

Composition and content of pyrethrin in different flower development stages of Dalmatian pyrethrum

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Introduction

Pyrethrin is a globally known insecticidal compound extracted from the dry, ground flower heads of Dalmatian pyrethrum (*Tanacetum cinerariifolium* (Trevir.) Sch. Bip). It consists of six compounds: pyrethrin I and II, cinerin I and II and jasmolin I and II. The highest pyrethrin content (94% of the total pyrethrin content) in pyrethrum was recorded in the achenes (Kiriamiti, 2003). The pyrethrin content depends among others, on genotype (Grdiša et al., 2014), climate conditions and the flower development stage in which the flowers are harvested (Grdiša et al., 2022). Several flower development stages can be distinguished. At first, the ray petals unfold, followed by the florets opening sequentially from the margins towards the center, with a single row of florets opening daily (Chandler, 1951). To achieve the highest possible pyrethrin yield, harvesting time is determined by the optimal developmental stage of the pyrethrum flowers (Head, 1966). This study was aimed at determining the pyrethrin content in Dalmatian pyrethrum flowers sampled in different flower development stages.

Materials and methods

Dalmatian pyrethrum flower heads from two distinct populations (Senj and Mt. Biokovo) were sampled in the following flower development stages: (1) well developed closed buds, top of the ray florets visible; (2) ray florets in a vertical position, covering disc florets (3) ray florets in a

vertical position, disk florets visible; (4) ray florets in horizontal position/0-20% ray florets opened; (5) 20-70% disc florets opened; (6) 70-80% disc florets opened; (7) 80-100% disc florets opened/color of disc florets diminishing, petal florets intact. A recently optimized matrix solid-phase dispersion method (MSPD) was utilized for pyrethrin extraction (Biošić et al., 2020). Separation and quantification of pyrethrin components were performed using high-performance liquid chromatography with diode array detector (HPLC-DAD). Pearson's correlation index was calculated between pyrethrin components, and differences between the populations were tested using the analysis of variance.

Results and discussion

Total pyrethrin content in the analyzed populations gradually changed with the flower development stage. In the first stage, the content was the lowest (on average 0.55% of dry flower weight), increasing on average by 41% in the second stage, and further increasing by 39% in the third stage of the flower development. A slight decrease in pyrethrin content was recorded in the fourth stage (on average 10%), followed by a slight increase in the fifth stage (on average 6%). In later stages, the pyrethrin content decreased, first by 12% (sixth stage), followed by an additional decrease by 21% (seventh stage). In the first stage the pyrethrin I/II ratio was on average 0.91 and it decreased by 17% in the second stage due to the high increase of pyrethrin II. In the Mt. Biokovo population, the ratio continued to decrease due to high pyrethrin II and low

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pyrethrin I content, increasing only slightly in the sixth phase (but still lower than in the first stage). In the Senj population, the ratio continued to increase steadily until the final phase reaching 1.22 (due to high content of pyrethrin I and lower content of pyrethrin II). Statistically significant strong positive correlation between both pyrethrin I and II, and total pyrethrin content was determined (0.87 and 0.79 respectively). Analysis of variance revealed significant differences in analyzed populations, based on pyrethrin I, jasmolin I and II content as well as pyrethrin I/II ratio. The changes in pyrethrin content of flower developmental stages in population from Senj are in congruence with previous research done on commercially grown pyrethrum crops (Bhat, 1995). The Mt. Biokovo population, on the other hand, did not follow the same pattern. Its distinct biochemical profile (lower pyrethrin I, cinerin I, jasmolin I and II content and higher pyrethrin II and cinerin II content) could be the population response to harsher climate in which it resides or consequence of the genetic isolation (Grdiša et al., 2014).

Conclusion

The highest total pyrethrin content was recorded in the third flower development stage in both populations of Dalmatian pyrethrum, and while both populations exhibited similar trends, the total pyrethrin content was on average higher in Senj population. The same population consistently showed higher pyrethrin I/II ratio compared to Mt. Biokovo population.

Acknowledgements

This research was funded by project KK.01.1.1.01.0005 Biodiversity and Molecular Plant Breeding, Centre of Excellence for Biodiversity and Molecular Plant Breeding (CoE CroP-BioDiv), Zagreb, Croatia.

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