Chemistry of Natural Compounds, Vol. 47, No. 4, September, 2011 [Russian original No. 4, July-August, 2011]

ALKALOID CONTENT IN VARIOUS PARTS OF *Sophora flavescens*

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UDC 582/739:547.944/945

Quinolizidine alkaloids are rather frequently encountered in plants of the family Fabaceae [1]. According to modern research, this alkaloid group is a chemotaxonomic marker for the genus *Sophora* L. [2]. We studied *Sophora flavescens* Soland., a medicinal plant that is widely used in traditional Eastern medicine [3–5]. A large number of recent publications concerns the isolation, identification, and pharmacological properties of alkaloids from roots of this plant [6–8]. However, the alkaloid content in other parts of the plant is insufficiently studied. Therefore, our goal was to study the accumulation dynamics of alkaloids in various parts of *S. flavescens*.

Raw material for analysis was collected in Chita Oblast in 2001–2002. Total alkaloids were obtained by the standard method [9]. The alkaloids were isolated and identified using HPLC, GC, and GC–MS.

According to the total alkaloids in the various parts of *S. flavescens*, the greatest amount of alkaloids was localized in the seeds (Table 1). A rather high content was noted in pericarps. The studied species characteristically produces many seeds. One generative runner forms on average 49.4 ± 14.2 seeds. Generative plants have 14.1 ± 1.77 runners. The mass of 1,000 seeds varies from 39.4 to 58.8 g. This all indicates that further study of the seeds and pericarps of *S. flavescens* as alkaloid sources is promising.

The accumulation of alkaloids in the subterranean part was maximum during flowering and lower during fruiting. Apparently this was related to the fact that active growth of plant rhizomes was observed during flowering whereas a large part of the alkaloids transfers to the seeds during fruiting. Alkaloids accumulated in those plant parts that were important or necessary during a particular development stage in order to create the next generation [10]. We showed earlier that both seed and vegetative propagations were characteristic of this species [11]. These biological features of *S. flavescens* apparently determine the alkaloid accumulation dynamics in the plant.

GC–MS studies of total alkaloids obtained from the subterranean part of *S. flavescens* showed that the main component in the mixture was matrine. Furthermore, the structurally related alkaloids sophoramine, sophocarpine, and sophoranol were present in small quantities. Table 2 presents the study results. The isolated total alkaloids were dissolved in $CHCl_3$ and precipitated by ether in order to obtain matrine and matrine *N*-oxide. Multiple crystallizations of the loose yellow precipitate from acetone isolated two types of crystals, prismatic with mp 205–206°C (matrine *N*-oxide) (mp 208°C [12]) and needle-like with mp 85°C (matrine) (mp 84°C [12, 13]).

The structures of these alkaloids were confirmed by PMR and ^{13}C NMR spectra, HPLC, and XSA. Also, GC–MS studies of the matrine sample obtained by us showed that impurities of structurally related minor alkaloids were present in the sample in addition to the main component. Therefore, we used the same sample for calibration after establishing beforehand the percent content of matrine in it. The sample purity (91%) was established by GC using a thermal-conductivity detector. This sample with a correction for 91% purity was used to calibrate the GC–MS data and to determine the quantitative content of matrine in the total alkaloids. Table 2 presents the GC–MS data for the percent content of matrine in the total alkaloids.

In summary, it can be noted that the comprehensive study of the alkaloid contents of *S. flavescens* found their dynamics in various parts of the plant and enabled biological features of the species to be assessed.

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0009-3130/11/4704-0669

TABLE 1. Alkaloid Contents in Various Parts of *S. flavescens*

Collection site	Collection date	Phenophase	Alkaloid content, %	Matrine content in total alkaloids, %
		Roots and rhizomes		
Tsokto-Khangil	24.07.2001	Flowering	1.18 ± 0.03	61.0
Tsokto-Khangil	11.07.2002	Flowering	1.64 ± 0.16	52.0
Tsokto-Khangil	27.08.2002	Fruiting	1.31 ± 0.05	58.5
Novoorlovsk	21.07.2001	Flowering	1.63 ± 0.09	59.0
Novoorlovsk	08.07.2002	Flowering	2.36 ± 0.03	65.0
Novoorlovsk	29.08.2002	Fruiting	1.89 ± 0.05	62.0
		Herb		
Nerchinsk plant	26.06.2002	Flowering	0.27 ± 0.02	–
		Seeds		
Nerchinsk plant	28.08.2002	Fruiting	2.48 ± 0.24	–
Tsokto-Khangil	26.08.2002	Fruiting	2.43 ± 0.10	–
		Pericarps		
Nerchinsk plant	28.08.2002	Fruiting	1.17 ± 0.09	–

TABLE 2. Principal Components of Total Alkaloids Determined by GC–MS

Compound	Retention time, min	M	Strongest ions			
Matrine	22.856	248	248	205	150	96
Sophocarpine	22.667	246	246	203	150	96
Sophoramine	24.370	244	244	215	136	96
Sophoranol	23.229	264	264	247	221	112

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