**Panax notoginseng Root and Rhizome Powder**

**Final Authorized Version 1.0**

*Panax notoginseng* Root and Rhizome Powder

**DEFINITION**

The article consists of the dried roots, rootlets, and rhizomes of *Panax notoginseng* (Burk.) F. H. Chen (Family Araliaceae), collected before flowering in autumn, reduced to a powder or very fine powder. It contains NLT 5.0% of total saponins calculated as the sum of notoginsenoside R1, ginsenoside Rg1, ginsenoside Re, ginsenoside Rb1, ginsenoside Rd, and NLT 0.6% of notoginsenoside R1, on the dried basis.

**POTENTIAL CONFOUNDING MATERIALS**

- *Panax ginseng* roots and rhizomes
- *Panax notoginseng* leaves
- *Panax notoginseng* flowers
- *Panax quinquefolius* roots and rhizomes

**CONSTITUENTS OF INTEREST**

- **Saponins:** Notoginsenoside R1, ginsenoside Rg1, ginsenoside Re, ginsenoside Rb1, and ginsenoside Rd
- **Amino acid:** Dencichine

**IDENTIFICATION**

- **A. BOTANICAL CHARACTERISTICS**
  - **Macroscopic:** Grayish-yellow in color
  - **Microscopic:** Fragments of cork cells; fragments of parenchyma cells, rare cluster crystals of calcium oxalate; fragments of secretory ducts containing yellow secretions; vessels, scalariform, reticulated and spiral, 15–85 μm in diameter; starch granules fairly abundant, simple granules spherical, semispherical, or round-polygonal, 5–20(30) μm in diameter; cross-shape when examined under a polarizing microscope, compound granules of 2–10 or more components, typically 40 μm in diameter; showing black.

- **B. THIN-LAYER CHROMATOGRAPHY**

  **Standard solution A:** 0.5 mg/mL of USP Ginsenoside Rg1 RS [1] in methanol
  **Standard solution B:** 10 mg/mL of USP *Panax notoginseng* Root and Rhizome Dry Extract RS [2] in alcohol. Sonicate for about 10 min, centrifuge, and use the supernatant.
  **Sample solution:** Sonicate about 1.0 g of *Panax notoginseng* Root and Rhizome Powder in 10 mL of alcohol for 15 min, centrifuge, and use the supernatant. [Note—Sample solution is stable at room temperature for 6 h.]

**Chromatographic system**

(See Chromatography <621> [3], Thin-Layer Chromatography.)

- **Adsorbent:** Chromatographic silica gel mixture with an average particle size of 5 μm (HPTLC plates, Si 60 F254)
- **Application volume:** 2 μL, as 8-mm bands
- **Relative humidity:** Condition the plate to a relative humidity of about 33% using a suitable device.
- **Temperature:** 25°
- **Developing solvent system:** Methylene chloride, dehydrated alcohol, and water (60: 45: 6.5)
- **Developing distance:** 6 cm
- **Derivatization reagent:** A solution of 10% sulfuric acid in alcohol. [Note—Prepare fresh. Keep alcohol cold over ice, carefully and gradually add sulfuric acid.]

**Analysis**

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

  Apply the Samples as bands to a suitable HPTLC plate and dry in air. Develop the chromatograms in a saturated chamber, remove the plate from the chamber, and dry. Treat with Derivatization reagent, heat at 105° for 5 min, and examine immediately under visible light and UV light at 366 nm.

**System suitability:** Under visible light, the chromatogram of Standard solution B exhibits five reddish-violet bands in the following order with increasing *R*ₐ: a band in the lower-third section due to ginsenoside Rb1; three less intense bands clearly separated in the middle-third section due to ginsenoside Rd, ginsenoside Re, and notoginsenoside R1, respectively; and a band at an *R*ₐ corresponding
to the ginsenoside Rg1 band in the chromatogram of Standard solution A. The most intense band is that of ginsenoside Rg1, followed in intensity by the band corresponding to ginsenoside Rb1.

Under UV light at 366 nm, the chromatogram of Standard solution B exhibits bands in the following order with increasing Rf: a blue fluorescent band in the lower-third section due to ginsenoside Rd, ginsenoside Re, and notoginsenoside R1, respectively (the band due to ginsenoside Rd is blue fluorescent while the other two bands are pinkish-violet); and a pinkish-violet band at an Rf corresponding to the ginsenoside Rg1 band in the chromatogram of Standard solution A. The two most intense bands are those of ginsenoside Rb1 and ginsenoside Rg1.

Acceptance criteria: Under visible light, the chromatogram of the Sample solution exhibits five reddish-violet bands corresponding in Rf to similar bands in the chromatogram of Standard solution B. These bands appear in the following order with increasing Rf: a band in the lower-third section due to ginsenoside Rb1; three less intense bands clearly separated in the middle-third section due to ginsenoside Rd, ginsenoside Re, and notoginsenoside R1, respectively; and a band at an Rf corresponding to the ginsenoside Rg1 band in the chromatogram of Standard solution A. The most intense band is that of ginsenoside Rg1, followed in intensity by the band corresponding to ginsenoside Rb1.

Under UV light at 366 nm, the chromatogram of the Sample solution exhibits the following bands in the following order with increasing Rf, corresponding to similar bands in the chromatogram of Standard solution B: a blue fluorescent band in the lower-third section due to ginsenoside Rb1; three less intense bands clearly separated in the middle-third section due to ginsenoside Rd, ginsenoside Re, and notoginsenoside R1, respectively (the band due to ginsenoside Rd is blue fluorescent while the other two bands are pinkish-violet); and a pinkish-violet band at an Rf corresponding to the ginsenoside Rg1 band in the chromatogram of Standard solution A. Two minor bands, due to ginsenoside Rg3 and ginsenoside Rg2, may be observed directly below the ginsenoside Rg1 band. The two most intense bands are those of ginsenoside Rb1 and ginsenoside Rg1.

[Note—Under UV light at 366 nm and in distinction from Panax notoginseng Root and Rhizome, Panax notoginseng leaves and flowers chromatograms exhibit a red band due to chlorophyll at the solvent front, and a minor or no bands at the Rf corresponding to ginsenoside Rg1.]

[Note—Under UV light at 366 nm and in distinction from Panax notoginseng Root and Rhizome, the Panax ginseng Root and Rhizome chromatogram lacks the band at the Rf corresponding to notoginsenoside R1 in the chromatogram of Standard solution B, and exhibits a pinkish-violet band at an Rf slightly higher than that of notoginsenoside R1. The band due to ginsenoside Rg1 is not one of the most intense bands in the chromatogram, and the most intense band is detected in the lower-third section of the chromatogram and in the region where the Rf of ginsenoside Rb1 is detected.]

[Note—Under UV light at 366 nm and in distinction from Panax notoginseng Root and Rhizome, the Panax quinquefolius Root and Rhizome chromatogram lacks the band at the Rf corresponding to notoginsenoside R1 in the chromatogram of Standard solution B, exhibits a minor band due to ginsenoside Rg1, and the most intense band is detected in the lower-third section of the chromatogram and in the region where the Rf of ginsenoside Rb1 is detected.]

- **C. UHPLC**
  - **Analysis:** Proceed as directed in the Assay for Content of Saponins, Procedure 1.
  - **Acceptance criteria:** The chromatogram of the Sample solution exhibits peaks at the retention times corresponding to the peaks due to notoginsenoside R1, ginsenoside Rg1, ginsenoside Re, ginsenoside Rb1, and ginsenoside Rd in the chromatogram of Standard solution B. The two most intense peaks in the chromatogram are those of ginsenoside Rg1 and ginsenoside Rb1. The content of notoginsenoside R1 is NLT 0.6% as determined in the Assay.

- **D. HPLC**
  - **Analysis:** Proceed as directed in the Assay for Content of Saponins, Procedure 2.
  - **Acceptance criteria:** The chromatogram of the Sample solution exhibits peaks at the retention times corresponding to the peaks due to notoginsenoside R1, ginsenoside Rg1, ginsenoside Re, ginsenoside Rb1, and ginsenoside Rd in the chromatogram of Standard solution B. The two most intense peaks in the chromatogram are those of ginsenoside Rg1 and ginsenoside Rb1. The content of notoginsenoside R1 is NLT 0.6% as determined in the Assay.

**ASSAY**

- **CONTENT OF SAPONINS** (The content of saponins can be determined either by Procedure 1 or Procedure 2.)

- **PROCEDURE 1**
  - **Solution A:** 0.03% Phosphoric acid in water
  - **Solution B:** Acetonitrile
  - **Mobile phase:** See Table 1.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Solution A (%)</th>
<th>Solution B (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>83</td>
<td>17</td>
</tr>
<tr>
<td>Time (min)</td>
<td>Solution A (%)</td>
<td>Solution B (%)</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------</td>
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</tr>
<tr>
<td>2.4</td>
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</tr>
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<td>5.0</td>
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</tr>
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<td>5.1</td>
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</tr>
<tr>
<td>6.0</td>
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</tr>
<tr>
<td>6.1</td>
<td>83</td>
<td>17</td>
</tr>
<tr>
<td>7.5</td>
<td>83</td>
<td>17</td>
</tr>
</tbody>
</table>

Solvent: Methanol and water (70:30)

**Standard solution A:** 0.04 mg/mL of USP Ginsenoside Rg1 RS [1] in methanol

**Standard solution B:** 3.0 mg/mL of USP Panax notoginseng Root and Rhizome Dry Extract RS [2] in Solvent. Sonicate for about 10 min, centrifuge, and use the supernatant. Before injection, pass through a PTFE filter of 0.2-μm pore size, and discard the first portion of the filtrate.

**Sample solution:** Transfer about 0.3 g of Panax notoginseng Root and Rhizome Powder, accurately weighed, to a 50-mL centrifuge tube. Add 10 mL of Solvent and sonicate for 10 min (140W, 42 kHz). Centrifuge and transfer the supernatant to a 25-mL volumetric flask. Repeat the above extraction two more times, each with 5 mL of Solvent. Combine the extracts in the volumetric flask, dilute with Solvent to volume, and mix. Before injection, pass through a PTFE filter of 0.2-μm pore size, and discard the first portion of the filtrate. [Note—Sample solution is stable at room temperature for 24 h.]

**Chromatographic system**
(See Chromatography <621> [3], System Suitability.)

**Mode:** UHPLC

**Detector:** UV 203 nm

**Column:** 2.1-mm × 5-cm; 1.7-μm packing L1 (similar to Kinetex™ C18 100 Å)

**Column temperature:** 30 ± 1°

**Flow rate:** 0.8 mL/min

**Injection volume:** 5 μL

**System suitability**

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

**Suitability requirements**

**Chromatogram similarity:** The chromatogram of Standard solution B is similar to the reference chromatogram provided with the lot of USP Panax notoginseng Root and Rhizome Dry Extract RS [2] being used.

**Resolution:** NLT 1.5 between ginsenoside Rg1 and ginsenoside Re peaks, Standard solution B

**Tailing factor:** NMT 2.0 for the ginsenoside Rg1 peak, Standard solution A

**Relative standard deviation:** NMT 2.0%, determined from the ginsenoside Rg1 peak in repeated injections, Standard solution A

**Analysis**

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

Using the chromatograms of Standard solution A, Standard solution B, and the reference chromatogram provided with the lot of USP Panax notoginseng Root and Rhizome Dry Extract RS [2] being used, identify the retention times of the peaks corresponding to different saponins in the Sample solution chromatogram. The approximate relative retention times are provided in Table 2. Separately calculate the percentage of each of the saponins in the portion of Panax notoginseng Root and Rhizome Powder taken.

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Approximate Relative Retention Times</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notoginsenoside R1</td>
<td>0.78</td>
<td>1.09</td>
</tr>
<tr>
<td>Ginsenoside Rg1</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Ginsenoside Re | 1.06 | 1.02
Ginsenoside Rb1 | 1.78 | 1.26
Ginsenoside Rd | 2.04 | 1.03

Result = \( \frac{r_U}{r_S} \times C_S \times \frac{V}{W} \times F \times 100 \)

- \( r_U \) = peak response of the analyte from the Sample solution
- \( r_S \) = peak response for ginsenoside Rg1 from Standard solution A
- \( C_S \) = concentration of ginsenoside Rg1 in Standard solution A (mg/mL)
- \( V \) = volume of the Sample solution (mL)
- \( W \) = weight of Panax notoginseng Root and Rhizome Powder taken to prepare the Sample solution (mg)
- \( F \) = conversion factors for the analytes as provided in Table 2

Calculate the content of saponins as the sum of the percentages of notoginsenoside R1, ginsenoside Rg1, ginsenoside Re, ginsenoside Rb1, and ginsenoside Rd.

**Procedure 2**

- **Solution A:** 0.03% Phosphoric acid in water
- **Solution B:** Acetonitrile
- **Mobile phase:** See Table 3.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Solution A (%)</th>
<th>Solution B (%)</th>
</tr>
</thead>
<tbody>
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<td>17</td>
</tr>
<tr>
<td>40</td>
<td>83</td>
<td>17</td>
</tr>
</tbody>
</table>

**Standard solution A:** Proceed as directed in Procedure 1.
**Standard solution B:** Proceed as directed in Procedure 1.
**Sample solution:** Proceed as directed in Procedure 1.

**Chromatographic system**

(See Chromatography <621> [3], System Suitability.)

- **Mode:** HPLC
- **Detector:** UV 203 nm
- **Column:** 4.6-mm × 10-cm; 2.6-µm packing L1 (similar to Kinetex™ C18 100 Å)
- **Column temperature:** 30 ± 1°
- **Flow rate:** 1.5 mL/min
- **Injection volume:** 10 µL

**System suitability:** Proceed as directed in Procedure 1.
**Analysis:** Proceed as directed in Procedure 1.
**Acceptance criteria**

- **Total saponins:** NLT 5.0% on the dried basis
- **Notoginsenoside R1:** NLT 0.6% on the dried basis
CONTAMINANTS

- **ELEMENTAL IMPURITIES** [4]—PROCEDURES <233>
  
  **Acceptance criteria**
  
  - Arsenic: NMT 2.0 µg/g
  - Cadmium: NMT 1.0 µg/g
  - Lead: NMT 5.0 µg/g
  - Mercury: NMT 1.0 µg/g

- **ARTICLES OF BOTANICAL ORIGIN** [5], *General Method for Pesticide Residues Analysis* <561>: Meets the requirements

- **ARTICLES OF BOTANICAL ORIGIN** [5], *Test for Aflatoxins* <561>: Meets the requirements

- **MICROBIAL ENUMERATION TESTS** <61> [7]: The total aerobic bacterial count does not exceed $10^5$ cfu/g, the total combined molds and yeasts count does not exceed $10^3$ cfu/g, and the bile-tolerant Gram-negative bacteria does not exceed $10^3$ cfu/g.

- **TESTS FOR SPECIFIED MICROORGANISMS** <62> [8]: Meets the requirements of the tests for the absence of *Salmonella* species and *Escherichia coli*.

SPECIFIC TESTS

- **PRESENCE OF DENCICHINE**
  
  **Standard solution**: 1.0 mg/mL of USP Dencichine RS in 70% methanol

  **Sample solution**: Sonicate about 0.5 g of *Panax notoginseng* Root and Rhizome Powder with 10 mL of water at 90° for 20 min. Evaporate the extract under reduced pressure to dryness. Reconstitute dried residue with 2 mL of 70% methanol, centrifuge, and use the supernatant.

  **Chromatographic system** (See *Chromatography* <621> [3], *Thin-Layer Chromatography*.)
  
  - **Adsorbent**: Chromatographic silica gel mixture with an average particle size of 5 μm (HPTLC plates, Si 60 F_{254})
  - **Application volume**: 2 μL, as 8-mm bands
  - **Relative humidity**: Condition the plate to a relative humidity of about 33% using a suitable device.
  - **Temperature**: 25°
  - **Developing solvent system**: Propanol, glacial acetic acid, and water (4:1:2)
  - **Developing distance**: 6 cm
  - **Derivatization reagent**: A solution of 2% ninhydrin in dehydrated alcohol

  **Analysis**
  
  - **Samples**: Standard solution and Sample solution
  - Apply the Samples as bands to a suitable HPTLC plate and dry in air. Develop the chromatogram in a saturated chamber, remove the plate from the chamber, and dry. Treat with Derivatization reagent, heat at 105° for 5 min, and examine immediately under visible light.

  **System suitability**: Under visible light, the chromatogram of the Standard solution exhibits, in the lower-third section, a yellow band due to the dencichine.

  **Acceptance criteria**: Under visible light, the chromatogram of the Sample solution exhibits, in the lower-third section, a yellow band due to dencichine at an $R_f$ corresponding to the band due to dencichine in the chromatogram of the Standard solution.

- **LOSS ON DRYING** <731> [9]
  
  - **Sample**: 1.0 g of *Panax notoginseng* Root and Rhizome Powder
  - **Analysis**: Dry the Sample at 105° for 5 h.
  - **Acceptance criteria**: NMT 14.0%

- **ARTICLES OF BOTANICAL ORIGIN** [5], *Total Ash* <561>
  
  - **Analysis**: 4.0 g of *Panax notoginseng* Root and Rhizome Powder
  - **Acceptance criteria**: NMT 6.0%

- **ARTICLES OF BOTANICAL ORIGIN** [5], *Acid-Insoluble Ash* <561>
  
  - **Analysis**: 4.0 g of *Panax notoginseng* Root and Rhizome Powder
  - **Acceptance criteria**: NMT 3.0%

ADDITIONAL REQUIREMENTS

- **PACKAGING AND STORAGE**: Preserve in well-closed containers, protected from light and moisture, and store at room temperature.

- **LABELING**: The label states the Latin binomial and the part(s) of the plant from which the article was derived.

- **USP Reference Standards** <11> [10]
  
  - USP Aflatoxins RS [6]
  - USP Dencichine RS