

Aroma in plants: can it serve as a criterion in delimitation of taxa at infraspecific level?

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Essential oils, volatile secondary metabolites responsible for the odours of aromatic plants, are used in perfumery, as aroma products, flavouring agents in foods and beverages, in cosmetic products and as drugs. There is an increasing global trend in the consumption of self-prescribed herbal and natural products (and thus non-regulated) for treating numerous ailments such as cancer, and even by healthy individuals as a preventative. This, however, poses a serious health risk since oils from different locations may differ in their chemical composition, thus affecting their biological activity. The quality and yield of essential oils, usually extracted by steam distillation, from aromatic plants is influenced by the harvesting season^{1,2}, fertilizer application³, choice and stage of drying conditions^{4,5}, geographic location⁶, chemotype, subspecies or cultivars⁷⁻¹⁰, choice of plant part or genotype¹¹ and extraction method¹².

The genus *Origanum* (tribe Menthaeae, family Lamiaceae) is portrayed by enormous morphological and chemical diversity. Ietswaart¹³ classified the genus into 10 sections (*Amaracus*, *Anatolicon*, *Brevifilamentum*, *Longitubus*, *Chilocalyx*, *Majorana*, *Campanulicalyx*, *Elongatispica*, *Origanum* and *Prolaticorolla*), divided into 52 taxa (43 species, 6 subspecies and 3 varieties), most of them having a restricted distribution around the Mediterranean. In particular, three taxa are restricted to Morocco and south of Spain, two occur in Algeria and Tunisia, three are endemic to Cyrenaica (Libya), nine are restricted to Greece, South Balkans and Asia Minor (six are local Greek endemics), 21 are found in Turkey, Cyprus, Syria and Lebanon, and eight are locally distributed in Israel, Jordan and the Sinai Peninsula.

According to Ietswaart¹³, only members of the monospecific section *Origanum* are found in India (*Origanum vulgare* L. subsp. *viridulum* (Martrin-Donos) Nyman and the typical subsp. *Origanum vulgare* L. subsp. *vulgare*). He recognized six subspecies in the section based on differences in the indumentum, number of sessile glands on the leaves, bracts and calyces, and in the size and colour of the bracts and flowers. However, various flora and revisionary studies in the fam-

ily Lamiaceae earlier in the Indian subcontinent discouraged any infraspecific taxa delimitation due to the intermediates present within the populations of *O. vulgare*^{14,15}. Hedge¹⁵ remarks 'after studying the rather abundant material now available from Pakistan, I conclude that, at least in our area, these subspecies were untenable; and, because the variation was so great and continuous, even varietal rank was not merited!' Hooker¹⁶ treated *O. normale* Don (with smaller, less-coloured bracts) and *O. laxiflora* Royle (a prostrate state) as synonyms under *O. vulgare* with the justification 'but intermediates are very common!' Botanists in many countries have always been motivated by the diversity encountered in *Origanum* and have made considerable efforts in trying to better classify it¹⁷. However, the intraspecific classification still has many contradictory points and certainly needs further attention for resolving the *O. vulgare* complex.

During surveys made by us in the Western Himalayan region from 2005 till date, the large number of morphological variations and the intermediates observed in the populations of *O. vulgare sensu lato* tempted us to collect them and study the chemo diversity (based on essential oil composition) reported by us earlier¹⁰. Six chemotypes were reported based on essential-oil composition depending on the percentage of phenolic compounds (thymol, carvacrol) and monoterpenes (linalool). Although similar in morphology, the chemotypes differed completely in the aroma that they impart. The population of *O. vulgare* rich in phenolic compounds had a 'spicy' or 'pungent' aroma, whereas the population rich in monoterpenes had a 'floral' or 'pleasant' aroma. The two populations were found intermingled; so the question of seasonal, environmental and ecological effect on the essential-oil composition does not arise. The characters outlined above based on degree of hairiness, colour and size were overlapped in the taxa and were not at all satisfactory to delimit taxa at infraspecific level, but as mentioned above the characters based on aroma did not at all overlap in the field and were quite satisfactory in delimiting the aroma types. Now the question to be answered is as follows: can aroma in the *O. vulgare*

complex be a criterion for delimiting infraspecific taxa? The answer may lie in the aroma.

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