Post Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products

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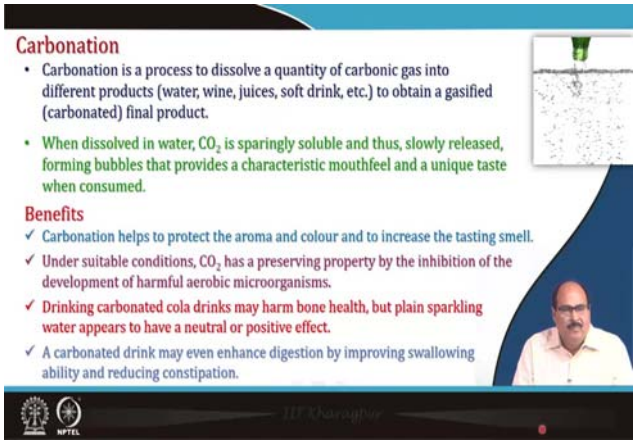
Lecture 49
Carbonated Fruit Juices and Premixes

This lecture discusses about carbonated fruit juices and pre mixes. The topics, which will be discussed include carbonation, process of carbonation, reason for carbonation etc. De-aerators and carbonators will also be discussed. Then soft drinks and their compositions, fruit material and nutraceutical as ingredients in these beverages, process for the preparation of carbonated fruit beverages will also be discussed. Finally, one case study i.e., the carbonated aonla beverage premix will be discussed.

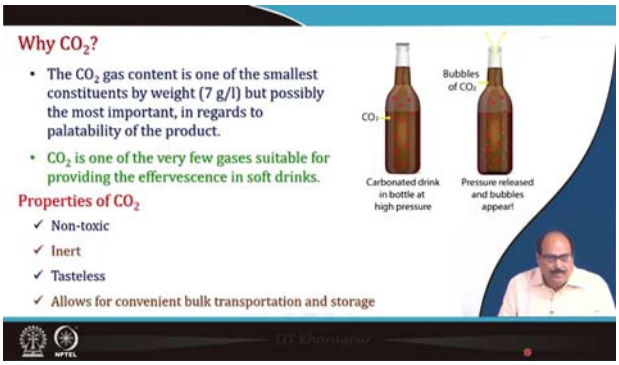


Carbonation

It is a process to dissolve a quantity of carbonic gas into different products. The products maybe water, wine, juices, soft drinks, etc. The purpose here is to obtain a gasified or carbonated final product. When dissolved in water, CO_2 is sparingly soluble, and thus, it is slowly released and forms bubble that provides a characteristic mouthfeel and unique taste, when these carbonated beverages are consumed or carbonated products are consumed.

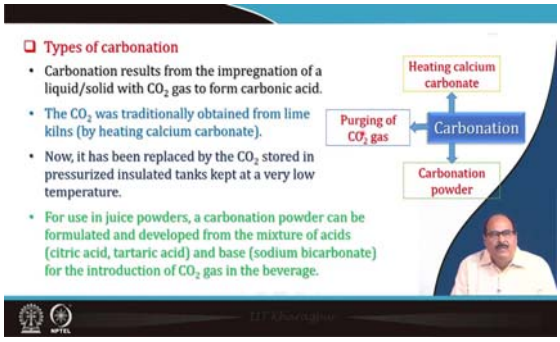
Benefits

The benefits of carbonation include that it helps to protect the aroma and color as well as to increase the tasting smell. Under suitable conditions, CO_2 has a preserving property. It inhibits the development of harmful aerobic microorganisms. Drinking carbonated cola drinks may harm bone health, but plain sparkling water appears to have a neutral or positive effect. A carbonated drink may even enhance digestion by improving swallowing ability and reducing constipation.



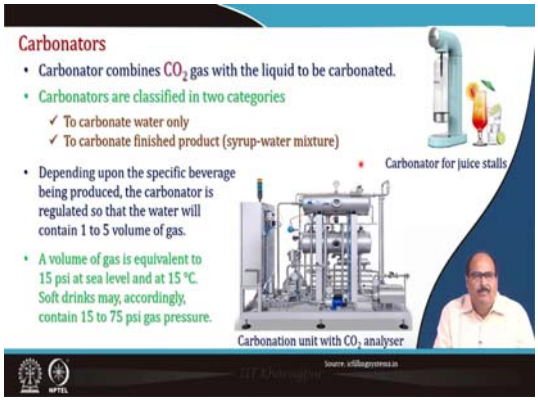
Why CO_2?

The CO_2 gas content is one of the smallest constituents by weight (7 g/l), but possibly the most important, in regards to palatability of the product. CO_2 is one of the very few gases, which is suitable for providing the effervescence in soft drinks. CO_2 is a non-toxic gas. It is inert, tasteless, and it allows for convenient bulk transportation and storage.



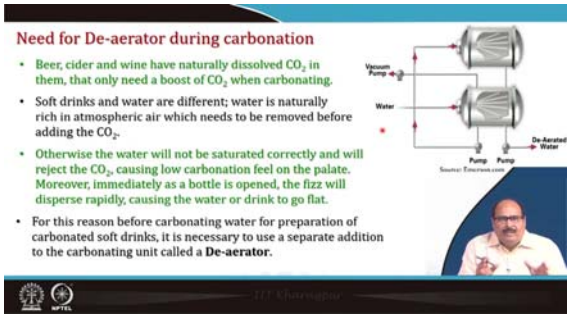
Types of carbonation

Carbonation results from the impregnation of a liquid/solid with CO_2 gas to form carbonic acid. The CO_2 was traditionally obtained from the lime kilns i.e., by hitting the calcium carbonate. The calcium carbonate is heated, the CO_2 gas is generated, and this is collected and this can be then used for the carbonation of the beverage. Now, it has been replaced by the CO_2 stored in pressurized insulated tanks, which are kept at a very low temperature. Even for the use in the juice powders, a carbonation powder premix can be formulated and developed from the mixture of acids such as citric acid, tartaric acid, and base component, which is sodium bicarbonate and this carbonation mixture or carbonation powder can be mixed with the fruit juice powder etc. and when it will dissolve, it will give the CO_2 gas effect in the beverage.



Carbonators

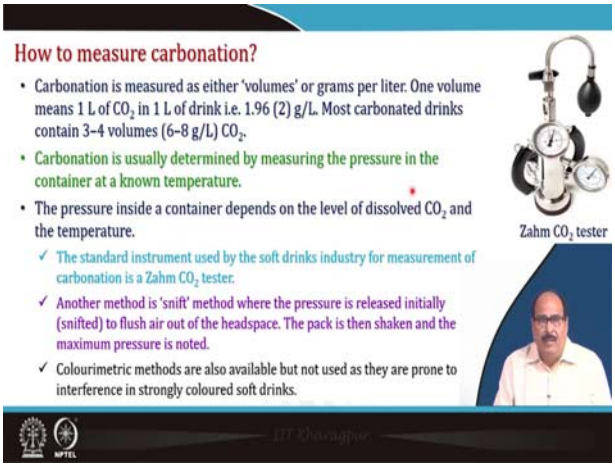
Carbonator combines CO_2 gas with the liquid to be carbonated. Carbonators are classified into two categories, one which is used to carbonate water only and the other is to carbonate the finished product (syrup-water mixture). Depending upon the specific beverage being produced, the carbonator is regulated so that the water will contain or beverage will contain about 1 to 5 volumes of gas. A volume of gas is equivalent to 15 psi pressure at sea level and at 15 °C temperature. Soft drinks may, accordingly, contain 15 to 75 psi gas pressure.



Need for De-aerator during carbonation

Beer, cider, and wine have naturally dissolved CO_2 in them, that only need is to a boost of CO_2 when carbonating. Soft drinks and water are different. Water is naturally rich in atmospheric oxygen, which needs to be removed before the CO_2 is added into it. Otherwise, the water will not be saturated correctly and will reject the CO_2, causing the water or drink to go flat.

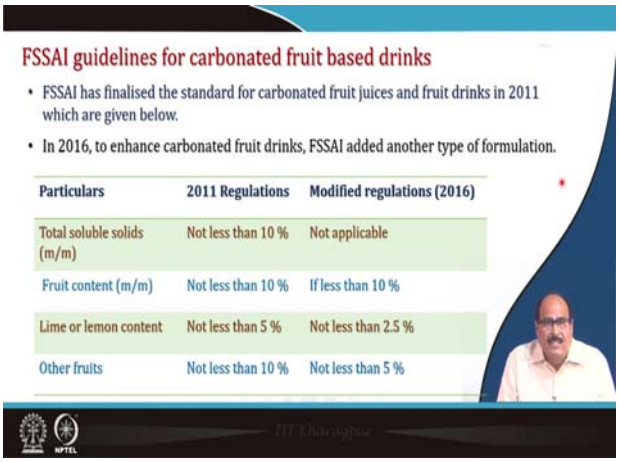
Moreover, immediately as a bottle is opened, the fizz will disperse rapidly if oxygen is present, causing the water to drink to go flat. For this reason, before carbonating water for preparation of carbonated soft drinks, it is necessary to use a separate addition to the carbonating unit, called a De-aerator to remove the oxygen from the beverage.



How to measure carbonation?

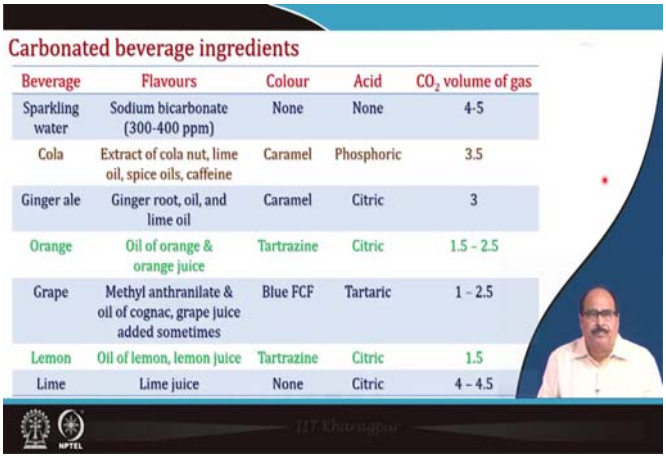
Carbonation is measured as either ‘volume’ or grams per liter. One volume means 1 L of CO_2 in 1 liter of drink i.e., 1.96 about approximately 2 g/L. Most carbonated drinks contain 3 to 4 volumes (6 – 8 g/L) CO_2. Carbonation is usually determined by measuring the pressure in the container at a known temperature. The pressure inside a container depends on the level of the dissolved CO_2 and the temperature. The solubility of the CO_2 in the liquid depends upon the pressure and the temperature of the liquid while it is being sterilized or while it is being carbonated. The standard instrument used by the soft drink industry, for the measurement of carbonation is a Zahm CO_2 tester. It can be seen in the figure. Another method is ‘snift’ method, where the pressure is released initially i.e., snifted to flush air out of the headspace. The pack is then shaken and the maximum pressure is noted. Colourimetric methods are also

available but they are not used as they are prone to interference in strongly coloured soft drinks. The color of the beverage may interfere with the measurement.



FSSAI guidelines for carbonated fruit-based drinks

FSSAI has finalized the standards for carbonated fruit juices and fruit drinks in the year 2011. Those are given in the table. In 2016, to enhance the carbonated fruit drinks, FSSAI added another type of formulation. They revised their earlier guidelines. As per the guideline, as per the 2011 regulations, total soluble solids (m/m) should not be less than 10%. But it is not applicable as per the modified regulations of 2016. Fruit content (m/m) in the beverage should not be less than 10% as per the earlier regulations. In the 2016, it was, if less than 10%. Lemon or lemon content not less than 5% by earlier regulations of 2011 and not less than 2.5% in the modified regulations. Other fruits not less than 10% as per the 2011 regulations and not less than 5% as per the 2016 regulations.



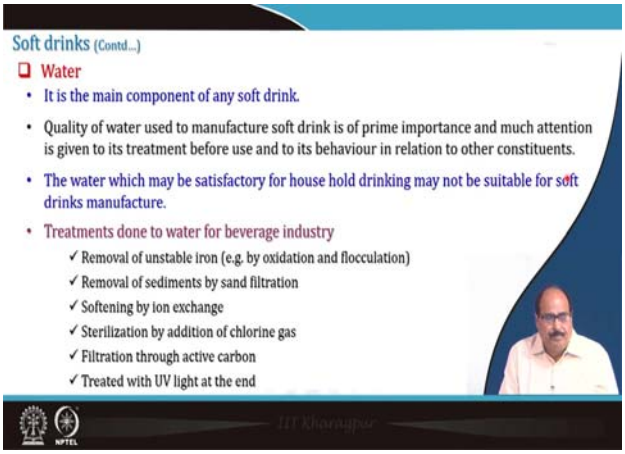
Carbonated beverage ingredients

In the table, the ingredients in a carbonated beverage are given. In case of sparkling water, where in the water, only sodium bicarbonate in the concentrations of 300 to 400 ppm, is added and it has no color, no acid is added into it and CO_2 volume of gas is around 4 to 5. In the ginger ale, the flavoring component is ginger root, oil, and lime oil. The color is caramel. Citric acid is the preservative, which is used and volume of the gas is around 3. In the orange

beverages, oil of orange and orange juice are normally used as flavorings and then tartrazine for coloring purposes and citric acid. The carbon dioxide volume is 1.5 to 2.5. In the grape beverage methyl anthranilate, oil of cognac, and grape juice added sometimes. Blue FCF color and the tartaric acid is permitted. 1 to 2.5 is the CO_2 volume of gas. Similarly, lemon and lime data also contain either lime juice, oil of lemon, lemon juice. Tartrazine is added even in the lime. Lime has no color. Citric acid is added in both lemon and lime beverages. Lemon beverage contain 1.5 volume of the CO_2 gas but the lime beverage contains around 4 to 4.5 volume of the gas.

Soft drinks

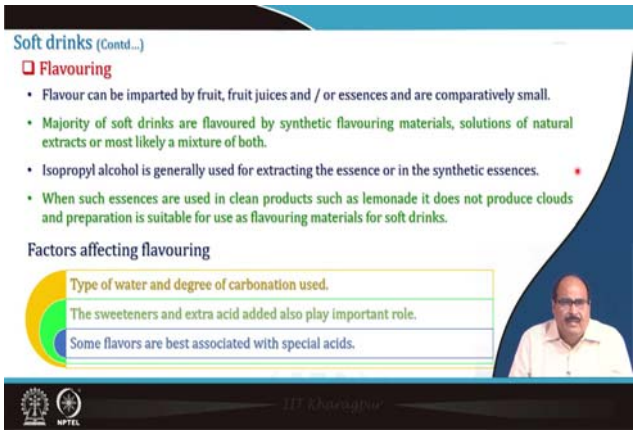
The major ingredients of the soft drink are water, flavour emulsion and emulsifier, colouring agents, sweeteners maybe sugar and sugar substitute, acids and preservatives and carbon dioxide. So, a quality soft drink should have a balanced blend of flavour at proper intensity leaving a clean mouth taste with no lingering flavour or unpleasant after taste and it should have a proper carbonation to impart zest and sparkle to drink.



Water

The main component of any beverage (carbonated beverage or in the soft drink) is the water. The quality of water used to manufacture the soft drink is of prime importance and much attention is given to its treatment and to its behavior particularly in relation to the other

constituents. The water which may be satisfactory for household drinking may not be suitable soft drinks manufacturing. Most of the soft drink manufacturing plants are provided with their water treatment unit. The water is treated for the removal of any unstable iron by oxidation or by flocculation. Any sediments are removed by sand filtration. Water is made soft by ion exchange. It is sterilized by the addition of chlorine gas. It is filtered through active carbon or treated with UV light at the end.

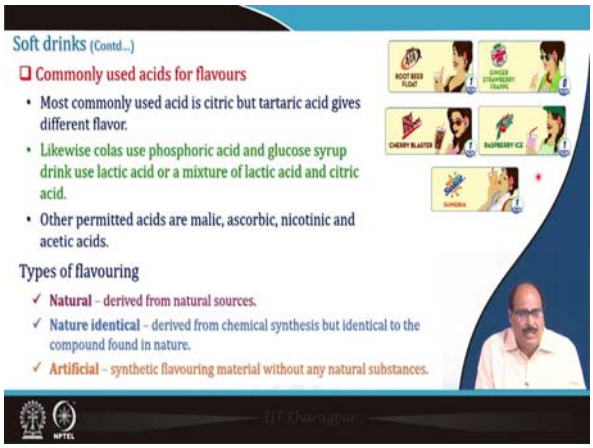


Flavouring

The flavorings can be imparted by the fruits, fruit juices, and or essences. They are comparatively smaller components. Majority of the soft drinks are flavored by synthetic flavouring materials, solutions of some natural extracts or most likely sometimes a mixture of both. Isopropyl alcohol is generally used for extracting the essence or in the synthetic essences. When such essences are used in clean products, such as lemonade, it does not produce any clouds and preparation is suitable for use as flavouring materials for soft drinks.

Factors affecting the flavorings

Factors affecting the flavorings include type of water and degree of carbonation used. The sweeteners and extra acid added also play an important role. Some flavours are best associated with special acids.

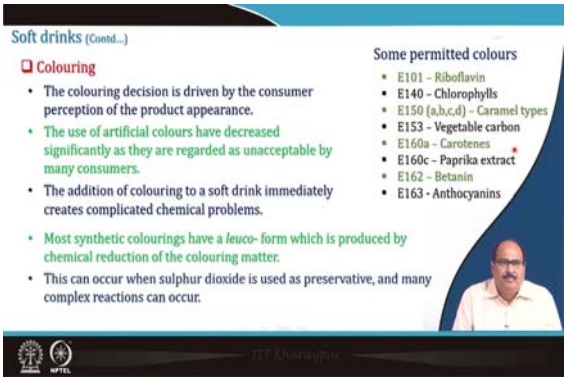


Commonly used acids for flavours

Most commonly used acids for flavours include citric acid but tartaric acid also gives different flavour. Likewise, colas they use phosphoric acid and glucose syrup drink use lactic acid or a mixture of lactic acid and citric acid. Other permitted acids are malic, ascorbic, nicotinic, acetic acids.

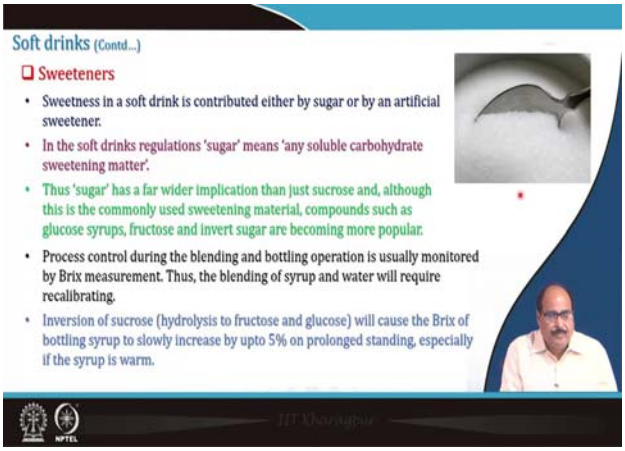
Types of flavourings

Types of flavorings include natural flavourings, derived from the natural sources or nature identical flavourings, which is derived from chemical synthesis but identical to the compound found in nature. Artificial flavour is fully synthetic flavoring material without any natural substances.



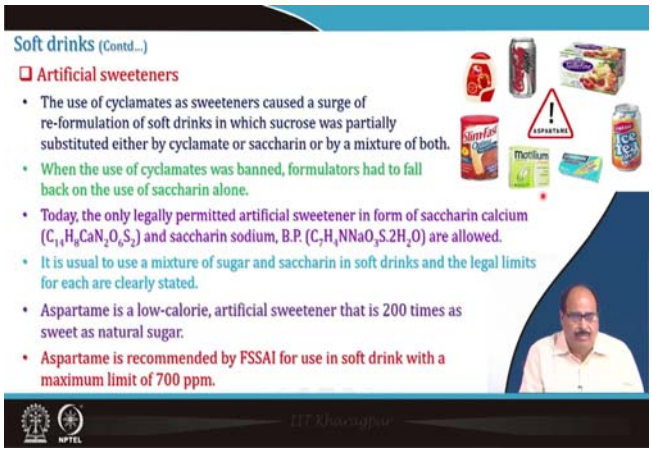
Colouring

The colouring decision is driven by the consumer perception of the product appearance. The use of artificial colours have been decreased significantly as they are regarded as unacceptable by many consumers. The addition of colouring to a soft drink immediately creates complicated chemical problems because most of these colours are synthetic colours. They blend up with various chemical compounds. These chemical compounds will have interactions with the flavouring compounds, with other components. Most of the synthetic colorings have a *leuco-* form, which is produced by chemical reduction of the colouring matter. This can occur when sulphur dioxide is used as a preservative. And many complex reactions may occur with this sulphur dioxide, fruit components and even with the other colouring materials, which are used. Some of the permitted colours are given here in the table.



Sweeteners

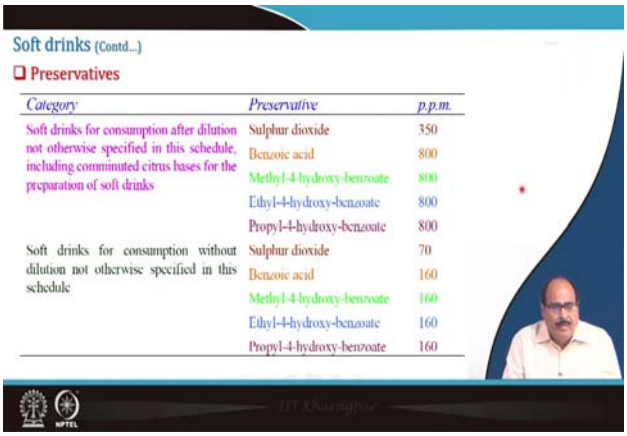
Sweeteners in a soft drink is contributed either by sugar or by an artificial sweetener. In the soft drink regulations 'sugar' means 'any soluble carbohydrate sweetening matter.' The 'sugar' has a far wider implication than just sucrose. Sucrose is most commonly used sweetening material. But the other compounds such as glucose syrup, fructose and invert sugars are also becoming more and more popular slowly and slowly. Process control during the blending and bottling operation is usually monitored by Brix measurement. Thus, the blending of syrup and water will require recalibrating. Inversion of sugar, i.e., hydrolysis sucrose into glucose and fructose, will cause the Brix of the bottling syrup to slowly increase by up to 5% on the prolonged standing, especially if the syrup is warm.



Artificial sweeteners

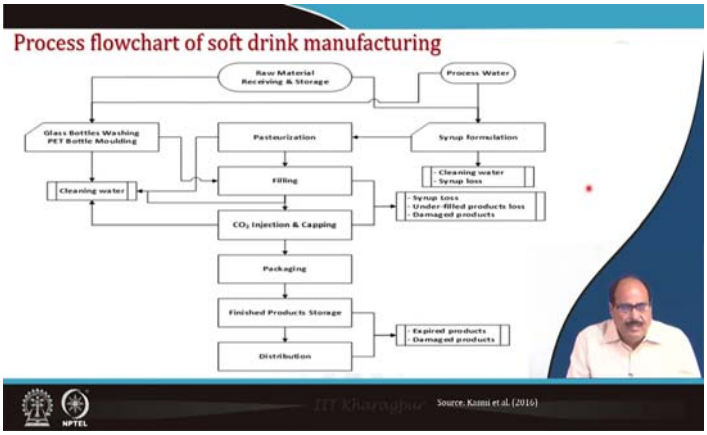
The use of cyclamates as sweeteners caused a surge of reformulation of soft drinks in which sucrose was partially substituted either by cyclamate, or saccharin or by a mixture of both. When the use of cyclamates was banned, formulators had to fall back on the use of saccharin alone. Today, the only legally permitted artificial sweeteners in the form of saccharin calcium and saccharin sodium are allowed. It is usual to use a mixture of sugar and saccharin in soft drinks and the legal limits for each of them are clearly stated in the country's regulations. Aspartame is a low-calorie, artificial sweetener that is 200 times as sweet as natural sugar.

Aspartame is recommended by FSSAI for use in soft drinks with a maximum limit of 700 ppm.



Preservatives

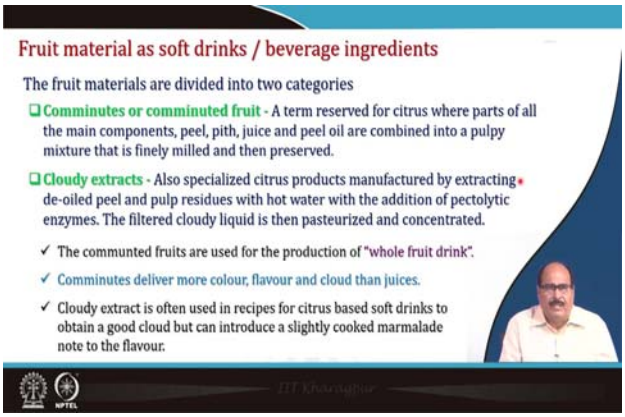
The permitted preservatives are given in the table. The category, 'soft drinks for direct consumption, that is consumption after dilution not otherwise specified in this schedule, including the comminuted citrus bases for the preparation of soft drinks' includes the preservatives like sulphur dioxide and its permitted concentration is 350 ppm, benzoic acid-800 ppm, methyl 4 hydroxy benzoate-800 ppm and ethyl 4 hydroxy benzoate, propyl 4 hydroxy benzoatet both-800 ppm. The category of the soft drink, which is for consumption without any dilution, not otherwise specified in this schedule, includes the same level of the preservative like sulphur dioxide, whose level is fixed at upper limit is 70 ppm and other are 160 ppm.



Process flowchart of soft drink manufacturing

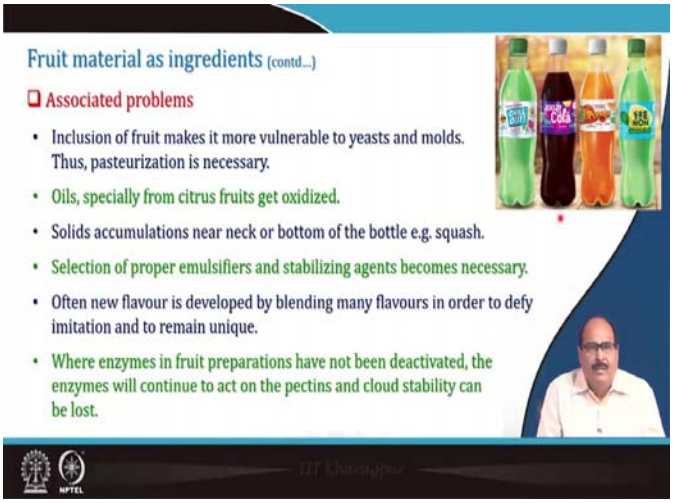
This is the process flowchart for soft drink manufacturing. In the soft drink manufacturing normally, there are two methods. One is that, a syrup is made by dissolving the sugar. Then the flavour concentrate is separately made. It contains all the flavouring materials, colouring components, acid etc. and the preservatives. The sugar syrup is made separately and then the

flavour concentrate is added into it. It is dissolved and then it is diluted and finally carbon dioxide is added into the diluted syrup, that is one way. This water is carbonated. Then in the prepared sugar syrup containing flavourings etc., carbonated water is added. Most of the standard manufacturing company keep the composition of the flavour concentrate, as highly guarded secret. They produce this syrup and the flavour concentrates are distributed in different countries and locations, where they have the carbonation facility, dilution facility, where liquid water is added as for the formulation and carbon dioxide is passed to these beverages to be carbonated.



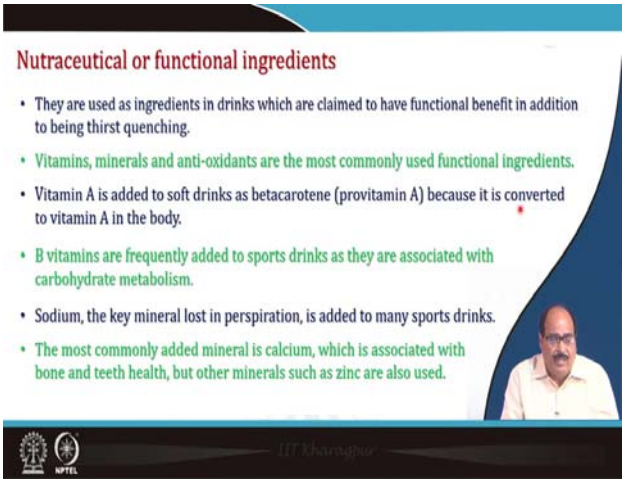
Fruit material as soft drinks/beverage ingredients

The fruit materials are divided into two categories. They are of two types like comminutes or comminuted fruits that is a term reserved for citrus, where parts of all the main components like peel, pith, juice, and peel oil etc. are combined into a pulpy mixture that is finely milled and then preserved and this is used as an ingredient for mixing in the beverage. The cloudy extracts are also a specialized citrus product manufactured by extracting de-oiled peel and pulp residues with hot water with the addition of pectolytic enzymes. The filtered cloudy liquids are then pasteurized and concentrated and this is used in the beverage manufacture. The comminuted fruits are used for the production of 'whole fruit drink'. Comminutes deliver more colour, flavour, and cloud than juices. The cloudy extracts are often used in recipes for citrus based soft drinks to obtain a good cloud but can introduce a slightly cooked marmalade note to the flavour.



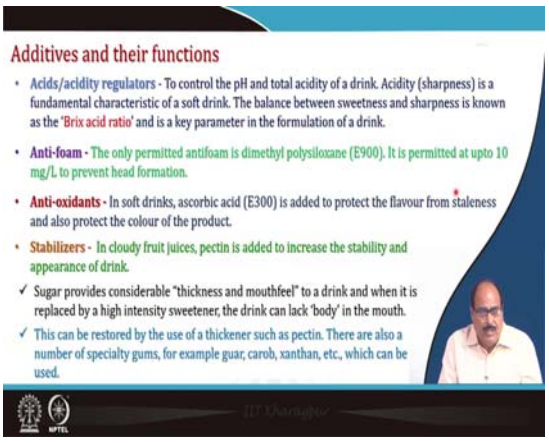
Associated problems

When the fruit juice or fruit pulp is to be used in a soft drink or in a beverage, there are certain issues which need to be resolved like inclusion of fruit makes it more vulnerable to yeasts and molds. If the juice or liquid beverage is not properly pasteurized, then these yeast and molds may create problems. Oils, especially from citrus fruits get oxidized. Solids accumulations near neck or bottom of the bottle like squash. Selection of proper emulsifiers and stabilizing agents becomes necessary. Often new flavour is developed by blending many flavours in order to defy imitation and to remain unique. When the enzymes in fruit preparations have not been deactivated, the enzymes will continue to act on the pectins and the cloud stability can be lost.



Nutraceutical or functional ingredients

They are used as an ingredient in drinks, which are claimed to have functional benefits in addition to being thirst quenching. Vitamins, minerals, antioxidants are the most commonly used functional ingredients and they are found in the natural fruit, vegetable juices. Vitamin A is added in soft drinks as beta carotene or provitamin A because it is converted to vitamin A in the body. B vitamins are added frequently into the sport drinks. The most commonly added mineral is calcium, which is associated with the bone and teeth health, but other minerals such as zinc are also used. Sodium, which is the key mineral, that is lost during the perspiration process, is also added into the sports drinks.



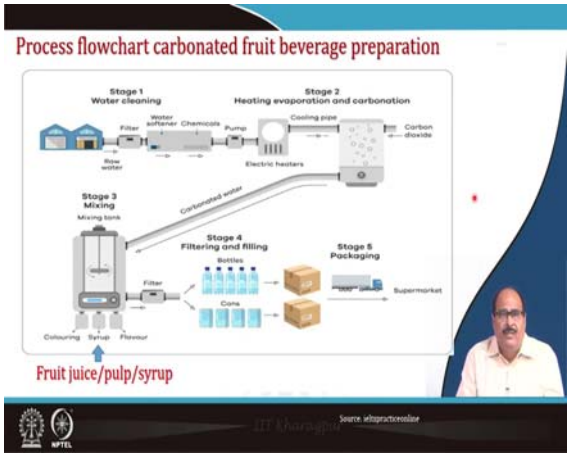
Additives and their functions

Acids and acidity regulators are used to control the pH and total acidity of a drink. Acidity is a fundamental characteristic of any soft drink. The balance between sweetness and sharpness is known as the 'Brix acid ratio' and it is the key parameter to the formulation of a soft drink.

Anti-foaming agent- The only permitted anti foaming agent is dimethyl polysiloxane (E900). It is permitted up to 10 mg/L to prevent head formation.

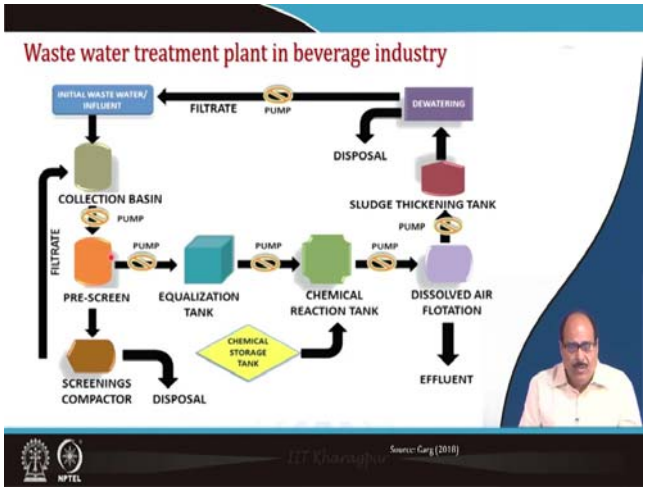
Antioxidants in soft drinks, like ascorbic acid is added to protect the flavour from staleness and to protect the colour of the product.

Stabilizers-In cloudy fruit juices, pectin is added to increase the stability and appearance of a soft drink. Sugar provides considerable "thickness and mouthfeel" to a drink and when it is replaced by a high intensity sweetener. The drink can lack the 'body' in the mouth. This can be resorted by the use of a thickener such as pectin. There are also a number of the specificity gums, for example gums like guar gum, carob, xanthan gum etc. can also be used as a stabilizer agent or thickening agent.



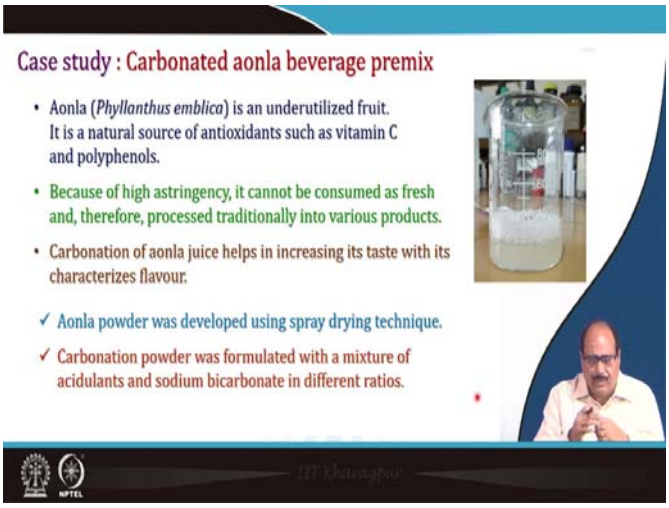
Process flowchart carbonated fruit beverage preparation

This is the process flow chart for the fruit beverage preparation. Water softening in the stage 1 and then heating evaporation and carbonation in the stage 2 are done. The water is carbonated in the secondary stage of mixing and in the third stage, carbonated water is coming to the mixing tank. In the mixing tank, the carbonated water is mixed with a colouring material, syrup, or flavour. Fruit juice and pulp are also added in this stage. Finally, the whole mixture is filtered properly, homogenized, and sent to the packaging unit.



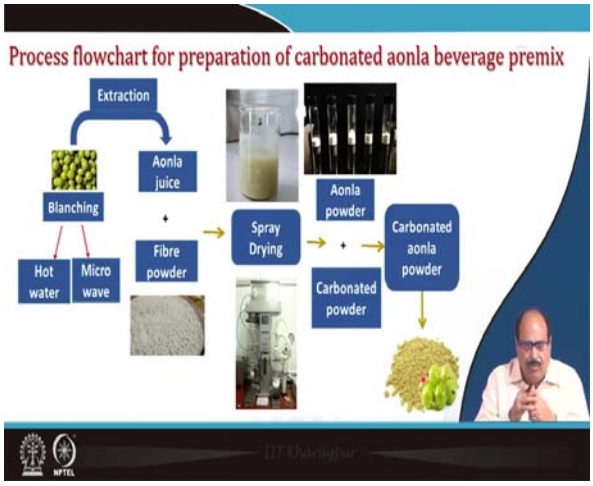
Waste water treatment plant in beverage industry

In the beverage unit for cleaning, a lot of waste influent water is generated. Most of these beverage manufacturers, the beverage industries have their wastewater treatment plant to optimize the water use or to improve the water use efficiency. This is a schematic of a wastewater treatment. The collected water is taken, it is prescreened, and then sent to the equalization tank, where there is salted chemicals reactions and tanks. The impurities, the sludges are dissolved in this as they are removed, through the sludge thickening tank, they are removed. It is recirculated again. After treatment, the effluent is collected here. So, this is in brief about wastewater treatment.



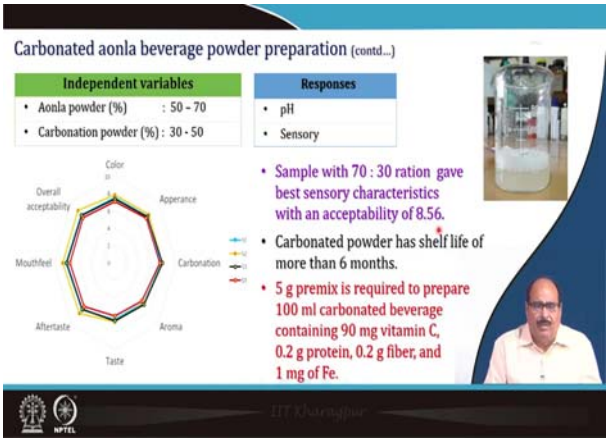
Case study: Carbonated aonla beverage premix

Aonla is an underutilized fruit. It is a natural source of antioxidants like vitamin C and polyphenols etc. Because of high astringency, and because of its bitter taste, it cannot be consumed as fresh and therefore, it is processed traditionally into various products. The carbonated aonla juice helps in increasing the taste with its characteristic flavour. Aonla powder was developed using spray drying technique. Carbonation powder was formulated with a mixture of acidulants and sodium bicarbonate in different ratios. These aonla powder and carbonation powders were mixed to get the carbonated aonla drink.



Process flowchart for preparation of carbonated anola beverage premix

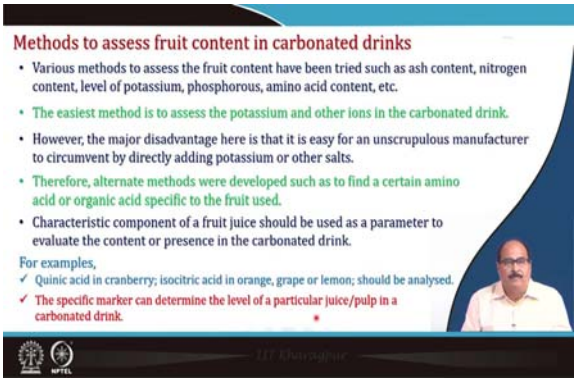
This is the process flowchart for the preparation of carbonated aonla beverage premix. The aonla is taken. It is blanched using either hot water or microwave. After blanching it, make it soft. Then the juice is extracted. After the extraction of juice, it is dried and then ground into fine powder. Some instantization treatment to the powder is given then. This instantized fiber powder and aonla juice are together mixed in a particular proportion and spray dried. Spray dried powder is obtained. The spray dried aonla powder and the carbonation powder are developed separately. Both are mixed in the proper proportion and the carbonated aonla powder premix is obtained. This can be dissolved in water, lukewarm water, or normal water. In plain water, it has a good solubility, good reconstitution. A very good tasty beverage is obtained in this way.



Carbonated aonla beverage powder preparation

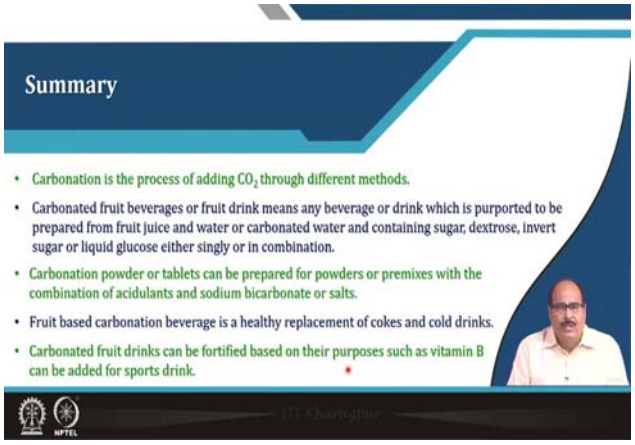
In the experiment, various combinations and permutations were used. The aonla powder was varied from 50 to 70% and carbonation powder from 30 to 50%. It was measured for the pH and sensory characteristics like colour, mouthfeel, taste, after taste, taste, aroma etc. and then it was formed finally. The sample with ratio of 70:30, gave best sensory characteristics with an acceptability of 8.56. The carbonated powder was found to have shelf life of about more than 6 months. 5 gram of premix is required to prepare 100 ml carbonated beverage containg 90 mg vitamn C., 0.2 g protein, 0.2 g fiber, and 1 mg Fe. 5 grams of that is required to

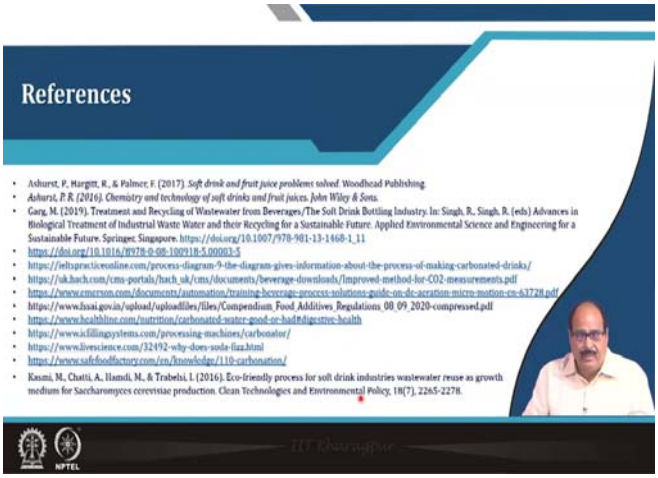
prepare 100 ml of carbonated beverage, aonla beverage, which contains 90 milligram of vitamin C, 0.2 grams protein, 0.2 grams fiber and 1 milligram of iron you can see. So, it becomes a very good nutritive and refreshing beverage or it can be considered as health beverage.



Methods to assess fruit content in carbonated drinks

There are various methods to assess the fruit content like the ash content, and nitrogen content or level of the minerals like potassium, phosphorus, amino acid etc. The easiest method normally is to assess the potassium and other ions in the carbonated drink. However, the major disadvantage of this method is that it is easy for an unscrupulous manufacturer to circumvent by directly adding potassium or other salts from outside. But it will be difficult to know that whether the potassium or other salts are from the fruit juice or it has been added from outside. So, alternate methods were developed to take care of such problems. The characteristic component of the fruit juice should be used as a parameter to evaluate the content or presence in the carbonated drink. So, that can be used as a marker parameter to evaluate the content of the presence of this particular juice in the drink. For examples, Quinic acid in Cranberry, isocitric acid in orange, grape or lemons should be analyzed. So, a specific marker can determine the level of a particular juice or pulp in a carbonated drink that should be used.





In summary, it can be said that carbonated soft drinks are very important category of beverages. These soft drinks available in the market do not have any nutritional value except that of the sucrose or sugar, which is added as a sweetening agent, otherwise they are taken as the thirst quenching drinks. But when these fruits or vegetable juices, pulp etc. are added in the beverages, they become a source of micronutrient. The nutritional value and health value of these drinks are increased. Such carbonated beverages can be used as a health drink, as a supplement for nutrition purposes. But adding the natural fruit juices pulps, it may invite certain problems, which must be resolved. There should be standard methods for proper mixing of the fruit ingredients that should not be interfering with the other components in this soft drink or beverage etc. So, the carbonated fruit drinks can be fortified based on their purposes, either by vitamins or other minerals etc. It can be promoted in the market as a health drink. The references are mentioned above.