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► To cite this version:

Clémentine Baccati, Charifat Saïd Hassane, Elnur Garayev, Béatrice Baghdikian. ”Arnica of Provence”: an alternative to *Arnica montana* L.? Investigations about polyphenolic composition and antioxidant potential. ICNPR 2024, Jul 2024, Krakow (Cracovie), Poland. hal-04661272v2

HAL Id: hal-04661272

<https://hal.science/hal-04661272v2>

Submitted on 11 Oct 2024

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"ARNICA OF PROVENCE": AN ALTERNATIVE TO ARNICA MONTANA L.? INVESTIGATIONS ABOUT POLYPHENOLIC COMPOSITION AND ANTIOXIDANT POTENTIAL



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A. montana

P. montanum

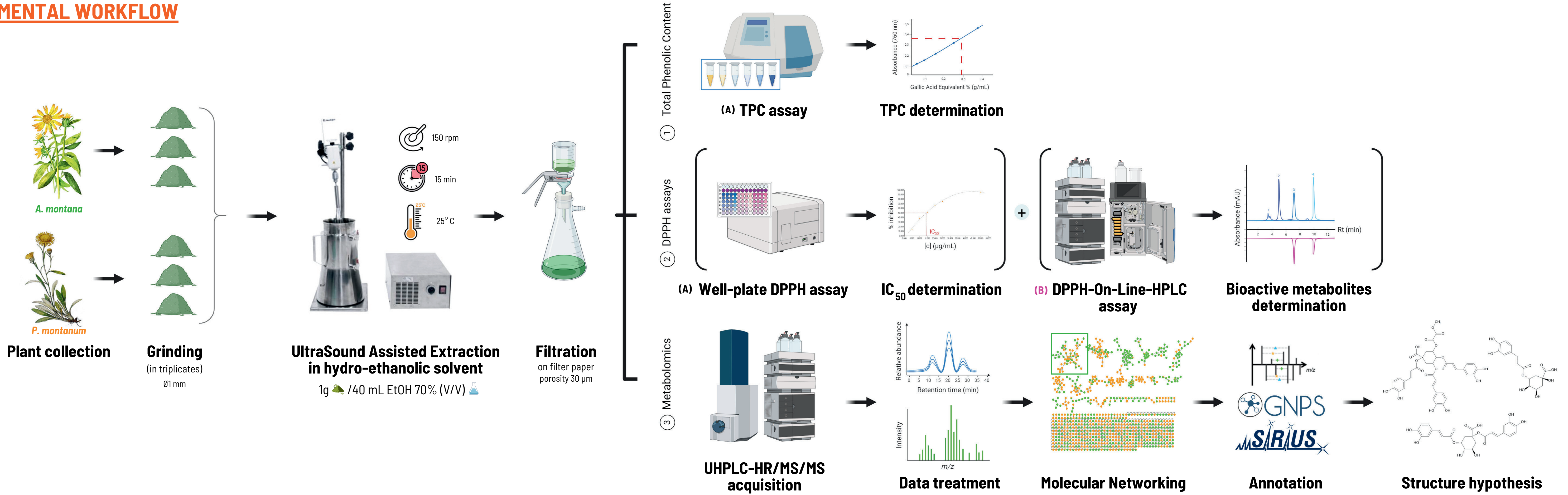
In Provence (South of France), the Asteraceae species *Pentanema montanum* (L.) D.Gut.Larr., Santos-Vicente, Anderb., E.Rico & M.M.Mart.Ort., formerly known as *Inula montana* L., is traditionally used for treating bruises, wounds, rheumatism, and muscular pain, similarly to *Arnica montana* L. It is locally referred to as "Arnica de Provence" [1, 2].

Both species mainly contain **sesquiterpene lactones and phenolic compounds**, which play a crucial role in defending against **oxidative stress**, a factor implicated in various acute and chronic diseases [3].

Due to cultivation difficulties, *A. montana* has been extensively harvested for the pharmaceutical and cosmetics industries, leading to a significant decline in wild populations. Conversely, *P. montanum*, which is easier to cultivate, could offer a viable local alternative.

This study compares the **antioxidant potential of both species** by evaluating their Total Phenolic Content (TPC) and using radical scavenging DPPH assays, including the DPPH-On-Line-HPLC assay. Additionally, their chemical composition was analyzed using UHPLC-HRMS/MS and Molecular Networking approaches [4].

EXPERIMENTAL WORKFLOW



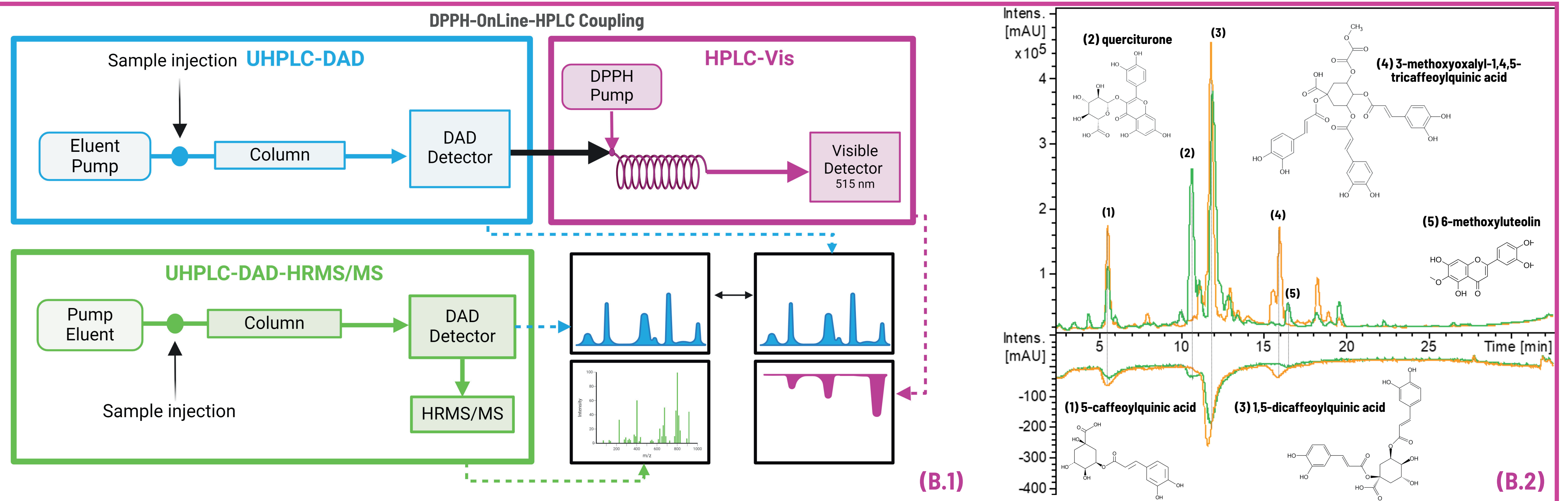
ANTIOXIDANT ACTIVITY

(A) ANTIOXIDANT POTENTIAL EVALUATION

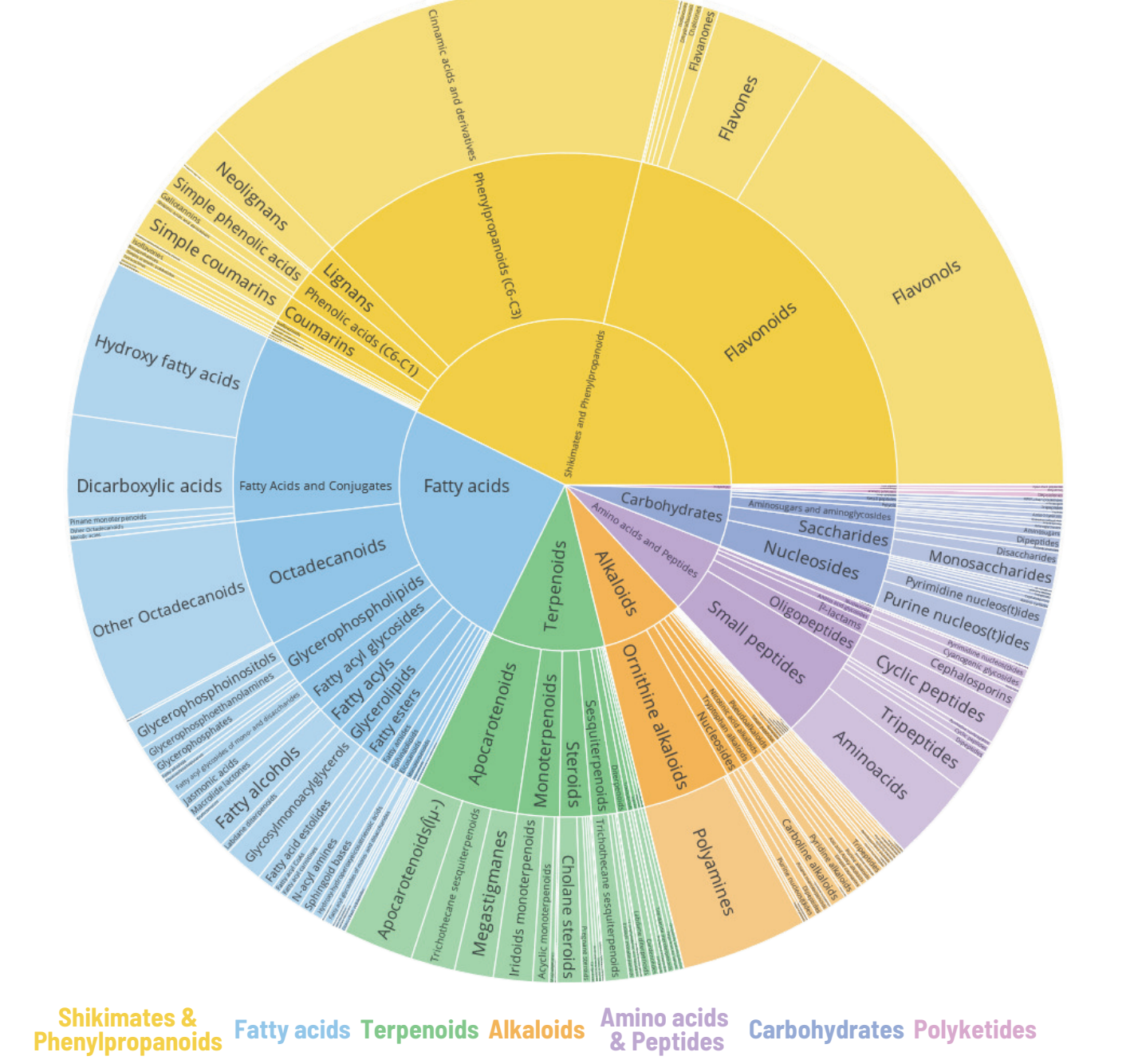
- P. montanum* TPC** << ***A. montana* TPC**
33.39 ± 0.46 mg GAE /100 mg << 44.59 ± 1.63 mg GAE /100 mg
- P. montanum* IC₅₀** << ***A. montana* IC₅₀**
23.66 ± 0.75 µg/mL << 45.71 ± 3.05 µg/mL

(B) ANTIOXIDANT COMPOUNDS DETERMINATION

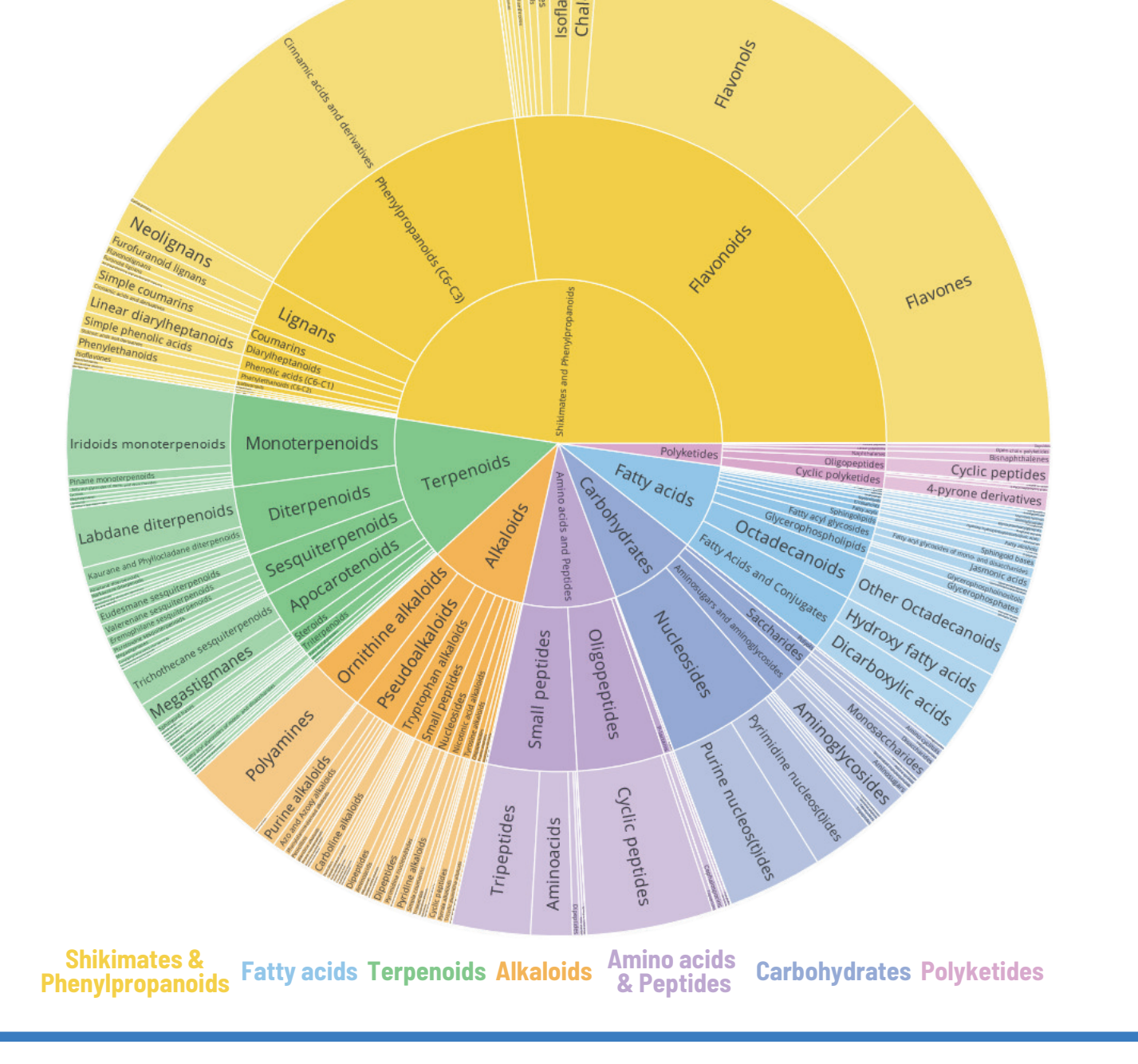
- Common bioactive compounds**
 - 1,5-dicaffeoylquinic acid (3)
 - 5-caffeoylquinic acid (1)
- A. montana* specific compounds**
 - quercitrone (2)
 - 1,4,5-tricaffeoyl-3-methoxyoxaloylquinic acid (4)
- P. montanum* specific compound**
 - 6-methoxyluteolin (5)



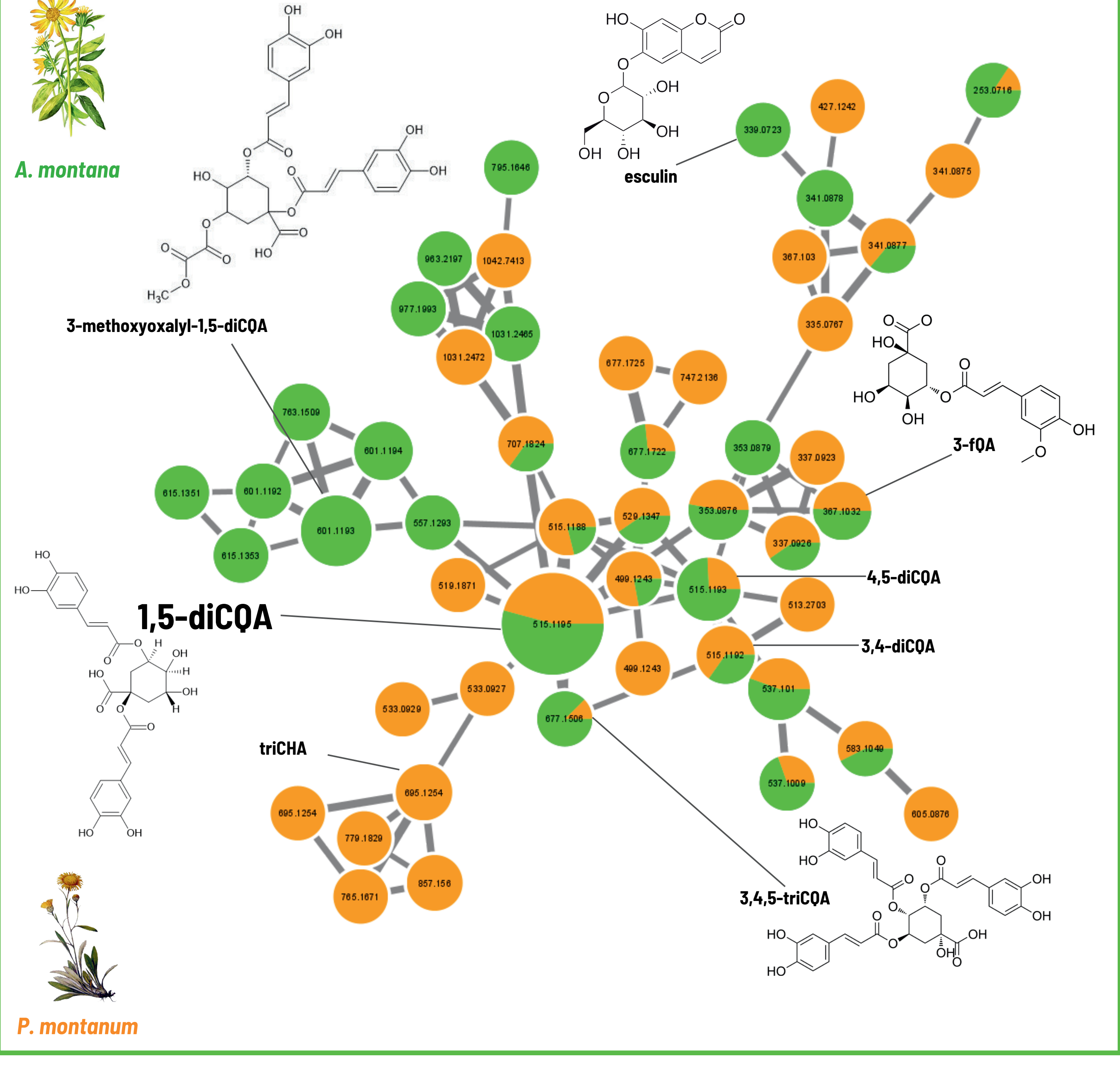
a) *A. montana* (C)



b) *P. montanum*



(D)



CHEMICAL COMPOSITION COMPARISON

(C) COMPOUNDS CLASSIFICATION ACCORDING TO CANOPUS TOOL PREDICTIONS

Both species are dominated by metabolites from the "Shikimates & Phenylpropanoids" pathway, especially **Flavonoids & Phenylpropanoids (C6 - C3)**

A. montana also showed high amounts of "Fatty acids"

(D) CHEMICAL DIVERSITY & MOLECULAR NETWORKING

Only **136 compounds** over 1054 were common to both species, among which **5-caffeoylquinic acid (1)** and **1,5-dicaffeoylquinic acid (3)**

Annotations of these main antioxidant compounds were confirmed by **injection of reference compounds**

Caffeoyl-Quinic Acid (CQA) derivatives are already known to exhibit strong antioxidant potential [5]

Example of **CQA derivatives cluster (D)** with some annotations:

- dicaffeoylquinic acid (diCQA) isomers
- tricaffeoylquinic acid (triCQA) isomers
- feruloylquinic acid (fQA) isomers
- methoxyoxalyl-diCQA esters: *A. montana* specific group
- caffeoylhexaric acids (CHA): *P. montanum* specific group

P. montanum & *A. montana* shared several CQA derivatives responsible for antioxidant activity

The antioxidant potential of *P. montanum* is higher than *A. montana*, although its TPC is lower

These studies demonstrated that *P. montanum* can be effectively used as a local alternative to *A. montana*



Antioxidant potential



Traditional knowledge



Local cultivable alternative



Sustainable development



Natural Cosmetics

[1] Garayev, E., Di Giorgio, C., Herbet, G., Mabrouki, F., Chiffolleau, P., Roux, D., Sallanon, H., Ollivier, E., Elias, R., & Baghdiikian, B. (2018). Bioassay-guided isolation and UHPLC-DAD-ESI-MS/MS quantification of potential anti-inflammatory phenolic compounds from flowers of *Inula montana* L. *Journal of ethnopharmacology*, 226, 176-184.
 [2] Gyawali, N., Rayamajhi, A., Karki, D., Pokhrel, T., & Adhikari, A. (2022). *Arnica montana* L.: Traditional Uses, Bioactive Chemical Constituents, and Pharmacological Activities. In H. P. Devkota & T. Aftab (Eds.), *Medicinal Plants of the Asteraceae Family: Traditional Uses, Phytochemistry and Pharmacological Activities* (p. 61-75). Springer Nature.
 [3] Vuolo, M. M., Lima, V. S., & Maróstica Junior, M. R. (2019). Chapter 2 - Phenolic Compounds: Structure, Classification, and Antioxidant Power. In M. R. S. Campes (Ed.), *Bioactive Compounds* (p. 33-50). Woodhead Publishing.
 [4] Breaud, C., Lallemand, L., Mares, G., Mabrouki, F., Bertolotti, M., Simmler, C., Gref, S., Mauduit, M., Herbet, G., Garayev, E., Lavergne, C., Cesari, M., Bun-Llopet, S.-S., Baghdiikian, B., & Garayev, E. (2022). LC-MS Based Phytochemical Profiling towards the Identification of Antioxidant Markers in Some Endemic Aloe Species from Mascarene Islands. *Antioxidants*, 12(1), 50.
 [5] Li, X., Li, K., Xie, H., Xie, Y., Li, Y., Zhao, X., & Chen, D. (2018). Antioxidant and cytoprotective effects of the Di-O-Caffeoylquinic acid family: The mechanism, structure-activity relationship, and conformational effect. *Molecules*, 23(1), 222.

