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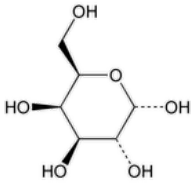
Galactose



$C_6H_{12}O_6$ 180.16

D-Galactopyranose CAS RN®: 59-23-4.

DEFINITION

Change to read:

▲Galactose contains NLT 98.0% and NMT 102.0% of D-galactopyranose ($C_6H_{12}O_6$), calculated on the anhydrous basis. It is obtained either as one of the products of the metabolism of lactose, a naturally occurring sugar in dairy products, by the digestive enzyme lactase, or from arabinogalactans isolated from a plant-derived source.▲ (NF 1-Aug-2020)

IDENTIFICATION

Change to read:

• **A. Spectroscopic Identification Tests ⟨197⟩, *Infrared Spectroscopy*: 197K**

▲[Note—Disregard any peaks at about 875 and 889 cm^{-1}.]▲ (NF 1-Aug-2020)

Delete the following:

▲• **B. Thin-Layer Chromatographic Identification Test ⟨201⟩**

Solution A: Methanol and water (60:40)

Standard solution A: 500 µg/mL of USP Galactose RS in *Solution A*

Standard solution B: 500 µg/mL each of USP Galactose RS, USP Dextrose RS, and USP Lactose Monohydrate RS in *Solution A*

Sample solution: Dissolve 10 mg of Galactose in 20 mL of *Solution A*.

Chromatographic system

(See *Chromatography ⟨621⟩, Thin-Layer Chromatography*.)

Application volume: 2 µL

Developing solvent system: Propanol and water (85:15)

Spray reagent: 0.5 g of thymol in a mixture of alcohol and sulfuric acid (95:5)

System suitability

Sample: *Standard solution B*

Suitability requirements

Resolution: There must be three clearly resolved spots in the chromatogram for *Standard solution B*.

Analysis

Samples: *Standard solution A*, *Standard solution B*, and *Sample solution*

Develop the plate in an unsaturated tank. After the solvent front has moved over 15 cm, remove the plate from the tank. Dry the plate with warm air, then spray the plate with *Spray reagent*. Heat for 10 min in an oven at 130°.

Acceptance criteria: The R_F of the principal spot of the *Sample solution* corresponds to that of *Standard solution A*. ▲ (NF 1-Aug-2020)

Add the following:

▲• **B. Chromatographic Identity**

Analysis: Proceed as directed in the *Assay*.

Acceptance criteria: The retention time of the major peak of the *Sample solution* corresponds to the galactose peak of the *Standard solution*, as obtained in the *Assay*.▲ (NF 1-Aug-2020)

Add the following:

▲• **C.**

Sample solution: 10 mg/mL

Analysis: To 10 mL of the *Sample solution* add 3 mL of alkaline cupric tartrate TS and heat.

Acceptance criteria: An orange or red precipitate is formed.▲ (NF 1-Aug-2020)

ASSAY

Add the following:

▲• **Procedure**

Mobile phase: 0.009 N sulfuric acid

System suitability solution: 10 mg/mL of USP Galactose RS and 0.2 mg/mL each of USP Arabinose RS, galacturonic acid, [1]USP Dextrose RS, and USP Anhydrous Lactose RS in *Mobile phase*

[NOTE—Use plastic HPLC vials for the *Standard solution* and *Sample solution*.]

Standard solution: 10 mg/mL of USP Galactose RS in *Mobile phase*

Sample solution: 10 mg/mL of Galactose in *Mobile phase*

Chromatographic system

(See *Chromatography ⟨621⟩, System Suitability*.)

Mode: LC

Detector: Refractive index

Column: Two 7.8-mm × 30-cm columns in tandem; 9-µm packing L17

Temperatures

Column: 35°

Detector: 40°

Flow rate: 0.25 mL/min

Injection volume: 25 µL

Run time: 70 min

System suitability

Samples: *System suitability solution* and *Standard solution*

[NOTE—The relative retention times for lactose, galacturonic acid, dextrose, galactose, and arabinose are listed in *Table 1*.]

Suitability requirements

Resolution: NLT 3.0 between the lactose and galacturonic acid peaks; NLT 1.5 between the galacturonic acid and dextrose peaks; NLT 2.0 between the dextrose and galactose peaks; NLT 3.0 between the galactose and arabinose peaks, *System suitability solution*

Relative standard deviation: NMT 1.0%, *Standard solution*

Analysis

Samples: *Standard solution* and *Sample solution*

Calculate the percentage of galactose in the portion of Galactose taken:

$$\text{Result} = (r_U/r_S) \times (C_S/C_U) \times 100$$

r_U = peak area of galactose from the *Sample solution*

r_S = peak area of galactose from the *Standard solution*

C_S = concentration of USP Galactose RS in the *Standard solution* (mg/mL)

C_U = concentration of Galactose in the *Sample solution* (mg/mL)

Acceptance criteria: 98.0%–102.0% on the anhydrous basis▲ (NF 1-Aug-2020)

IMPURITIES

Add the following:

▲• **Related Substances**

Mobile phase, System suitability solution, Sample solution, and **Chromatographic system:** Proceed as directed in the *Assay*.

Sensitivity solution: 5 µg/mL each of USP Arabinose RS, galacturonic acid, [1]USP Dextrose RS, and USP Anhydrous Lactose RS in *Mobile phase*.

System suitability

Samples: *System suitability solution* and *Sensitivity solution*

Suitability requirements

Resolution: NLT 3.0 between the lactose and galacturonic acid peaks; NLT 1.5 between the galacturonic acid and dextrose peaks; NLT 2.0 between the dextrose and galactose peaks; NLT 3.0 between the galactose and arabinose peaks, *System suitability solution*

Signal-to-noise ratio: NLT 10 for the lactose, galacturonic acid, dextrose, and arabinose peaks, *Sensitivity solution*

Analysis

Sample: *Sample solution*

Record the chromatograms and measure the area response of each peak in the chromatogram of the *Sample solution*. Disregard any peak due to the solvent and the peak at the relative retention time of approximately 0.64.

Calculate the percentage of each individual impurity in the portion of Galactose taken:

$$\text{Result} = r_U/(r_S \times F) \times 100$$

r_U = peak area of each individual impurity from the *Sample solution*

r_S = peak area of galactose from the *Sample solution*

F = relative response factor (see *Table 1*)

Acceptance criteria: See *Table 1*.

Table 1

Name	Relative Retention Time	Relative Response Factor	Acceptance Criteria, NMT (%)
Lactose and 1,6-galactosylgalactose	0.79	0.95	0.6
Galacturonic acid	0.89	0.88	0.6
Dextrose	0.93	0.99	0.6
Tagatose	0.96	0.96	0.6
Dulcitol	1.06	0.96	0.6
Arabinose	1.10	0.95	0.6
Any unspecified impurity	—	1.0	0.2
Total impurities	—	—	1.0▲ (NF 1-Aug-2020)

- **Residue on Ignition ⟨281⟩:** NMT 0.1%
- **Limit of Lead**

Diluent: Dilute 12 mL of acetic acid with water to 100 mL. Mix equal parts of this solution and water to prepare the *Diluent*.

Lead standard solution: 16 µg/mL of lead nitrate

Standard solutions: To three identical flasks add 0.5, 1.0, and 1.5 mL of *Lead standard solution*, respectively, and then add to each flask 20.0 g of Galactose. Dilute with *Diluent* to 100 mL. To each flask add 2.0 mL of ammonium pyrrolidinedithiocarbamate solution (10 mg/mL) and 10.0 mL of methyl isobutyl ketone, then shake for 30 s. Protect from light. Allow the layers to separate, and use the methyl isobutyl ketone (upper) layer.

Sample solution: Dissolve 20.0 g of Galactose in 100 mL of *Diluent*. Add 2.0 mL of ammonium pyrrolidinedithiocarbamate solution (10 mg/mL) and 10.0 mL of methyl isobutyl ketone, and shake for 30 s. Protect from light. Allow the layers to separate, and use the methyl isobutyl ketone (upper) layer.

Instrumental conditions

(See *Atomic Absorption Spectroscopy ⟨852⟩*.)

Mode: Atomic absorption spectrophotometry

Analytical wavelength: 283.3 nm

Lamp: Lead hollow-cathode

Flame: Air–acetylene

Analysis

Samples: *Standard solutions* and *Sample solution*

Concomitantly determine, at least in triplicate, the absorbances of the *Samples*. Record the average steady readings for each of the *Standard solutions* and the *Sample solution*. Plot the absorbances of the *Standard solutions* and the *Sample solution* versus the amount of lead added. Extrapolate the line joining the points on the graph until it meets the concentration axis. The distance between this point and the intersection of the axes represents the concentration of lead in the *Sample solution*.

Acceptance criteria: NMT 0.5 µg/g

• **Barium**

Standard solution: Add 6 mL of water to 5 mL of the *Sample solution* prepared for the *Acidity* test.

Sample solution: Add 5 mL of water and 1 mL of dilute sulfuric acid to 5 mL of the *Sample solution* prepared for the *Acidity* test. Allow to stand for 1 h.

Acceptance criteria: Any opalescence in the *Sample solution* is not more intense than that in the *Standard solution*.

SPECIFIC TESTS

• **Appearance of Solution**

Sample solution: Dissolve, with heating at 50°, 10.0 g of Galactose in 50 mL of carbon dioxide-free water.

Control solution: Prepare immediately before use by mixing 3.0 mL of ferric chloride CS, 3.0 mL of cobaltous chloride CS, and 2.4 mL of cupric sulfate CS with dilute hydrochloric acid (10 mg/mL) to make 10 mL, and diluting 1.5 mL of this solution with the dilute hydrochloric acid to 100 mL.

Analysis: Compare by viewing the *Sample solution* and the *Control solution* downward in matched color-comparison tubes against a white surface (see *Color and Achromicity ⟨631⟩*).

Acceptance criteria: The *Sample solution* is not more intensely colored than the *Control solution*.

• **Microbial Enumeration Tests ⟨61⟩** and **Tests for Specified Microorganisms ⟨62⟩:** The total aerobic microbial count does not exceed 10^3 cfu/g, and the total combined molds and yeasts count does not exceed 10^2 cfu/g. It meets the requirements of the tests for absence of *Salmonella* species, *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*.

• **Optical Rotation ⟨781S⟩, *Procedures, Specific Rotation***

Sample solution: Transfer 10.0 g to a 100-mL volumetric flask, and dissolve in 80 mL of water. Add 0.2 mL of ammonia TS, allow to stand for 30 min, then dilute with water to volume.

Analysis: Perform at 20°.

Acceptance criteria: +78.0° to +81.5°

• **Acidity**

Sample solution: Dissolve 10.0 g of Galactose, with heating at 50°, in 40 mL of carbon dioxide-free water. Dilute with carbon dioxide-free water to 50 mL. [Note—Use this solution for the *Barium* test.]

Analysis: To 30 mL of the *Sample solution* add 0.3 mL of phenolphthalein TS, and titrate with 0.01 N sodium hydroxide to a pink color.

Acceptance criteria: NMT 1.5 mL of 0.01 N sodium hydroxide is required.

• **Water Determination ⟨921⟩, *Method I*:** NMT 1.0%

ADDITIONAL REQUIREMENTS

• **Packaging and Storage:** Preserve in a tight container. No storage requirements specified.

Add the following:

▲• **Labeling:** Label it to indicate whether Galactose is derived from an animal or plant source.▲ (NF 1-Aug-2020)

Change to read:

• **USP Reference Standards ⟨11⟩**

▲ USP Arabinose RS▲ (NF 1-Aug-2020)

USP Dextrose RS

USP Galactose RS

▲ USP Anhydrous Lactose RS▲ (NF 1-Aug-2020)

▲1 Use a suitable grade with a content of NLT 97.0%. ▲ (NF 1-Aug-2020)

Auxiliary Information - Please check for your question in the FAQs before contacting USP.

Topic/Question	Contact	Expert Committee
GALACTOSE	Documentary Standards Support	SE2020 Simple Excipients

Chromatographic Database Information: Chromatographic Database

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