was treated with a solution of 0.3 g of chromium trioxide in 8 ml of pyridine, and the mixture was left at room temperature for a week. Then it was poured into 200 ml of cooled 15% sulfuric acid and was treated with hexane-ether (2:1; 3 × 70 ml). The residue obtained after washing and the distillation of the solvent was chromatographed on a column of silica gel (2 × 20 cm). The column was washed with the benzene-hexane (1:1) system. Fractions 4-6 were combined and evaporated in vacuum to give 0.05 g of the ketone (VI), Rf 0.73 (revealed with 2,4-dinitrophenylhydrazine).

Oxidation of Fecerol. Compound (III) (0.5 g) was oxidized with chromium trioxide (0.5 g) in 15 ml of pyridine with stirring for 6 h. The reaction mixture was treated in the manner described above. The residue after the distillation of the solvent was chromatographed on a column of silica gel treated with 5% AgNO₃ solution (2 × 15 cm). Elution was performed with benzene. Fractions 3-10 were combined and evaporated in vacuum, and the residue was crystallized from hexane giving 0.15 g of the ketone (VI) with mp 76-77°C, Rf 0.7.

SUMMARY
Ferocin and ferocinin — esters of the new sesquiterpene alcohol fecerol with p-hydroxybenzoic and vanillic acids, respectively — have been isolated from the roots of Ferula cero-tophylla.

On the basis of spectral characteristics and chemical transformations, the structure of 1,1,8-trimethylcycloundeca-2,4(14),7-trien-10-ol is proposed for fecerol.

LITERATURE CITED

A NEW LACTONE, ISORIDENTIN, FROM Achillea biebersteinii


Sesquiterpene lactones (I), (II), and (III), isolated from Achillea biebersteinii, have been identified by spectral characteristics and chemical transformations as rupicolins A and B and artecalin, respectively [1, 2].

A fourth lactone with the composition C₁₅H₂₀O₄, mp 197-199°C, [α]₂⁰ + 181° (c 0.46; methanol) has proved to be new and has been called isoridentin (IV). It is soluble in ethyl acetate and ethanol.

The PMR spectrum of isoridentin taken in deuteropyridine showed the following characteristic signals: singlet at 1.83 ppm (H₂C=C=C-); triplet at 4.42 ppm (²J 9.8 Hz each — lactone proton); singlets at 4.80 and 5.21 ppm (H₂C=C-); doublets at 5.29 and 6.12 ppm (exomethylene group conjugated with a lactone carbonyl); multiplets with broadened lines at 4.19 and 4.4 ppm (protons located geminally with respect to hydroxy groups); and doublets at 6.19 and 6.60 ppm (protons of hydroxy groups). Consequently, there are three double bonds in (IV). The elementary composition given and the results of a study of the PMR spectrum of the lactone show that it belongs to the sesquiterpene lactones of the germacrane series.

The presence in the isoridentin molecule of two secondary hydroxy groups was also shown by the preparation of a diacetyl derivative (V), the IR spectrum of which had the characteristic bands of the vibrations of an ester group at 1740 and 1240 cm⁻¹.

The hydrogenation of (IV) with NaBH₄ gave dihydroisoridentin (VI), C₁₅H₂₂O₄, mp 187-

189°C, mol. wt. 266 (mass spectrometry). From the products of the hydrogenation of the lactone in the presence of PtO₂ we isolated a tetrahydro derivative, C₁₂H₂₄O₄, mp 228–230°C, mol. wt. 268 (mass spectrometry). Selective oxidation of isoridentin led to a keto compound (VII) the IR spectrum of which showed an absorption band at 1650 cm⁻¹ (C=O conjugated with a double bond).

On comparing the PMR spectra of diacetylisoridentin and of the lactone itself it was found that the signal of the protons of the methyl group in the latter appears in the weaker field by 0.29 ppm. This fact shows that the methyl group and one of the hydroxy groups are present on adjacent carbon atoms.

Analysis of the PMR spectra of (V) taken with the addition of the paramagnetic shift reagent Eu(FOD)₃ showed that both the groups of protons geminal to hydroxy groups interact vicinally with the protons of the same methylene group. Consequently, the OH groups are present on the C-1 and C-3 atoms and the lactone ring is trans-linked to the germacrane skeleton at C-6 and C-7.

Thus, isoridentin is a stereoisomer of ridentin [3] and has the structure (IV).

**EXPERIMENTAL**

The IR spectra were taken on a UR-20 instrument (KBr tablets), the mass spectra on an MKh-1303 instrument, and the PMR spectra on a JNM-4H-100 spectrometer in CDCl₃ and deuteropyridine solutions, D – HMDS.

**Diacetylisoridentin (V).** A solution of 70 mg of the lactone in 1 ml of pyridine was treated with 1.5 ml of acetic anhydride. After 2 h, the spot of the initial lactone had disappeared. The solvent was evaporated off and then chromatography on silica gel (KSK, 200 μm) yielded 40 mg of crystals with mp 136–138°C (hexane–benzene) and the composition C₁₂H₂₄O₄ (II).

**Oxidation of Isoridentin (VII).** A cooled solution of CrO₃ in pyridine was added to 100 mg of the lactone in pyridine. The mixture was kept at −6°C for 3 h and was then evaporated in vacuum, after which water was added to the residue and it was shaken with chloroform. The chloroform extract was washed with water, the solvent was distilled off, and the residue was chromatographed on silica gel with elution by benzene and then by benzene–ether (10:1). This gave 40 mg of the hydroxy compound (VII) with the composition C₁₂H₁₈O₄, mp 155–157°C (hexane–ethyl acetate), [α]D² + 130.4° (c 0.46; MeOH).

**Dihydroisoridentin (VI).** A solution of 150 mg of the lactone in ethanol was treated with 200 mg of NaBH₄. The reaction took place slowly, and methanol was added dropwise to accelerate it. The reaction was followed by TLC on silica gel in the chloroform–methanol (30:1) system with a 0.5% solution of vanillin in concentrated H₂SO₄ as the chromogenic agent. The excess of NaBH₄ was decomposed with water. The mixture was neutralized with 10% CH₃COOH, and the reaction product was extracted with chloroform. This yielded crystals with the composition C₁₂H₂₄O₄, mp 187–188°C (ethanol), H+ 266.

**Tetrahydroisoridentin.** A solution of 100 mg of isoridentin in 5 ml of glacial acetic acid was treated with 10 mg of PtO₂ and hydrogenated for 2.5 h. From the reaction products