EXPERIMENT

Aim

To test the presence of Carbohydrate in the given food sample.

Theory

Carbohydrates are polyhydroxy aldehydes, polyhydroxy ketones, their derivatives and the substances which yield them on hydrolysis. The name carbohydrate is used for the compounds having the general formula, $C_x(H_2O)_y$. These are called carbohydrates because they can be treated as hydrates of carbon.

Material Required

Test tubes, burner, glass rod, water bath, Glucose, sucrose (cane-sugar), lactose (milk-sugar), starch, Molisch's reagent, Fehling's solution, Benedict's solution and iodine solution.

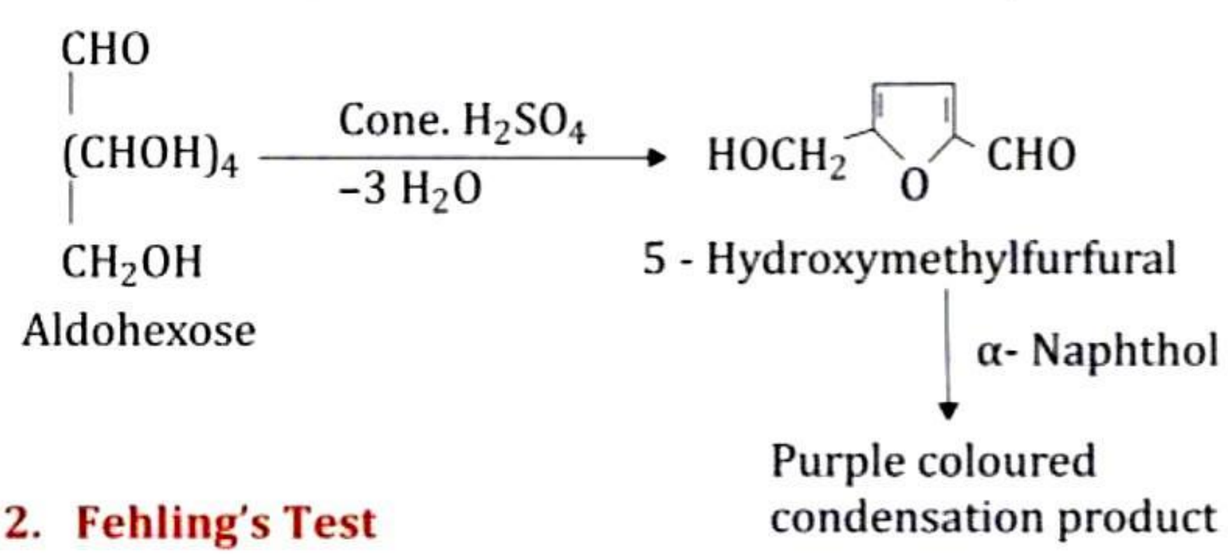
Procedure

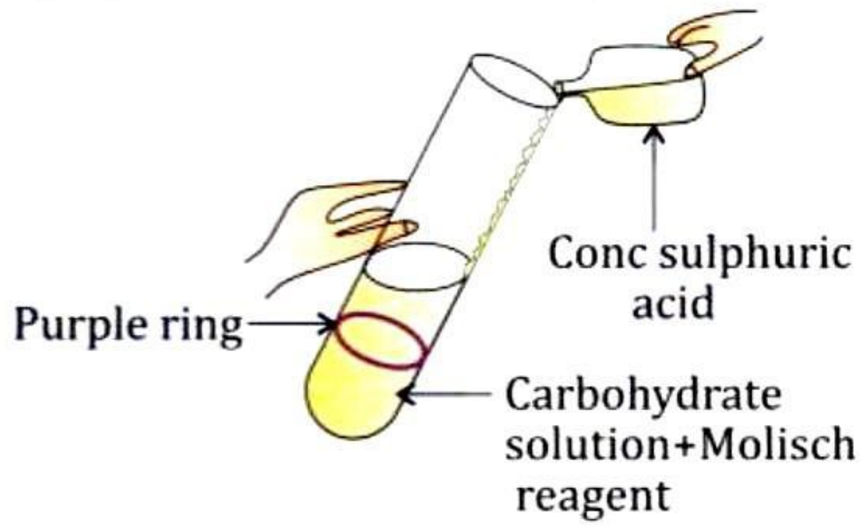
1. Molisch's Test

Carbohydrates of all classes give this test.

Take 1-2 ml of aqueous solution of carbohydrate (suspension in case of starch) and add few drops of Molisch's reagent (1% alcoholic solution of 1-naphthol). Put one ml of conc. H_2SO_4 slowly along the side of the test tube. A red purple ring is produced at the junction of two layers.

Chemistry of the test: Carbohydrates form furfural or 5-hydroxymethylfurfural on reaction with conc. H_2SO_4. which then condenses with α-naphthol to form purple violet condensation product.





2. Fehling's Test

Take 2 ml of aqueous solution of carbohydrate (nearly 5%) and add 1-2 ml each of Fehling's solution A and B. Keep the test tube in boiling water bath. Reddish ppt. indicates the presence of a reducing sugar.

Preparation of Fehling's solution

Solution A.

Dissolve 17.5 g of $CuSO_4$ in 250 ml of distilled water containing few drops of H_2SO_4.

Solution B.

Dissolve 86.5 g of sodium potassium tartrate and 30 g NaOH in 250 ml of distilled water.

$$CuSO_4 + 2NaOH \longrightarrow \underset{\text{Deep blue}}{Cu(OH)_2} + Na_2SO_4$$

$$Cu(OH)_2 \longrightarrow CuO + H_2O$$

$$\begin{array}{l}CHO\\|\\(CHOH)_4\\|\\CH_2OH\\\text{Glucose}\end{array} + \underset{\text{Copper(II) Oxide}}{2CuO} \xrightarrow{\triangle} \begin{array}{l}COOH\\|\\(CHOH)_4\\|\\CH_2OH\\\text{Gluconic acid}\end{array} + \underset{\text{Red ppt. Copper(I) Oxide}}{Cu_2O\downarrow}$$

3. Benedict's Test

To 1-2 ml of aqueous solution of carbohydrate in a test-tube add 1-2 ml of Benedict's reagent. Keep the test-tube in a boiling water bath. Reddish ppt. indicates the presence of reducing sugar.

Preparation of Benedict's Reagent

Dissolve 17.3 g of sodium citrate and 10 g of anhydrous Na_2CO_3 in about 80 ml of distilled water. Heat if necessary. Dissolve 1.73 g of copper sulphate in 10 ml of water. Mix the two and make the volume 100 ml by adding water.

$$\begin{array}{l}CHO\\|\\(CHOH)_4\\|\\CH_2OH\\\text{Glucose}\end{array} + 2Cu(OH)_2 + NaOH \xrightarrow[\text{ions}]{\text{Tartrate}} \begin{array}{l}CHO\\|\\(CHOH)_4\\|\\CH_2OH\\\text{(Sodium salt of gluconic acid)}\end{array} + 3H_2O + \underset{\text{Red ppt.}}{Cu_2O\downarrow}$$

Note: Chemistry of this test is the same as that of Fehling's test. Here citrate ions are used as complexing agent.

4. Tollen's Test

Take 2-3 ml of aqueous solution of carbohydrate in a test tube. Add to it 2-3 ml of Tollen's reagent. Keep the test tube in a boiling water bath for 10 minutes.

A shining silver mirror indicates the presence of reducing carbohydrate.

Preparation of Tollen's Reagent

$$AgNO_3 + NH_4OH \rightarrow NH_4NO_3 + AgOH$$

$$2AgOH \rightarrow Ag_2O + H_2O$$

$$Ag_2O + 2NH_4OH \rightarrow 1[Ag(NH_3)_2]OH + 3H_2O$$

$$\begin{array}{l}CHO\\|\\(CHOH)_4\\|\\CH_2OH\\\text{Glucose}\end{array} + Ag_2O \xrightarrow{NH_4OH} \begin{array}{l}COOH\\|\\(CHOH)_4\\|\\CH_2OH\\\text{Gluconic acid}\end{array} + \underset{\text{Silver mirror}}{2Ag}$$

Add NaOH solution to $AgNO_3$ solution. Then add NH_4OH solution drop wise till the ppt. just dissolve. The clear solution obtained is Tollen's reagent.

5. **Iodine Test (For starch only)**

To the aqueous suspension of the sample, add 1-2 drops of iodine solution.
Appearance of blue colouration indicates the presence of starch.

Observations

Table.1.

S. No.	Test	Glucose	Lactose	Sucrose	Starch
1.	Taste	Sweet	Sweet	Sweet	Tasteless
2.	Solubility	Soluble	Soluble	Soluble	Insoluble
3.	Molisch's test	Purple ring	Purple ring	Purple ring	Purple ring
4.	Fehling's test	Red ppt.	Red ppt.	Negative	Negative
5.	Benedict's test	Red ppt.	Red ppt.	Negative	Negative
6.	Iodine test	Negative	Negative	Negative	Blue colour

Results

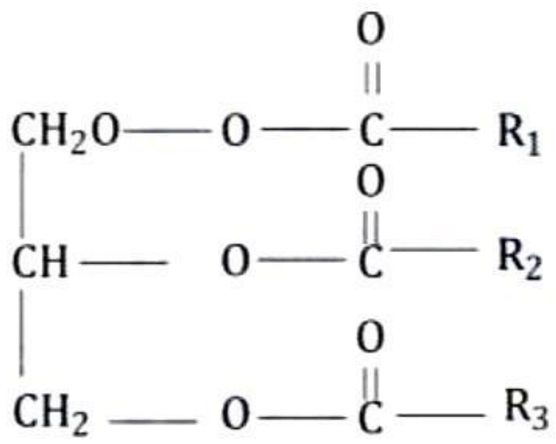
In case of Fehling's test, the formation of orange-red colored precipitate and brick-red ppt. in case of Benedict's test due to the formation of Cu(I) oxide (Cu_2O) indicates the presence of reducing sugar. Whole in case of Tollen's test, the silver mirror formed on the inner walls of the test tube shows the presence of reducing sugar.

Precautions

1. While performing Tollen's test, do not heat the test tube directly otherwise it may cause explosion.
2. The reagents used to carry out the tests must be freshly prepared.

Oils And Fats

Oils and fats are triesters of glycerol with higher fatty acids. Their structure can be represented as:



R_1, R_2 and R_3 are long chain saturated or unsaturated aliphatic groups that may be same or different. Some examples of fatty acids are $C_{17}H_{25}COOH$ (Stearic acid), $C_{15}H_{31}COOH$ (palmitic acid) (they both are saturated acids) and oleic acid $C_{17}H_{32}COOH$ (unsaturated acid).
Triglycerides with higher proportion of unsaturated fatty acids are liquid at ordinary temperature and are called oils.

VIVA VOCE

Q 1. What is the general chemical formula for carbohydrates?

Ans. The general chemical formula for carbohydrates is $(CH_2O)_n$, where "n" represents the number of carbon atoms.

Q 2. Explain the principle behind the Benedict's test for reducing sugars.

Ans. Benedict's test is based on the reduction of copper(II) ions to copper(I) ions by reducing sugars. The color change from blue to orange or red indicates the presence of reducing sugars.

Q 3. How does the iodine test detect the presence of starch in a food sample?

Ans. Iodine forms a complex with starch, resulting in a color change from yellow-brown to blue-black. This color change indicates the presence of starch.

Q 4. Describe the procedure for performing the Benedict's test.

Ans. The Benedict's test involves mixing the food sample with Benedict's reagent and heating the mixture. The appearance of a color change indicates the presence of reducing sugars.

Q 5. Can you name some common reducing sugars found in food?

Ans. Common reducing sugars include glucose, fructose, maltose, and lactose.

Q 6. Why is it important to use a control in carbohydrate testing experiments?

Ans. A control is essential to compare the results and ensure that any observed color change is specific to the tested carbohydrate and not due to other factors.

Q 7. Why is it important for humans to consume a balanced diet containing carbohydrates?

Ans. Carbohydrates are a primary source of energy for the body, providing fuel for various physiological functions.

Q 8. Explain the role of enzymes in carbohydrate digestion.

Ans. Enzymes, such as amylase, break down complex carbohydrates into simpler sugars during the process of digestion.

Q 9. What reagent is commonly used to test for the presence of carbohydrates?

Ans. Benedict's solution is commonly used to test for the presence of reducing sugars, which are a type of carbohydrate.

Q 10. Describe the principle behind the Benedict's test for carbohydrates.

Ans. Benedict's solution contains copper ions, which are reduced by reducing sugars in the presence of heat, forming a red precipitate of copper(I) oxide.

Q 11. What color change indicates a positive result in the Benedict's test?

Ans. A positive result is indicated by a color change from blue (the color of the Benedict's solution) to green, yellow, orange, or red, depending on the concentration of reducing sugars present.

Q 12. Can all carbohydrates be detected using the Benedict's test?

Ans. No, not all carbohydrates can be detected using the Benedict's test. Only reducing sugars, such as glucose and fructose, can react with Benedict's solution to produce a positive result.

Q 13. How can you ensure the accuracy of the Benedict's test?

Ans. To ensure accuracy, it's essential to use a control solution with a known concentration of reducing sugars, follow the correct procedure, and perform appropriate controls and repetitions.