Intraspecific Taxonomy of *Coriandrum sativum* L.: Comparison of Morphological and Phytochemical Data

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Abstract

***Coriandrum sativum* L., Apiaceae (Coriander) is a major spice plant of the Indian sub-continent. Leaves, seeds and essential oils prepared from leaves and seeds are all used as spice material, the leaves also as vegetables. The species has a wide range of distribution and a formal taxonomic classification into three subspecies with ten botanical varieties. A complete morphological description is required to characterize the accessions and to evaluate the botanical classification. In addition, the analysis of the essential oil content is helpful for chemotaxonomic studies. Molecular studies with Amplified Fragment Length Polymorphism (AFLP) are planned to verify the taxonomy of the subspecies and the varieties.**

INTRODUCTION

Coriandrum sativum L., (Coriander) is a major crop plant especially in the Indian sub-continent but also in Europe, Northern Africa and Asia. Coriander probably originated in the Near East (the oldest record being from Israel in 6,000 BC). Leaves, seeds and essential oil prepared from leaves and seeds are all used as spice material. Today most coriander fruits are used for curry powder. Coriander has also been known as a vegetable in China since the 5th century and it has been grown in Europe since the 15th century. The use of the vegetative part of the plant, known as Cilantro, is increasingly popular in North America and Western Europe today.

The species has a very wide range of distribution and a formal taxonomy distinguishing three subspecies and ten botanical varieties (Diederichsen, 1996a; Diederichsen and Hammer, 2003).

The coriander collection of the German ex situ genebank covers 457 accessions from more than 60 countries of origin. All subspecies and varieties are represented. More than 380 of these accessions were under cultivation to study the biodiversity of the collection. A main focus of this study was to compare morphological data with the results of phytochemical and molecular studies in order to assess and to verify the existing taxonomic classification.

MATERIAL AND METHODS

Three hundred eighty eight accessions were cultivated in Gatersleben under standard environmental conditions. A complete morphological description of the accessions was made based on leaf shapes, colour of the flowers, size and shape of fruits, and the thousand grain weight. Characterisation followed a modified version of the descriptor used by the International Plant Genetic Resources Institute (Diederichsen, 1996b). Based on these morphological descriptions identification was carried out using the key published by Diederichsen and Hammer (2003).

For phytochemical studies, seeds of all accessions were prepared by wet milling. 500 mg of the seeds were mixed with 4 ml iso-octane (2,2,4-trimethylpentane) and fenchone (1:2000) as internal standard and milled in the solvent with an ultra-thurrax-homogeniser. The amounts of α-pinene, p-cymene, limonene, γ-terpinene, linalool, camphor, geraniol, and geranyl acetate were detected and the essential oil value was calculated as the sum of all detected single volatile components. The detailed method is described in Krüger et al. (1998) and also published for fennel (Krüger and Schulz, 2007).

There is a good correlation (R^2=0.97) with hydrodistillation results.

The intraspecific classification was studied with AFLP analysis. Total DNA extraction was carried out using DNeasy kit (Qiagen), according to the manufacturer's instructions. The AFLP protocol followed the instructions described by Vos et al. (1995) with minor modifications.

RESULTS AND DISCUSSION

Morphological Descriptions

Based on the detailed results of the morphological description (described above), identification to subspecies could be accomplished very easily, however identification of varieties is a serious problem. In spite of having access to all the morphological data, exact separation of varieties is often very difficult or impossible.

Phytochemical Studies

There was enough seed material of only 149 accessions to produce reliable results on the essential oil (monoterpene) content and compounds. The results agree with a previous phytochemical evaluation (Krüger et al., 1998), which showed that there is no differentiation of the three subspecies because of the heterogeneity of varieties within the subspecies (Figs. 1 and 2). This means that identification of the subspecies was based on morphological data only. Two varieties can be separated by monoterpene content, var. *syriacum* Diederichsen with almost no essential oil (<0.1%) and var. *microcarpum* (DC.) Hegi with oil content higher than 0.5% (Fig. 2). The content of the main monoterpene linalool gives no further information for identification of the varieties. In conclusion, no other varieties can be identified by the essential oil content or compounds.

Molecular Studies

For clear identification of the varieties molecular data are important. But the results from one primer pair were not enough to give a final conclusion. Running further gels with additional primer pairs will be necessary to reveal the intraspecific structure of the subspecies.

CONCLUSIONS

In order to study the intraspecific taxonomy of *Coriandrum sativum*, morphological, phytochemical, and molecular data must be compared. Morphological information gives a good differentiation of the subspecies. For the varieties, additional data are necessary. The quality and the quantity of the essential oil is not helpful in separating all varieties. Molecular data are necessary to verify the intraspecific structure.

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Figures

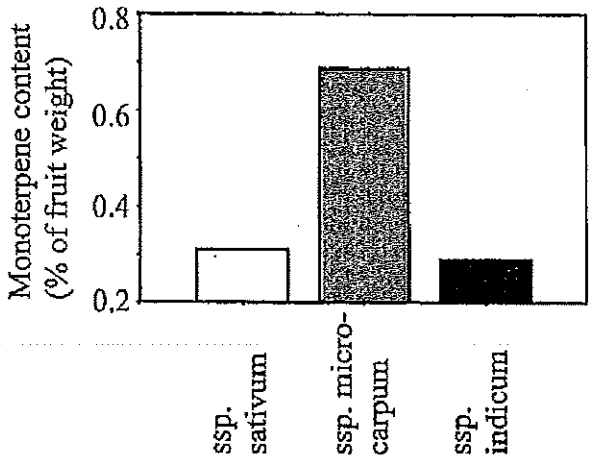

Fig. 1. Differences of the monoterpene content of the subspecies.

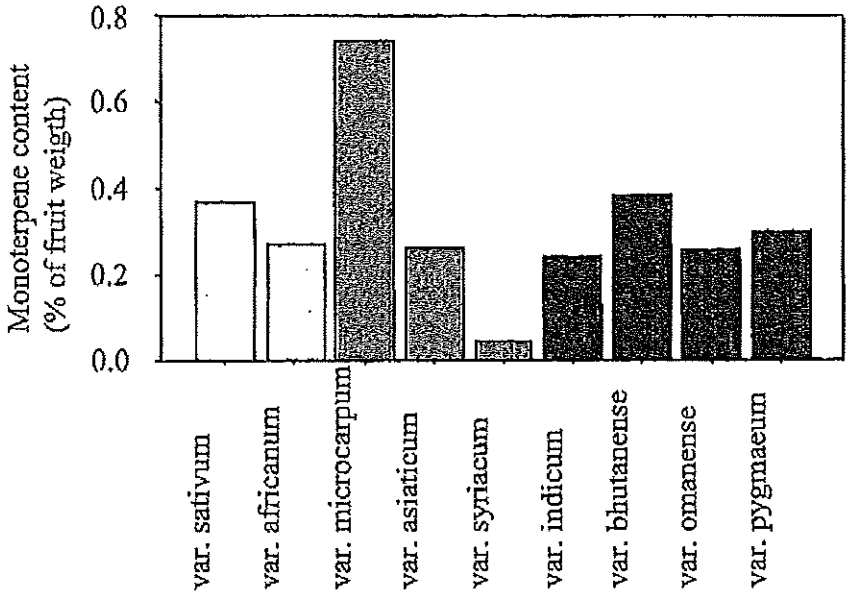

Fig. 2. Differences of the monoterpene content of the varieties.