

This is the first time that artecanin, estafiatin, and balchanolide have been isolated from Achilleum millefolium L. s. l. Thus, European and Central Asian yarrows differ with respect to the qualitative compositions of the sesquiterpene lactones that they contain.

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#### ANTIOXIDANT ACTIVITY OF $\ell$ -CHIMGIN

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As is known, an important role in the pathology of various diseases is played by the peroxidic oxidation of polyunsaturated fatty acids (PFAs) [1-3]. Forming one of the trigger mechanisms in the development of numerous pathological states, lipid peroxides disturb the permeability of biomembranes and suppress the activity of enzymes and other regulatory mechanisms of metabolic processes [4, 5].

A basic method of combating the undesirable consequences of an increase in the free-radical oxidation of lipids is the use of various antioxidants, preference being given to antioxidants from natural sources. Such physiologically active substances are usually non-toxic and may serve as a source of raw material for obtaining medicinal preparations. Plant materials form a rich source of natural antioxidants [6, 7].

The aim of the present work was to study the antioxidant activity of mouse liver lipids in a model of hyperoxia with the addition of an aromatic ester isolated from the roots of Ferula dissecta gathered in the environs of the village of Kainarark, Alma-Ata province, KazSSR, and identified as  $\ell$ -chimgin [8].

The antioxidant activity was determined on the model of the autooxidation of methyl oleate [9], the lipids being extracted from liver homogenates by Folch's method [10]. The amount of hydroperoxides of the liver lipids was determined by iodometric titration [11]. Table 1 gives the results obtained for three groups, each of which consisted of 40 mice.

TABLE 1. Amounts of Lipid Hydroperoxides in Mouse Livers, moles/g of Lipids ( $M \pm m \times 10^{-2}$ )

Hyperoxia	Methyl oleate	Methyl oleate + $\ell$ -chimgin in the following doses, mg/kg		
		100	150	200
After 10 h	$7.8 \pm 0.2$ $P < 0.05$	$2.7 \pm 0.1$ $P < 0.05$	$2.4 \pm 0.1$ $P < 0.05$	$2.8 \pm 0.1$ $P < 0.05$
20 h	$18.0 \pm 0.1$ $P < 0.05$	$4.2 \pm 0.2$ $P < 0.01$	$3.8 \pm 0.2$ $P < 0.1$	$4.6 \pm 0.1$ $P < 0.05$
30 h	—	$8.8 \pm 0.1$ $P < 0.05$	$8.2 \pm 0.1$ $P < 0.05$	$9.0 \pm 0.2$ $P < 0.05$

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The experiments showed that the intraperitoneal administration of  $\beta$ -chimgin in doses of 100-200 mg/kg live weight led to an increase in the antioxidant activity of the lipids, which averaged 2200 h·ml/g. In the control group (pure methyl oleate) it was 1000 h·ml/g, while for the well-known antioxidant  $\alpha$ -tocopherol it was 1300 h·ml/g.

The results presented demonstrate that  $\beta$ -chimgin possesses a pronounced antioxidant effect. Chimgin may apparently play the role of donor of the proton of a hydroxy group for peroxide radicals, thereby inhibiting the autooxidation of methyl oleate, because of which a break appears in the radical chain reaction.

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#### CYCLIZATION AND REARRANGEMENTS OF DITERPENOIDS

##### X. SUPERACID CYCLIZATION OF LABD-8,13E- AND -8,13Z-DIEN-15-OIC ACIDS AND THEIR ESTERS

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In continuation of studies on the superacid cyclization of terpenoids [1-4], in the present communication we report results on the cyclization of labd-8,13E- and -8,13Z-dien-15-oic acids (I and II) and their methyl esters (III and IV).

Nakano and Hernandez [5] performed the cyclization of the ( $\pm$ )-isomer of acid (I) having a double bond at C8-C17 with formic acid (boiling, 4 h), and, after methylation, they obtained methyl ( $\pm$ )-isoagath-12-en-15-oate (V) (64% yield).

By the interaction of the 13E- acid (I) in 2-nitropropane with fluorosulfonic acid (ratio of substrate to  $\text{FSO}_3\text{H}$  = 1:20, concentration of substrate 0.15 M,  $-(50-55)^\circ\text{C}$ , 30 min;  $\text{Et}_3\text{N}$  was added to the reaction mixture and it was then worked up in the usual way), followed by the methylation of the reaction product with diazomethane and chromatographic purification on a column of  $\text{SiO}_2$ , we have isolated a 92.5% yield of methyl (14R)-isoagath-12-en-15-oate (V), mp  $102-103.5^\circ\text{C}$  (from  $\text{CH}_3\text{OH}$ ),  $[\alpha]_D^{22} -62^\circ$  (c 1.1;  $\text{CHCl}_3$ ). According to the literature [6], mp  $104-105^\circ\text{C}$ ,  $[\alpha]_D -58^\circ$  (see top of following page).

Under the same conditions, the cyclization of the 13Z- acid (II) required 45 min for completion. After analogous working up, methyl (14S)-isoagath-12-en-15-oate (VI) was isolated in 86.5% yield, mp  $80-81.5^\circ\text{C}$  (from  $\text{CH}_3\text{OH}$ ),  $[\alpha]_D^{22} +188^\circ$  (c 1.3;  $\text{CHCl}_3$ ). Asselineau et al. [6] reported: mp  $79^\circ\text{C}$ ,  $[\alpha]_D +197^\circ$ .

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