquid is significantly important. However, it is 80 times faster oxidation of ethanol to acetic acid.

iii) Post-fermentation Process

- a) *Aging*: Vinegar produced by quick process is kept for aging for about six months.
- b) *Clarification*: Before bottling, vinegar is made sparkling clear.
- c) *Pasteurization*: It is heated in an open vessel to about 60°C and then cooled and bottled.
- d) *Spoilage of Vinegar*: Lactic acid producing bacteria grow initially and spoil the vinegar. It should be fully avoided. Film yeast growing on the top also spoil the process of vinegar generation. Vinegar flies are well known to affect the quality of vinegar. Vinegar eels, louse and vinegar mites are the enemies of vinegar production. They should be completely eliminated.

At present a large proportion of our demand for vinegar is being met by synthetic vinegar. However, the fruit vinegar may be encouraged for consumption. People are not familiar with fruit vinegars and therefore, these have to be popularized highlighting their therapeutic importance in human health.

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 the importance of vinegar.

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2. What are the steps involved in vinegar generation and types of vinegar produced?

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3. List commercial processes used for Vinegar generation.

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13.9 LET US SUM UP

Production of exotic beverages in smaller quantities is an art but to meet the increasing demand of the people, large-scale operations at commercial scales are required. Therefore economically viable technologies are warranted for industrial production. All the beverages are commercially produced and marketed all over the world. Commercial vats or tanks with juice extractor and filtration or clarifier units are employed for these alcoholic beverages. Brandy manufacture requires a distillation unit along with the modern bottling plant. Vinegar is also a commercial fermentation produced throughout the world. There are a number of quick processes which take considerably shorter time for vinegar generation.

13.10 KEY WORDS

Vats and Tanks	:	Open or closed mouth vessels for wine fermentation.
Sparkling cider	:	Artificially carbonated cider.
Vermouth	:	Wine flavoured with herb and spices containing 15-21%, ethanol.
Brandy	:	Distilled wine or fermented fruit juice.
Fenny	:	Wine from cashew apple pulp.
Vinegar	:	Prepared from sugary materials by fermentation containing 4 grams of acetic acid/100 ml.



13.11 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1. Your answer should include the following points:
 - It is an art at house-hold or small scale production.
 - For Commercial production, large scale operation needed.
 - For large scale operations, engineering inputs needed for fermentation, filtration, maturation and bottling.
2. Your answer should include the following points:
 - Unlike other fermentations (antibiotic, citric acid), non porous and non-toxic vessels are used.
 - They are constructed from non-aromatic wood, cement, stainless steel or fibre glass.
 - Vats and tanks used for wine fermentation.
3. Your answer should include the following points:
 - Prepared by carbonation.
 - Secondary fermentation done at lower temperatures.
 - Wine which flavoured with herbs and spices and contain ethanol in the range of 15-21%: vermouth.
4. Your answer should include the following points:
 - Distilled wine or any fermented juice (brandy).
 - Mostly 40-45% ethanol volume (brandy).

5. Your answer should include the following points:

- Produced from fleshy pulp
- Sorting of pulp → extraction of juice → allowing spontaneous fermentation or addition of starter culture for 2-3 days → distillation of the fermented juice.
- Distilled product contains 42% ethanol.

Check Your Progress Exercise 2

1. Your answer should include the following points:

- A fermentation derived product, containing not less than 4 grams of acetic acid per 100 ml.
- Prepared in the household in small quantities from sugarcane juice in India or cider or wine of fruits.

2. Your answer should include the following points:

- Two distinct processes: the first being sugar fermentation to ethyl alcohol by *Saccharomyces cerevisiae* and the next being conversion of ethyl alcohol to acetic acid by *Acetobacter* spp.
- Commercially available vinegar: Vinegar from jaggery, vinegar from cider, Barley malt vinegar.

3. Your answer should include the following points:

- Slow process
- Orleans process
- Quick process
- Fringe process
- Submerged process

13.12 SOME USEFUL BOOKS

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.