



Edition: BP 2025 (Ph. Eur. 11.6 update)

Heparin Sodium



[General Notices](#)

(Ph. Eur. monograph 0333)

Action and use

Anticoagulant.

Preparations

[Heparin Flush Solution](#)

[Heparin Injection](#)

Ph Eur

DEFINITION

Preparation containing the sodium salt of a sulfated glycosaminoglycan present in mammalian tissues. It is prepared from the intestinal mucosae of pigs. On complete hydrolysis, it liberates D-glucosamine, D-glucuronic acid, L-iduronic acid, acetic acid and sulfuric acid. It has the property of delaying the clotting of blood by catalysing the inhibition of thrombin and factor Xa by antithrombin.

Potency

Minimum 180 IU/mg (dried substance), determined by the assay of anti-factor IIa activity as described under Assay.

PRODUCTION

The animals from which heparin sodium is derived must fulfil the requirements for the health of animals suitable for human consumption. All stages of production and sourcing are subjected to a suitable quality management system. The identity of the source species and the absence of material from possible contaminant species such as cattle, sheep and goats, is verified by appropriate testing during production. The method used to confirm the identity of the source species and its point of application in the process are validated. Species verification by methods based on polymerase chain reaction (PCR) amplification of species-specific DNA sequences is well established as an appropriate surrogate to confirm the absence of contaminant species. If such a method is chosen, it is also used to test for porcine DNA and to determine that it is present at a consistent level, in line with the manufacturing process used. This surrogate method is applied at the stage in the process where DNA is still present in sufficient amounts and is shown to have a limit of detection that is at least 1000-fold lower than the determined amount of porcine DNA.

Heparin sodium is produced by methods of manufacturing designed to minimise or eliminate substances lowering blood pressure.

CHARACTERS

Appearance

White or almost white, hygroscopic powder.

Solubility

Freely soluble in water.

IDENTIFICATION

- A. It complies with the requirements described under Assay.
B. Carry out the assay of anti-factor Xa activity of heparin ([2.7.5](#)). The ratio of anti-factor Xa activity to anti-factor IIa activity determined as described under Assay, ranges between 0.9 and 1.1.
C. Nuclear magnetic resonance spectrometry ([2.2.33](#)).

Solution A A solution in [deuterium oxide R](#) containing 20 µg/mL of [deuterated sodium trimethylsilylpropionate R](#) and if the signal at 5.22 ppm is smaller than 80 per cent of the signal at 5.44 ppm, 12 µg/mL of [sodium edetate R](#).

Preparation Dissolve 20 mg of the substance to be examined in 0.7 mL of solution A.

Comparison Dissolve 20 mg of [heparin sodium for NMR identification CRS](#) in 0.7 mL of solution A.

If stored, the sodium edetate and deuterated sodium trimethylsilylpropionate solutions must be kept in high-density, natural polyethylene bottles.

Apparatus Spectrometer operating at minimum 300 MHz.

Acquisition of ¹H-NMR spectra:

- **number of transients:** minimum 16; it is adjusted until the signal-to-noise ratio is at least 1000:1 for the heparin methyl signal at 2.04 ppm;
- **temperature:** about 25 °C; test sample and reference spectra have to be obtained at the same temperature;
- **acquisition time:** minimum 2 s;
- **repetition time** (acquisition time plus delay): minimum 4 s;
- **spectral width:** 10-12 ppm, centred at around 4.5 ppm;
- **pulse width:** to give a flip angle between 30° and 90°.

Processing:

- **exponential line-broadening window function:** 0.3 Hz;
- Fourier transformation;
- trimethylsilylpropionate reference signal set at 0.00 ppm.

Results:

- the principal characteristic signals of heparin sodium must be present: 2.04 ppm, 3.27 ppm (doublet), 4.34 ppm, 5.22 ppm and 5.42 ppm, all within ± 0.03 ppm;
- the ¹H-NMR spectrum obtained with the test sample and that obtained with [heparin sodium for NMR identification CRS](#) are compared qualitatively after the 2 spectra have been normalised so as to have a similar intensity; dermatan sulfate with a methyl signal at 2.08 ± 0.02 ppm may be observed; no unidentified signals larger than 4 per cent compared to the height of the heparin signal at 5.42 ppm are present in the ranges 0.10-2.00 ppm, 2.10-3.10 ppm and 5.70-8.00 ppm; signals from the solvent or process-related substances may be present and have to be identified to be accepted; variations in the intensity of some signal regions of the spectrum of heparin may occur: the intensity-variable regions are between 3.35 ppm and 4.55 ppm, where the signal pattern is approximately kept but intensity varies.

- D. Liquid chromatography ([2.2.29](#)) as described in the test for related substances with the following modifications.

Injection Test solution (a) and reference solution (c).

Relative retention With reference to heparin (retention time = about 26 min): dermatan sulfate and chondroitin sulfate = about 0.9; over-sulfated chondroitin sulfate = about 1.3.

System suitability Reference solution (c):

— [peak-to-valley ratio](#): minimum 1.3, where H_p = height above the baseline of the peak due to dermatan sulfate and chondroitin sulfate and H_v = height above the baseline of the lowest point of the curve separating this peak from the peak due to heparin.

Results The principal peak in the chromatogram obtained with test solution (a) is similar in retention time and shape to the principal peak in the chromatogram obtained with reference solution (c).

E. It complies with the test for sodium (see Tests).

TESTS

Appearance of solution

The solution is clear ([2.2.1](#)) and not more intensely coloured than intensity 5 of the range of reference solutions of the most appropriate colour ([2.2.2, Method II](#)).

Dissolve a quantity equivalent to 50 000 IU in [water R](#) and dilute to 10 mL with the same solvent.

pH ([2.2.3](#))

5.5 to 8.0.

Dissolve 0.1 g in [carbon dioxide-free water R](#) and dilute to 10 mL with the same solvent.

Nucleotidic impurities

Dissolve 40 mg in 10 mL of [water R](#). The absorbance ([2.2.25](#)) measured at 260 nm is not greater than 0.15.

Protein

Maximum 0.5 per cent (dried substance).

Solution A Mix 2 volumes of a 10 g/L solution of [sodium hydroxide R](#) and 2 volumes of a 50 g/L solution of [sodium carbonate R](#) and dilute to 5 volumes with [water R](#).

Solution B Mix 2 volumes of a 12.5 g/L solution of [copper sulfate pentahydrate R](#) and 2 volumes of a 29.8 g/L solution of [sodium tartrate R](#) and dilute to 5 volumes with [water R](#).

Solution C Mix 1 volume of solution B and 50 volumes of solution A.

Solution D Dilute a phosphomolybdotungstic reagent in [water R](#). Suitable dilutions produce solutions of pH 10.25 ± 0.25 after addition of solutions C and D to the test and reference solutions.

Test solution Dissolve the substance to be examined in [water R](#) to obtain a concentration of 5 mg/mL.

Reference solutions Dissolve [bovine albumin R1](#) in [water R](#) to obtain a concentration of 100 mg/mL. Prepare dilutions of the solution in [water R](#) as prescribed in general chapter [2.5.33, method 2](#).

Blank [water R](#).

Procedure To 1 mL of each reference solution, of the test solution and of the blank, add 5 mL of solution C. Allow to stand for 10 min. Add 0.5 mL of solution D, mix and allow to stand at room temperature for 30 min. Determine the absorbances ([2.2.25](#)) of the solutions at 750 nm, using the solution prepared from the blank as compensation liquid.

Calculations As prescribed in general chapter [2.5.33, method 2](#).

Related substances

Liquid chromatography ([2.2.29](#)). *Reference solutions are stable at room temperature for 24 h.*

Test solution (a) Dissolve an accurately weighed quantity of about 50 mg of the substance to be examined in 5.0 mL of [water for chromatography R](#). Mix using a vortex mixer until dissolution is complete.

Test solution (b) Dissolve an accurately weighed quantity of about 0.1 g of the substance to be examined in 1.0 mL of [water for chromatography R](#). Mix using a vortex mixer until dissolution is complete. Mix 500 µL of the solution and 250 µL of [1 M hydrochloric acid](#), then add 50 µL of a 250 mg/mL solution of [sodium nitrite R](#). Mix gently and allow to stand at room temperature for 40 min before adding 200 µL of [1 M sodium hydroxide](#) to stop the reaction.

Reference solution (a) Dissolve 250 mg of [heparin for physico-chemical analysis CRS](#) in [water for chromatography R](#) and dilute to 2.0 mL with the same solvent. Mix using a vortex mixer until dissolution is complete.

Reference solution (b) Add 1200 µL of reference solution (a) to 300 µL of [dermatan sulfate and over-sulfated chondroitin sulfate CRS](#). Mix using a vortex mixer to homogenise.

Reference solution (c) Add 100 µL of reference solution (b) to 900 µL of [water for chromatography R](#). Mix using a vortex mixer to homogenise.

Reference solution (d) Add 400 µL of reference solution (a) to 100 µL of [water for chromatography R](#) and mix using a vortex mixer. Add 250 µL of [1 M hydrochloric acid](#), then add 50 µL of a 250 mg/mL solution of [sodium nitrite R](#). Mix gently and allow to stand at room temperature for 40 min before adding 200 µL of [1 M sodium hydroxide](#) to stop the reaction.

Reference solution (e) To 500 µL of reference solution (b), add 250 µL of [1 M hydrochloric acid](#), then add 50 µL of a 250 mg/mL solution of [sodium nitrite R](#). Mix gently and allow to stand at room temperature for 40 min before adding 200 µL of [1 M sodium hydroxide](#) to stop the reaction.

Precolumn:

- size: $l = 0.05$ m, $\varnothing = 2$ mm;
- stationary phase: [strongly basic anion-exchange resin for chromatography R2](#) (13 µm).

Column:

- size: $l = 0.25$ m, $\varnothing = 2$ mm;
- stationary phase: [strongly basic anion-exchange resin for chromatography R2](#) (9 µm);
- temperature: 40 °C.

Mobile phase:

- mobile phase A: dissolve 0.40 g of [sodium dihydrogen phosphate R](#) in 1000 mL of [water for chromatography R](#) and adjust to pH 3.0 with [dilute phosphoric acid R](#);
- mobile phase B: dissolve 0.40 g of [sodium dihydrogen phosphate R](#) in 1000 mL of [water for chromatography R](#), add 140 g of [sodium perchlorate R](#) and adjust to pH 3.0 with [dilute phosphoric acid R](#); filter and degas;

Time (min)	Mobile phase A (per cent V/V)	Mobile phase B (per cent V/V)
0 - 10	75	25
10 - 35	75 → 0	25 → 100
35 - 40	0	100

Flow rate 0.22 mL/min.

Detection Spectrophotometer at 202 nm.

Equilibration At least 15 min.

Injection 20 µL of test solution (b) and reference solutions (d) and (e).

Relative retention With reference to heparin (retention time = about 26 min): dermatan sulfate and chondroitin sulfate = about 0.9; over-sulfated chondroitin sulfate = about 1.3.

System suitability:

- the chromatogram obtained with reference solution (d) shows no peak at the retention time of heparin;
- **resolution**: minimum 3.0 between the peak due to dermatan sulfate and chondroitin sulfate and the peak due to over-sulfated chondroitin sulfate in the chromatogram obtained with reference solution (e).

Limits:

- *sum of dermatan sulfate and chondroitin sulfate*: not more than the area of the peak due to dermatan sulfate and chondroitin sulfate in the chromatogram obtained with reference solution (e) (2.0 per cent);
- *any other impurity*: no peak with an area greater than 0.01 times the area of the peak due to dermatan sulfate and chondroitin sulfate in the chromatogram obtained with reference solution (e) is detected (corresponding to a disregard limit of 0.02 per cent). Disregard any peaks that appear during the initial isocratic step.

Nitrogen (2.5.9)

1.5 per cent to 2.5 per cent (dried substance), determined on 0.100 g.

Sodium

10.5 per cent to 13.5 per cent (dried substance).

Atomic absorption spectrometry ([2.2.23, Method I](#)).

Test solution Dissolve 50 mg of the substance to be examined in a 1.27 mg/mL solution of [caesium chloride R](#) in [0.1 M hydrochloric acid](#) and dilute to 100.0 mL with the same solvent.

Reference solutions Prepare reference solutions containing 25 ppm, 50 ppm and 75 ppm of Na, using [sodium standard solution \(200 ppm Na\) R](#) diluted with a 1.27 mg/mL solution of [caesium chloride R](#) in [0.1 M hydrochloric acid](#).

Source Sodium hollow-cathode lamp.

Wavelength 330.3 nm.

Atomisation device Flame of suitable composition (for example 11 L of air and 2 L of acetylene per minute).

Loss on drying (2.2.32)

Maximum 8.0 per cent, determined on 1.000 g by drying at 60 °C over [diphosphorus pentoxide R](#) at a pressure not exceeding 670 Pa for 3 h.

Bacterial endotoxins (2.6.14)

Less than 0.01 IU per International Unit of heparin, if intended for use in the manufacture of parenteral preparations without a further appropriate procedure for the removal of bacterial endotoxins.

ASSAY

Carry out the assay of anti-factor IIa activity of heparin ([2.7.5](#)). The estimated potency is not less than 90 per cent and not more than 111 per cent of the stated potency. The confidence limits of the estimated potency ($P = 0.95$) are not less than 80 per cent and not more than 125 per cent of the stated potency.

STORAGE

In an airtight container. If the substance is sterile, the container is also sterile and tamper-evident.

LABELLING

The label states the number of International Units per milligram.

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