Rhizoma Belamcandae

Figure 1　A photograph of Rhizoma Belamcandae

1. NAMES

Official Name: Rhizoma Belamcandae

Chinese Name: 射干

Chinese Phonetic Name: Shegan

2. SOURCE

Rhizoma Belamcandae is the dried rhizome of *Belamcanda chinensis* (L.) DC. (Iridaceae). The rhizome is collected in early spring when the plant is budding, or in late autumn when the aerial part is withering. Fibrous roots and soil removed, washed clean, then dried under the sun to obtain Rhizoma Belamcandae.

3. DESCRIPTION

Irregularly nodulated, 2-7 cm long, 10-20 mm in diameter. Externally yellowish-brown, dark brown to blackish-brown, shrunken, with profuse annular striations. Several dish-shaped and sunken stem scars are found on the upper part, occasionally with remains of stem bases, while remains of thin roots and root scars are found on the lower part. Texture hard; fracture yellow, granular. Odour slight; taste bitter and slightly pungent (Fig. 1).

4. IDENTIFICATION

4.1 Microscopic Identification *(Appendix III)*

Transverse section

Cork consists of several layers of irregularly shaped cells. Cortex marked by sparsely scattered leaf-trace vascular bundles; endodermis indistinct. Vascular bundles in the stele are of amphivasal and collateral types, densely arranged near the outer edge. Parenchyma cells contain columnar crystals of calcium oxalate, as well as starch granules and oil drops (Fig. 2).

Powder

Colour yellowish-brown. Columnar crystals of calcium oxalate abundant, mostly broken; intact crystals 49-388 μm long. Starch granules simple, globose to ellipsoid, 2-14 μm in diameter, the hilum dotted; compound granules rare. Reticulate, spiral and bordered-pitted vessels frequent, 9-39 μm in diameter. Fibres mostly in bundles, slender, the end truncated.

Parenchyma cells subglobose to ellipsoid, their wall slightly thickened or beaded, with simple pits. Cork cells brown, polygonal in surface view, the wall slightly sinuous, some cells contain brown masses (Fig. 3).

4.2 Thin-Layer Chromatographic Identification *[Appendix IV(A)]*

Standard solution

Irisflorentin standard solution

Weigh 1.0 mg of irisflorentin CRS (Fig. 4) and dissolve in 2 mL of methanol.

Developing solvent system

Prepare a mixture of petroleum ether (60-80°C) and ethyl acetate (1:1, v/v).

Test solution

Weigh 1.0 g of the powdered sample and place it in a 50-mL centrifuge tube, then add 10 mL of methanol. Sonicate (240 W) the mixture for 30 min. Centrifuge at about 2000 × *g* for 10 min. Collect the supernatant.

Procedure

Carry out the method by using a HPTLC silica gel F_{254} plate, a twin trough chamber and a freshly prepared developing solvent system as described above. Apply separately irisflorentin standard solution (4 μL) and the test solution (8 μL) to the plate. Before the development, add the developing solvent to one of the troughs of the chamber and place the HPTLC plate in the other trough. Cover the chamber with a lid and let equilibrate for about 15 min. Carefully tilt the chamber to allow sufficient solvent to pass from the trough containing the solvent to the other containing the HPTLC plate for development. Develop over a path of about 7 cm. After the development, remove the plate from the chamber, mark the solvent front and dry in air. Examine the plate under UV light (254 nm). Calculate the R_f value by using the equation as indicated in Appendix IV(A).

For positive identification, the sample must give spot or band with chromatographic characteristics, including the colour and the R_f value, corresponding to that of irisflorentin.

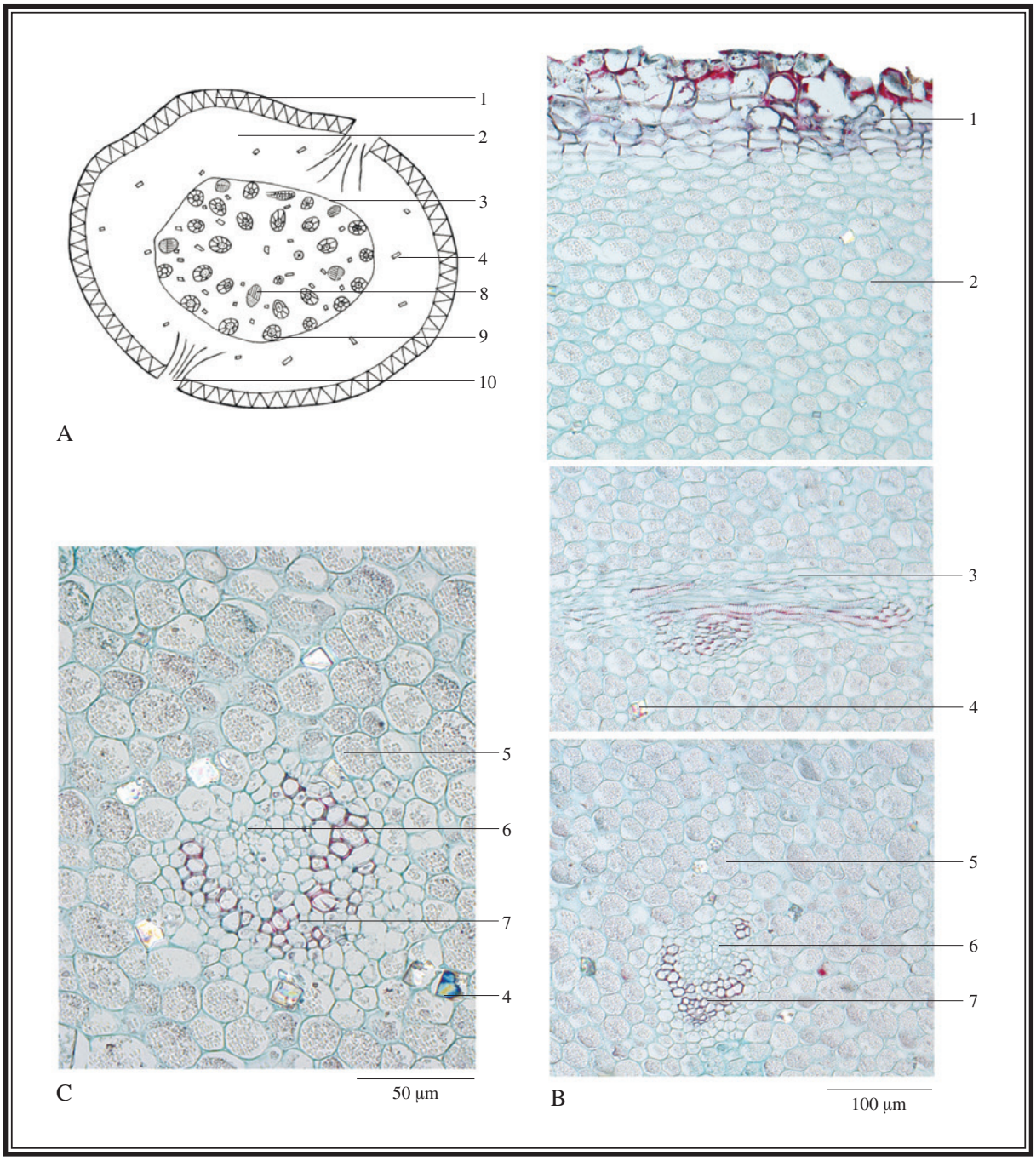


Figure 2 Microscopic features of transverse section of Rhizoma Belamcandae

A. Sketch B. Section illustration C. Vascular bundle

1. Cork 2. Cortex 3. Endodermis 4. Columnar crystals of calcium oxalate
5. Starch granules 6. Phloem 7. Xylem 8. Collateral vascular bundles
9. Amphivasal vascular bundles 10. Leaf-trace vascular bundles

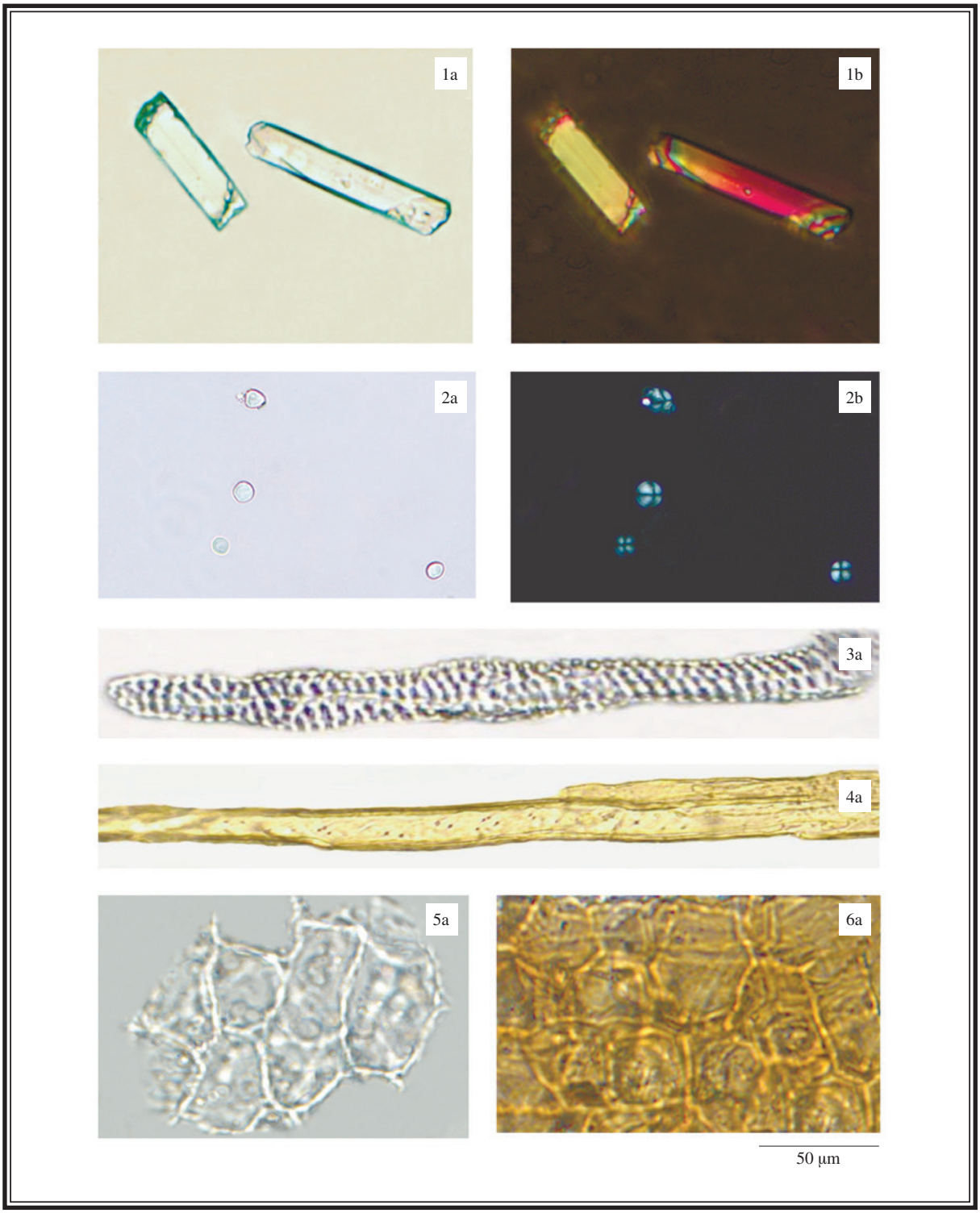
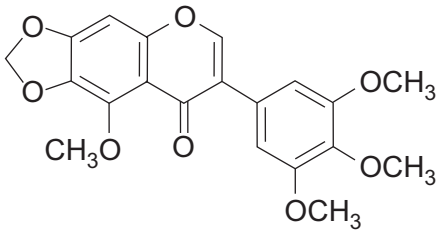


Figure 3 Microscopic features of powder of Rhizoma Belamcandae

1. Columnar crystals of calcium oxalate 2. Starch granules 3. Reticulate vessels 4. Fibres
5. Parenchyma cells 6. Cork cells

a. Features under the light microscope b. Features under the polarized microscope

(i)



(ii)

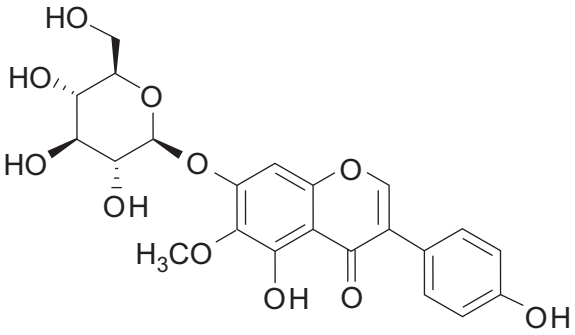


Figure 4 Chemical structures of (i) irisflorentin (ii) tectoridin

4.3 High-Performance Liquid Chromatographic Fingerprinting *(Appendix XII)*

Standard solutions

Tectoridin standard solution for fingerprinting Std-FP (20 mg/L)

Weigh 2.0 mg of tectoridin CRS (Fig.4) and dissolve in 100 mL of ethanol (70%).

Irisflorentin standard solution for fingerprinting, Std-FP (10 mg/L)

Weigh 1.0 mg of irisflorentin CRS and dissolve in 100 mL of ethanol (70%).

Test solution

Weigh 0.1 g of the powdered sample and place it in a 50-mL centrifuge tube, then add 10 mL of ethanol (70%). Sonicate (240 W) the mixture for 30 min. Centrifuge at about 3000 × *g* for 5 min. Transfer the supernatant to a 25-mL volumetric flask. Repeat the extraction for one more time. Combine the supernatant. Make up to the mark with ethanol (70%). Filter through a 0.45-μm PTFE filter.

Chromatographic system

The liquid chromatograph is equipped with a DAD (266 nm) and a column (4.6 × 250 mm) packed with ODS bonded silica gel (5 μm particle size). The flow rate is about 1.0 mL/min. Programme the chromatographic system as follows (Table 1) –

Table 1 Chromatographic system conditions

Time (min)	0.05% Phosphoric acid (%, v/v)	Acetonitrile (%, v/v)	Elution
0–15	82→80	18→20	linear gradient
15–25	80→67	20→33	linear gradient
25–45	67→60	33→40	linear gradient
45–60	60→47	40→53	linear gradient
60–65	47	53	isocratic

System suitability requirements

Perform at least five replicate injections, each using 10 μL of tectoridin Std-FP and irisflorentin Std-FP. The requirements of the system suitability parameters are as follows: the RSD of the peak areas of tectoridin and irisflorentin should not be more than 5.0%; the RSD of the retention times of tectoridin and irisflorentin peaks should not be more than 2.0%; the column efficiencies determined from tectoridin and irisflorentin peaks should not be less than 3500 and 20000 theoretical plates respectively.

The *R* value between peak 1 and peak 2 in the chromatogram of the test solution should not be less than 1.0 and the *R* value between peak 4 and the closest peak in the chromatogram of the test solution should not be less than 1.0 (Fig. 5).

Procedure

Separately inject tectoridin Std-FP, irisflorentin Std-FP and the test solution (10 μL each) into the HPLC system and record the chromatograms. Measure the retention times of tectoridin and irisflorentin peaks in the chromatograms of the corresponding Std-FP and the retention times of the four characteristic peaks (Fig. 5) in the chromatogram of the test solution. Identify tectoridin and irisflorentin peaks in the chromatogram of the test solution by comparing their retention times with those in the chromatograms of the corresponding Std-FP. The retention times of tectoridin and irisflorentin peaks in the chromatograms of the test solution and the corresponding Std-FP should not differ by more than 2.0%. Calculate the RRTs of the characteristic peaks by using the equation as indicated in Appendix XII.

The RRTs and acceptable ranges of the four characteristic peaks of Rhizoma Belamcandae extract are listed in Table 2.

Table 2 The RRTs and acceptable ranges of the four characteristic peaks of Rhizoma Belamcandae extract

Peak No.	RRT	Acceptable Range
1 (marker 1, tectoridin)	1.00	-
2	0.44 (vs peak 4)	±0.03
3	0.49 (vs peak 4)	±0.03
4 (marker 2, irisflorentin)	1.00	-

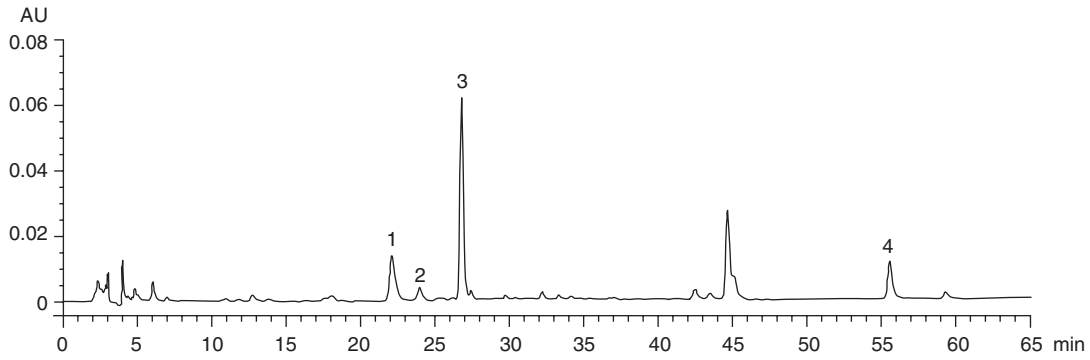


Figure 5 A reference fingerprint chromatogram of Rhizoma Belamcandae extract

For positive identification, the sample must give the above four characteristic peaks with RRTs falling within the acceptable range of the corresponding peaks in the reference fingerprint chromatogram (Fig. 5).

5. TESTS

5.1 Heavy Metals *(Appendix V)*: meet the requirements.

5.2 Pesticide Residues *(Appendix VI)*: meet the requirements.

5.3 Mycotoxins *(Appendix VII)*: meet the requirements.

5.4 Sulphur Dioxide Residues *(Appendix XV)*: meet the requirements.

5.5 Foreign Matter *(Appendix VIII)*: not more than 2.0%.

5.6 Ash *(Appendix IX)*

Total ash: not more than 7.0%.
Acid-insoluble ash: not more than 1.0%.

5.7 Water Content *(Appendix X)*: not more than 10.0%.

6. EXTRACTIVES *(Appendix XI)*

Water-soluble extractives (hot extraction method): not less than 21.0%.
Ethanol-soluble extractives (hot extraction method): not less than 22.0%.

7. ASSAY

Carry out the method as directed in Appendix IV(B).

Standard solution

Mixed tectoridin and irisflorentin standard stock solution, Std-Stock (20 mg/L for tectoridin and 10 mg/L for irisflorentin)

Weigh accurately 5.0 mg of tectoridin CRS and 2.5 mg of irisflorentin CRS and dissolve in 250 mL of ethanol (70%).

Mixed tectoridin and irisflorentin standard solution for assay, Std-AS

Measure accurately the volume of the mixed tectoridin and irisflorentin Std-Stock, dilute with ethanol (70%) to produce a series of solutions of 2, 4, 8, 16, 20 mg/L for tectoridin and 1, 2, 4, 8, 10 mg/L for irisflorentin.

Test solution

Weigh accurately 0.1 g of the powdered sample and place it in a 50-mL centrifuge tube, then add 10 mL of ethanol (70%). Sonicate (240 W) the mixture for 30 min. Centrifuge at about 3000 × *g* for 5 min. Transfer the supernatant to a 25-mL volumetric flask. Repeat the extraction for one more time. Combine the supernatant. Make up to the mark with ethanol (70%). Filter through a 0.45-μm PTFE filter.

Chromatographic system

The liquid chromatograph is equipped with a DAD (266 nm) and a column (4.6 × 250 mm) packed with ODS bonded silica gel (5 μm particle size). The flow rate is about 1.0 mL/min. Programme the chromatographic system as follows (Table 3) –

Table 3 Chromatographic system conditions

Time (min)	0.05% Phosphoric acid (%, v/v)	Acetonitrile (%, v/v)	Elution
0–15	82→80	18→20	linear gradient
15–25	80→67	20→33	linear gradient
25–45	67→60	33→40	linear gradient
45–60	60→47	40→53	linear gradient
60–65	47	53	isocratic

System suitability requirements

Perform at least five replicate injections, each using 10 μL of the mixed tectoridin and irisflorentin Std-AS (16 mg/L for tectoridin and 8 mg/L for irisflorentin). The requirements of the system suitability parameters are as follows: the RSD of the peak areas of tectoridin and irisflorentin should not be more than 5.0%; the RSD of the retention times of tectoridin peak and irisflorentin peak should not be more than 2.0%; the column efficiencies determined from tectoridin and irisflorentin peaks should not be less than 3500 and 20000 theoretical plates respectively.

The *R* value between tectoridin peak and the closest peak in the chromatogram of the test solution should not be less than 1.4 and the *R* value between irisflorentin peak and the closest peak in the chromatogram of the test solution should not be less than 1.5.

Calibration curves

Inject a series of the mixed tectoridin and irisflorentin Std-AS (10 μL each) into the HPLC system and record the chromatograms. Plot the peak areas of tectoridin and irisflorentin against the corresponding concentrations of the mixed tectoridin and irisflorentin Std-AS. Obtain the slopes, y-intercepts and the r^2 values from the corresponding 5-point calibration curves.

Procedure

Inject 10 μL of the test solution into the HPLC system and record the chromatogram. Identify tectoridin and irisflorentin peaks in the chromatogram of the test solution by comparing their retention times with those in the chromatogram of the mixed tectoridin and irisflorentin Std-AS. The retention times of tectoridin and irisflorentin peaks from the two chromatograms should not differ by more than 2.0%. Measure the peak areas and calculate the concentrations (in milligram per litre) of tectoridin and irisflorentin in the test solution, and calculate the percentage contents of tectoridin and irisflorentin in the sample by using the equations indicated in Appendix IV(B).

Limits

The sample contains not less than 0.14% of tectoridin ($C_{22}H_{22}O_{11}$) and not less than 0.10% of irisflorentin ($C_{20}H_{18}O_8$), calculated with reference to the dried substance.