Title: The chromosome-based lavender genome provides new insights into Lamiaceae evolution and terpenoid biosynthesis

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Backgrounds: *Lavandula* is a distinctive genus that belongs to the species-rich and chemically diverse subclade Nepetoideae (3600 species) within Lamiaceae (~7173 species). The aromatic shrub *L. angustifolia* produces various volatile terpenoids that serve as resources for essential oils and function in plant-insect communication, such as in herbivore deterrence or pollinator attraction.

Methods: We present a high-quality reference genome for the Chinese lavender cultivar 'Jingxun 2' using PacBio and Hi-C technologies. The genetic basis underlying gene duplication was elucidated using comparative genome analysis of Lamiaceae species. Metabolites and transcriptional analyses helped investigate the evolution of volatile terpenoids in lavender.

Results: Herein, a chromosome-level genome of lavender comprising 27 pseudochromosomes was reported. In addition to the γ triplication event, lavender underwent two rounds of whole-genome duplication (WGD) during the Eocene–Oligocene (29.6 MYA) and Miocene–Pliocene (6.9 MYA) transitions. As a result of tandem duplications and lineage-specific WGDs, gene families related to terpenoid biosynthesis in lavender are substantially expanded compared to those of five other species in Lamiaceae. Many terpenoid biosynthesis transcripts are abundant in glandular trichomes. We further integrated the contents of ecologically functional terpenoids and coexpressed terpenoid biosynthetic genes to construct terpenoid-gene networks. Typical gene clusters, including *TPS-TPS*, *TPS-CYP450*, and *TPS-BAHD*, linked with compounds that primarily function as attractants or repellents, were identified by their similar patterns of change during flower development or in response to methyl jasmonate.

Conclusion: The present work sheds light on the effect of polyploidy on Lamiaceae diversity and lavender adaption. Comprehensive analysis of the genetic basis for the production of volatiles in

lavender could serve as a foundation for future research into Lamiaceae evolution, phytochemistry and ecology.

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