

Secondary Metabolites from Glandular Trichome Exudates

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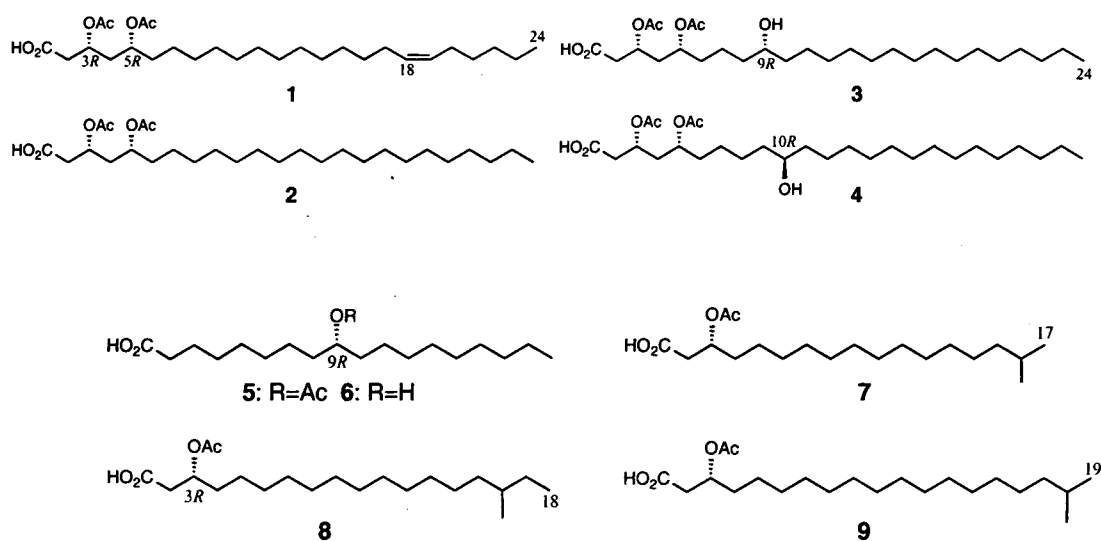
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Glandular trichomes are highly specialized epidermal cells common to many plant groups and are involved in the synthesis, storage, and secretion of a variety of secondary metabolites. The secondary metabolites produced by glandular trichomes may have diverse biological activities, such as acting to protect the aerial parts of plants against herbivores and pathogens. We carried out phytochemical studies on glandular trichome exudates over 30 plants, which led to the identification of a number of new compounds. Accumulated evidence, in addition to the results of earlier studies, will be useful for further understanding of the biosynthetic capacity of glandular trichomes. Typical structures of the secondary metabolites characterized in our study are illustrated according to their structure types in this abstract. Unless otherwise mentioned, the glandular trichome exudates were collected from leaves and/or stems.

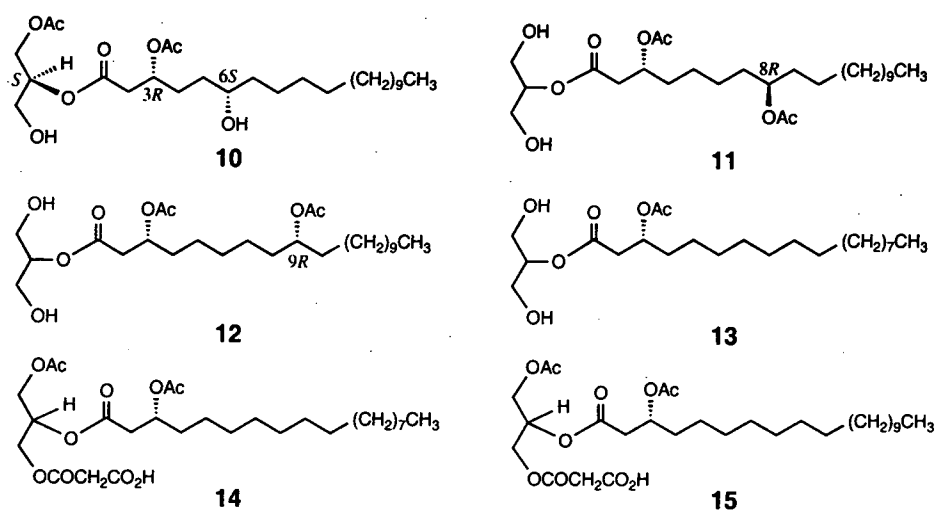
Oxygenated fatty acids

Uncarina grandidieri (Pedaliaceae) yielded oxygenated fatty acids including 1–4. Calyxes and stems of *Silene vulgaris* (Caryophyllaceae) furnished 5 and 6. *Rubus trifidus* (Rosaceae) afforded a series of iso- and anteiso-fatty acids as major constituents including 7–9.



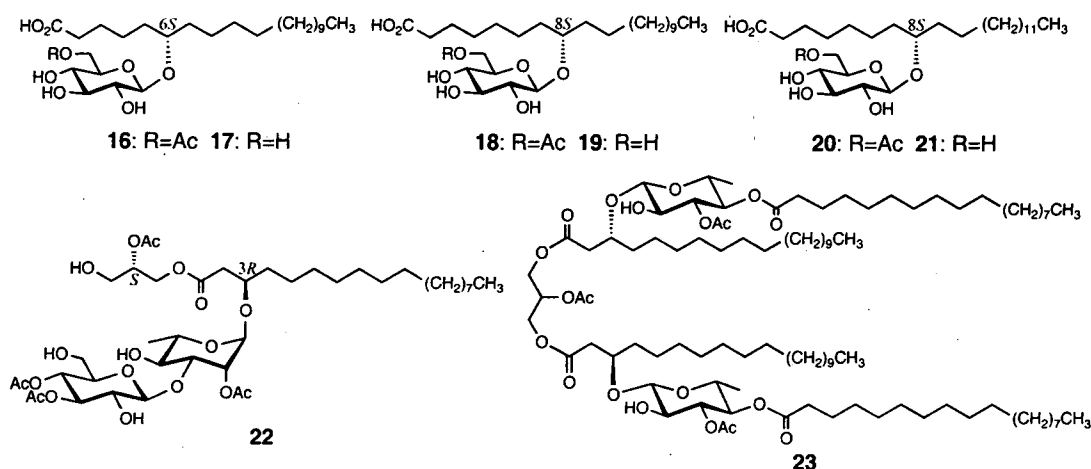
2-(Oxygenated fatty acyl) glycerol derivatives

Paulownia tomentosa (Scrophulariaceae) yielded 30 glycerides including compounds **10–13**. *Verbascum blattaria f. erubescens* (Scrophulariaceae), *Ibicella lutea* (Martyniaceae), *Proboscidea louisiana* (Martyniaceae) and *Orobanche minor* (Orobanchaceae) furnished similar glycerides. *Ceratotheca triloba* (Pedaliaceae) afforded nine unique malonylated glycerides including **14** and **15**.

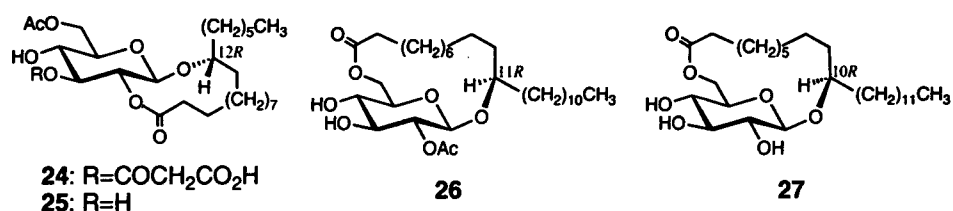


Glycosyloxy-fatty acid derivatives

Ibicella lutea yielded 6-glucosyloxy-fatty acids including **16** and **17**, whereas *Proboscidea louisiana* furnished 8-glucosyloxy-fatty acids **18–21**. *Cerasus yedoensis* (Rosaceae) yielded a glycolipid **22**, and young fruits of *Julgans mandshurica* var. *sieboldiana* (Juglandaceae) yielded a series of complex glycolipids such as **23**.

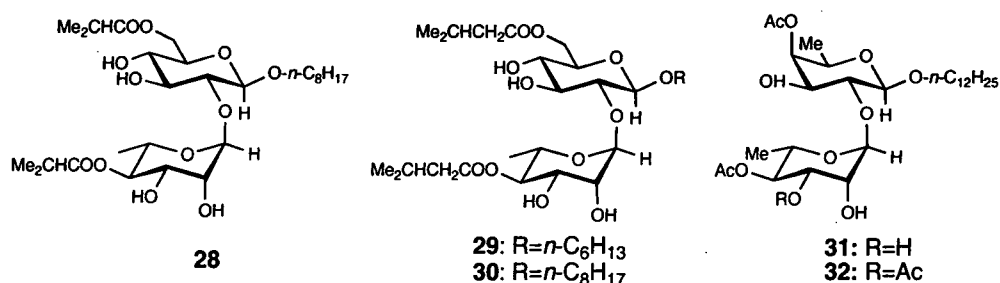


Caryophyllaceae plants are likely to produce cyclic fatty acyl glycosides: *Silene gallica* yielded a series of cyclic compounds including **24** and **25**, whereas *Cerastium glomeratum* afforded other type of cyclic compounds including **26** and **27**.



Alkyl glycoside derivatives

Geraniaceae plants characteristically afforded *n*-alkyl disaccharids: compound **28** from *Geranium carolinianum*, compounds **29** and **30** from *G. roberitianum*, and compounds **31** and **32** from *Erodium pelargoniflorum*.



Other classes of secondary metabolites were also characterized. Young fruits of *Paulownia tomentosa* exclusively furnished 6-geranyl and 6-prenyl flavanones. Dammarane triterpenes were isolated from *I. lutea*, *P. louisiana*, *J. mandshurica* var. *sieboldiana*, *C. yedoensis*, *Salvia militiorrhiza* (Labiatae). *Rosa multiflora* (Rosaceae) furnished more than 10 triterpenes of various backbones including new dammaradienol stereoisomers. *Brillantaisia* sp. (Acanthaceae) contained a sesquiterpene glycoside, (-)-*epi*- α -bisabolol 6-deoxy- β -D-gulopyranoside. Furthermore, *S. militiorrhiza* and *Rhododendron macrosepalum* afforded polyesters arising from hydroxy fatty acids, which is reminiscent of cutin of the cuticle.

In summary, the present study indicated that secondary metabolites contained in glandular trichome exudates would be much more structurally diverse than ever before expected, and the unique micro-organ is capable of introducing a hydroxy group at various positions of fatty acyl chains.