Analysis of the Active Compounds in Different Parts of the *Schisandra chinensis* Plant by Means of Pyrolysis-GC/MS

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**Summary.** Different parts of the *S. chinensis* tree (seeds, seed shells, fruits, leaves, and shoots) were characterized by means of analytical pyrolysis – gas chromatography/mass spectrometry. The samples were pyrolyzed at 350°C leading to the evaporation of the thermally stable lignans. Besides the quantification of the lignans deoxyschisandrin, gomisin N, schisandrin, wuweizisu C, gomisin A, and angeloylgomisin H, further information about the composition of the plant parts, such as lignin, terpene, fatty acid, and carbohydrate content, could be obtained. The results were compared to the ones obtained by supercritical fluid extraction with carbon dioxide as well as literature data and were found to match.

**Keywords.** Lignans; Natural products; Pyrolysis-gas chromatography/mass spectrometry; *Schisandra chinensis*.

**Introduction**

*Schisandra chinensis* is a woody, deciduous liana with round, light red berries. Its natural distribution area is Japan, China, Korea, and Russia, but the plant can also be cultivated in central Europe. Parts of it have long been used in traditional Chinese medicine. Especially to mention is the hepatoprotective effect, which is due to the high content of dibenzo[a,c]cyclooctadiene lignans [1, 2]. This group of compounds has firstly been isolated from the nonsaponifiable part of the seed oil [3] and up to now about forty different lignans of this type have been described. The results of pharmacological investigations led to the development of the synthetic drug *DDB* (dimethyl-4,4′-dimethoxy-5,6,5′,6′-dimethylenedioxybiphenyl-
2,2′-dicarbonate) which is derived from the natural lignan schisandrin C [4]. The lignans of *S. chinensis* have been characterized extensively by means of mass spectrometry, as they yield a stable molecular ion upon EI ionization, which makes them easy to trace and identify [5–7]. Major lignans in European seeds are reported to be deoxyschisandrin (1) (0.07–1.09%), gomisin N (2) (0.24–1.49%), schisandrin (3) (0.75–1.86%), wuweizisu C (4) (0.01–0.34%), and gomisin A (5) (0.13–0.90%) [5], but distribution and content of lignans strongly depend on the origin and the growth conditions of the plant [8].

A disadvantage of the GC/MS and HPLC/MS techniques used so far is that the plant material has to be extracted with a solvent prior to analysis. Thus discrimination of some compounds can occur with different solvents and therefore not all components might be transferred to the analytical process quantitatively. Analytical pyrolysis on the other hand is a technique, where the whole sample (e.g. a plant part) is rapidly heated up to a defined temperature and the volatile pyrolysis products are immediately transferred onto the column of a GC/MS system. This method has already been used for the characterization of wood [9–12], cellulose [13–16], lignin [17–21], and other plant materials [22]. Galletti et al. investigated the pyrolytic behavior of a series of 2,6-diaryl-3,7-dioxabicyclo[3.3.0]octane lignans [23], which formed mostly monoaromatic rings with a C₁ to C₃ side chain attached as known from lignin. Despite the fact that analytical pyrolysis aims at the destruction of large molecules, small, thermally stable molecules will not be fragmented but evaporated from the surrounding matrix. Therefore the method was applied to the problem of identifying lignans in different parts of *S. chinensis* and predicting their composition in an oil obtained by supercritical fluid extraction.

**Results and Discussion**

In this work the lignan composition of seeds, seed shells, fruits, leaves, and shoots from *S. chinensis* was investigated. The plants used were grown in Austria since 1991 and harvested in 2000, except for the leaves which were harvested in 1992. Table 1 shows the structure of the main lignans present in *S. chinensis*. A pyrolysis temperature of 350°C was chosen because preliminary experiments have shown that this temperature is high enough to give a reproducible profile of lignans and the decomposition of the matrix is much lower than at higher temperatures. Investigations on the plant matrix have been carried out at 500°C to achieve satisfactory pyrolytic cleavage of high molecular weight compounds (lignin, cellulose, etc.).

Upon chromatography the pyrolysis products can be assigned to several groups, as there are terpenes, fatty acid derivatives, lignans, and lignin derived products in the case of seed shells and shoots. Figure 1a shows the chromatogram of seeds after pyrolysis at 350°C, Fig. 1b is an enlargement of the lignan region.

The main fraction of lignans can be found in the seeds, seed shells, and fruits, where the total content of the six lignans investigated is 3.21%, 1.87%, and 1.43%. Leaves and shoots also contain the same lignans but only in very low concentrations (0.43% and 0.44%). Seeds as well as seed shells have a high amount of gomisin N (2) and schisandrin (3), whereas in fruits the content of gomisin N (2) is about five times higher than that of all other lignans. In leaves and shoots all lignans seem to be evenly distributed between 0.5% and 1.2%. Figure 2 shows the concentrations of