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Sugars are simple carbohydrates which are classified as monosaccharides namely glucose, fructose, galactose and disaccharides namely sucrose, maltose and lactose. Sugar plays a very important role in any cuisine. Additionally it provides energy to the body as it is form of carbohydrate.

13.1 Sources and properties of sugars :

The main source of sucrose are sugar cane (10-12%), beetroot (12-18%), honey and some fruits and vegetable. Natural sources of monosaccharides and disaccharides are indicated in table 13.1.

13.1 Table: Natural sources of sugar

Sugar	Natural sources
Monosaccharide	
Glucose or Dextrose	Fruit and plant juices, honey, part of cane and beet sugar
Fructose or fruits sugar	Fruits, fruits juices, honey, part of cane and beet sugar
Galactose	Milk and milk product
Disaccharides	
Sucrose	Sugar cane, beet root, vegetables like carrots, ripe fruit
Lactose	Milk and milk products
Maltose	Wheat, barley, etc.

Properties of sugar

- Hygroscopic nature:** Sugars have the ability to absorb moisture from surroundings. So sugar should be stored in dry place, in airtight containers, that's why sugar based products become sticky if not properly stored. Fructose has the highest hygroscopic power.
- Solubility:** Sugars are soluble carbohydrates. Based on solubility the sugars can be arranged in descending order as- fructose, sucrose, glucose, maltose and lactose.
- Sweetness index:** All sugars differ in their sweetness from each other. Generally sucrose is considered as standard with value 1.0. All other sugars are compared with this standard and their sweetness index is considered as shown in figure Table 13.2.

Table 13.2 Sweetness index

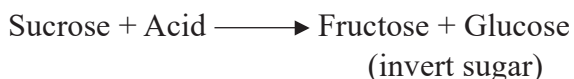
Sugar	Sweetness
Sucrose	1.0 (Standard value)
Glucose	0.7
Fructose	1.7
Maltose	0.3 to 0.6
Sorbitol	0.5 to 0.6
Mannitol	0.4 to 0.6
Aspartame	200 times

4. **Fermentation:** Sugar (Sucrose) undergoes fermentation easily by the biological process. In which enzymes from yeast are involved to convert into glucose, fructose, or maltose, and last products carbon dioxide and alcohol. This property is very much important in bakery industry, alcoholic beverages, other fermented products like *idli*, *dosa*, etc.

5. **Hydrolysis reactions:** These reactions are categorized in two types

A. **Acid Hydrolysis**

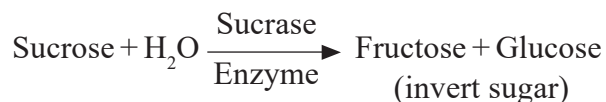
Sugar on reaction with acids hydrolyses to a new product.



Heat is an accelerator in the hydrolysis by acid

B. **Enzyme Hydrolysis**

Sucrase enzyme hydrolyses sucrose to yield a liquid invert sugar.



6. **Heat Treatment:** Sugar can be treated with heat in two ways either by dry heat (caramelisation) or wet heat treatment. (Crystallization)

Do You Know?

- Sugar, which is regularly used in sweet preparations is chemically known as sucrose.
- Molasses is the byproduct of sugar cane industry used for alcohol production.

13.2 Effect of dry heat on sugar-caramelization

Caramelisation is the complex process in which when sugar is heated without any water or liquid where various physical and chemical changes take place.

Definition : When dry heat is applied to sugar crystals and it reaches a temperature above its melting point, the sugar melts and decomposes to form a colourless liquid which on continuous heating changes its colour to yellow, light brown and finally dark brown. This decomposed sugar is known as caramel and this process is known as Caramelisation.

Characteristics:

- Caramel sugar is brown in colour.
- It has pungent and strong flavor and slightly bitter taste.
- It is less sweet than original sugar.
- It is in a crystalline state, which is soluble in water.

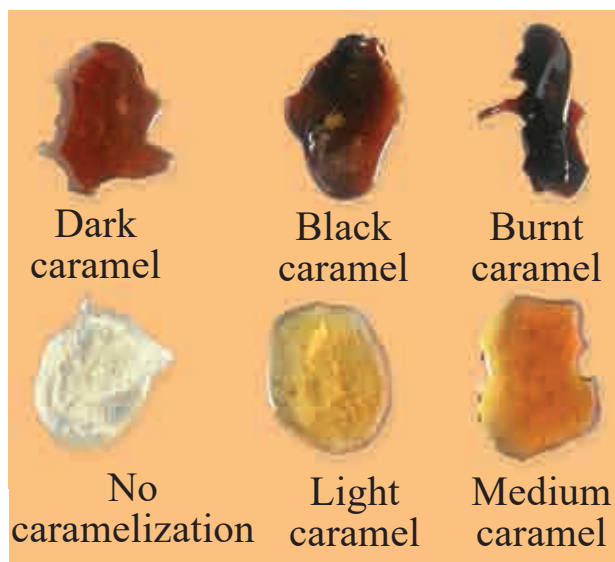


Fig. 13.2 : Caramelisation of sugar

- On cooling, caramel turns solid and brittle and has transparent shiny appearance.
- Temperature of caramelisation depends on type of sugar. Fructose caramelizes at 110 °C, sucrose at 170°C and maltose at 180°C.
- It can be used as a flavouring in puddings and desserts, as a filling in bonbons, or as a topping for ice cream and custard.

Uses of Caramel in cookery

- Decoration:** Caramel is used to decorate desserts like custard and puddings. It is also used on cakes as a decorative agent.
- Binding agents:** Since caramel solidifies on cooling, it can be used as a binding agent. When the hot liquid caramel is mixed with other food ingredients and allowed to cool it turns solid, thereby holding the ingredients together. This is seen in sugar brittles such as *til* or groundnut *chikki* where caramel acts as binding agent.
- Flavour and Taste :** Addition of caramel to fruit cake and christmas cake imparts a desirable flavour and taste to the preparation.
- Colour :** Since the caramel is brown in colour, it gives a brown natural colour to preparations like fruit cake, and christmas cake.
- Variations in texture :** Solid pieces of caramel in chocolates and ice creams brings variation in the texture of the products.
- Coating agents :** In preparations like caramel popcorn, caramel acts as a coating agent and improves the appearance, colour and flavour.

Activity – 1

Aim: - To find out the effect of dry heat on sugar- caramelisation

Materials needed:- Sugar, pan, burner

Method:-

1. Take a pan, add sugar to it.
2. Heat on a slow flame.

3. Sugar will start melting into a colourless liquid.
4. Slowly the colour will start becoming yellow and then darken.
5. Take out from flame and let it cool.
6. Crush the caramel into small chunks and use it for garnishing ice-creams, etc.

Conclusion: Caramel helps to improve texture

13.3 Effect of moist heat on sugar-crystallization:

Sugars are soluble in water due to which they impart various degrees of sweetness to different products like tea, coffee, syrups. etc. Solubility increases with increase in temperature. This property is extremely useful in preparation of sweets like *rawa laddu*, *burfi*, *balushahi* and sugar coated groundnuts.

In order to understand how and why crystals are formed in a sugar solution, let us first understand the types of solution.

Solution: Solution is made up of solute and solvent.

Solute + Solvent $\longrightarrow$ Solution
Sugar Water Sugar water solution

Types of solution:

- 1. Unsaturated solution:** When a solution has the capacity to dissolve more solute at the ambient temperature, then this type of solution is called as unsaturated solution.
- 2. Saturated solution:** When a solution does not have the capacity to dissolve any more solute at the ambient temperature, then this type of solution is called as saturated solution.
- 3. Supersaturated solution:** At a given temperature, if more sugar is added to a saturated solution, it will become supersaturated.

Definition: When a saturated sugar solution cools down to form a supersaturated solution, the extra solute precipitates in the form of crystals. This process of crystal formation is called Crystallization of sugar.

e.g. balushahi, sugar coated nuts and Fudge etc.

Factors affecting crystallization :

1. Temperature of crystallization:

Temperature at which crystallization occurs, affects size of the crystals. Bigger crystals are formed if crystallization occurs at a higher temperature. At a lower temperature smaller crystals are formed.

2. Agitation or stirring:

If a cooling supersaturated solution is not stirred at all and left to stand, crystallization starts, however, the crystals formed would be large and less in number. Stirring the solution favours the formation of small and more crystals. Therefore, stirring results in small sized more number of crystals resulting in soft and smooth products. Agitation also incorporates air and gives a light texture to the products.

3. Interfering substances:

Substances such as glucose, honey, milk, fat, lemon juice, citric acid and enzymes decrease the process of crystallization. These substances are adsorbed by the surface of the crystals and retard crystal growth. This results in formation of tiny crystals and retard crystals but more in number which gives a soft and smooth product.

Do You Know?

Sugar industry is the 2nd largest agro-processing industry in India. Maharashtra and Uttar Pradesh accounts for major sugar producing states.

13.4 Uses of sugar in cookery

- Sweetening agent:** Food preparation like tea, coffee, milk shake, *kheer*, *gulabjam* and puddings would not be palatable without sugar.
- Binding agent:** In preparation like *rawa-besan laddu* and *vadi*, saturated sugar solution is prepared. When this solution cools down, sugar crystals are formed. While crystallization is taking place, other ingredients are bound together to give a particular shape.
- Coating agent:** In preparation like sugar coated groundnuts, *balushahi*, sugar coated *shankarpali*, preparations are dipped in concentrated sugar solution. On cooling, crystals are formed which coat the surface of the products.
- Decorating agents:** Sugar is the one of the important ingredients used for the icing of cakes and pastries.
- Preservative:** In products like jam, jelly and *muramba*, sugar is added in sufficient amounts to preserve the products. About 70% sugar in the preparation is sufficient to preserve the product.

Points to remember

- Most commonly used sugar is sucrose
- Sugar is of very hygroscopic nature therefore it should be stored in airtight containers / bags.
- Fructose is the sweetest and most soluble sugar
- Effect of dry heat on sugar is known to form caramelization product.
- Effect of moist heat on sugar is known to develop crystallisation product.
- Solution is made up of solute and solvent. Solution are of three types-unsaturated, saturated and super saturated

Exercise

Q. 1 (a) Select the most appropriate option:

- i. _____ is most commonly used sugar.
(Sucrose, Maltose, Glucose)
- ii. Application of moist heat to sugar results in _____.
(Caramelisation, Inversion, Crystallization)
- iii. is the byproduct of sugar cane industry used for alcohol production.
(Molasses, Oil, Water)

(b) Match the following:

A		B	
i.	Caramel	a.	Rawa laddu
ii.	Crystallisation	b.	Lactose
iii.	Least soluble sugar	c.	Sugar chikki
iv.	Sweetest sugar	d.	Alcohol making
v.	Molasses	e.	Sucrose
		f.	Fructose

(c) State whether the following statements are true and false:

- i. Sucrose is the most regularly used sugar.
- ii. Lactose is found in fruits and vegetables.
- iii. By fermentation sugar is converted into alcohol and carbon dioxide.
- iv. Effect of moist heat on sugar is known as caramelization.

Q.2 Give reasons

- i. Why sugar is stored in air tight containers?
- ii. How sugar helps in preserving jam?
- iii. Which property of sugar is important in bakery and Why?

Q. 3 Answer the following in brief

- i. Name the effect of dry heat on sugar?
- ii. Name the effect of moist heat on sugar.
- iii. Define caramelisation.
- iv. Define crystallisation.

Q.4 Long answer question

- i. Explain various properties of sugar.
- ii. Explain uses of caramel.
- iii. Explain various types of solution.
- iv. Describe the various factors affecting Crystallization.
- v. Illustrate the uses of sugar in cookery.

❖ Project :

Select any ten recipes where Sugar is used as the main ingredient. Prepare an attractive booklet of these recipes with their ingredients, amounts used and method of preparation.

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