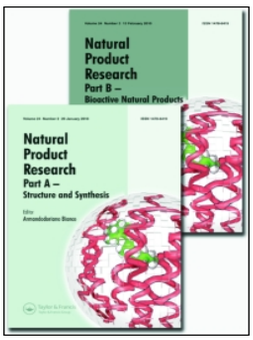

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SHORT COMMUNICATION

Chemical constituents of the aerial part of *Taraxacum mongolicum* and their chemotaxonomic significance

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ABSTRACT

A phytochemical investigation of *Taraxacum mongolicum* led to the isolation of 24 compounds, including six flavonoids (**1**–**6**), four sesquiterpenes (**7**–**10**), two sphingolipids (**11** and **12**), six glycerols (**13**–**18**) and six triterpenoids and sterols (**19**–**24**). The structures of these compounds were identified by spectroscopic methods, and their data compared with those reported in the literature. This is the first report of compounds **11**–**19** from *T. mongolicum* and the genus *Taraxacum*, and compounds **11**, **12**, **15**, **16**, **18** and **19** from the Asteraceae family. The chemotaxonomic relationship between *T. mongolicum* and other *Taraxacum* species is also discussed.

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Taraxacum mongolicum; asteraceae; flavonoid; glyceroglycolipid; sesquiterpene; triterpenoid

1. Introduction

The genus *Taraxacum* (Asteraceae) is widely distributed in warm temperate zones of the northern hemisphere, inhabiting fields, roadsides and rural sites (Lee et al. 2011). *Taraxacum mongolicum* Hand-Mazz. have long been used as medicinal herbs to treat inflammatory diseases, such as hepatitis, arthritis, rheumatism, breast abscess, lungabscess and intestinal abscess (Shi et al. 2008a). Furthermore, fresh leaves of *T. mongolicum* have been used by

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local people as vegetable food in northern China (Jia et al. 2014). Previous phytochemical investigations of *T. mongolicum* were focused on the aerial parts and explored the sesquiterpenes, such as ainslioside (Michalska & Kisiel 2008); flavonoids, such as artemetin, quercetin and luteolin (Shi et al. 2008b); and phenylpropanoids, such as caffeic acid, chlorogenic acid and esculetin (Shi et al. 2008c; Liu et al. 2014). In this study, aerial parts of *T. mongolicum* were purchased from Daegu Pharmacopoeia Market, South Korea in 2014. The voucher specimen (No. DS-NPC-0010) was deposited in the Pharmacognosy and Natural Products Chemistry Lab of the College of Pharmacy, Duksung Women's University, South Korea.

2. Results and discussion

2.1. Structure elucidation of compounds 1–24

Twenty-four secondary metabolites were isolated from the aerial parts of *T. mongolicum*, including six flavonoids (**1**–**6**), four sesquiterpenes (**7**–**10**), two sphingolipids (**11** and **12**), six glycerols (**13**–**18**) and six triterpenoids and sterols (**19**–**24**). Their structures were identified as apigenin (**1**), luteolin (**2**),quercetin (**3**), luteolin-7-β-D-glucopyranoside (**4**), quercetin-7-β-D-glucopyranoside (**5**), quercetin-37-*O*-β-D-diglucopyranoside (**6**), 1β,3β-dihydroxyeudesman-11(13)-en-6α,12-olide (**7**), ainslioside (**8**), 1β,3β-dihydroxyeudesman-6α,12-olide (**9**), 11β,13-dihydrotaraxinic acid (**10**), gynuramide II (**11**), phytolacca cerebroside (**12**), 1-linoleylglycerol (**13**), gingerglycolipid B (**14**), (2*S*)-3-linolenoylglycerol β-D-galactopyranoside (**15**), (2*S*)-2-linolenoylglycerol β-D-galactopyranoside (**16**), gingerglycolipid A (**17**), (2*S*)-23-bis-linolenoylglycerol 6-*O*-(α-D-galactopyranosyl)-β-D-galactopyranoside (**18**), gigantursenol A (**19**), taraxasterol (**20**), β-sitosterol (**21**), β-sitosterol-3-O-β-D-glucoside (**22**), stigmasterol (**23**) and β-sigmasterol-3-*O*-β-D-glucoside (**24**). Detailed information of isolation of compounds was obtained in Supplemental material. This is the first report of compounds **11**–**19** from *T. mongolicum* and the genus *Taraxacum*, and compounds **11**, **12**, **15**, **16**, **18** and **19** from the Asteraceae family (Figure 1). Additionally, to the best of our knowledge, this is the first comprehensive chemical investigation of the aerial parts of *T. mongolicum*.

2.2. Chemotaxonomic significance

Flavonoids are the primary components of the genus *Taraxacum*. In this paper, six flavonoids (**1**–**6**) were isolated. Of them, four compounds (apigenin **1**, luteolin **2**, quercetin **3** and luteolin-7-β-D-glucopyranoside **4**) were previously isolated from *T. mongolicum* and other species, such as *T. officinale* (Davaatseren et al. 2013), which supports the fact that *T. mongolicum* and *T. officinale* are considered twin species. Compounds **2**–**4** were also reported from *T. coreanum* (Yamabe et al. 2014) and *T. formosanum* (Chen et al. 2012). Moreover, quercetin-7-β-D-glucopyranoside (**5**) and quercetin-37-*O*-β-D-diglucopyranoside (**6**) are found only in *T. mongolicum* in the genus *Taraxacum*, and may be applicable as chemotaxonomic markers of *T. mongolicum*. Sesquiterpenes are the characteristic metabolites of *T. mongolicum*, especially ainslioside (**8**) and 1β,3β-dihydroxyeudesman-6α,12-olide (**9**), which were previously isolated from *T. officinale*, *T. udum*, *T. serotinum*, *T. laevigatum*, *T. disseminatum* and *T. hallaisanensis* (Yang et al. 1996; Michalska & Kisiel 2008, 2009; Michalska et al. 2010). These findings suggest that similar metabolic pathways for glycosides exist in these species of the genus *Taraxacum*. 1β,3β-dihydroxy-eudesman-11(13)-en-6α,12-olide (**7**) and 11β,13-dihydrotaraxinic acid (**10**)

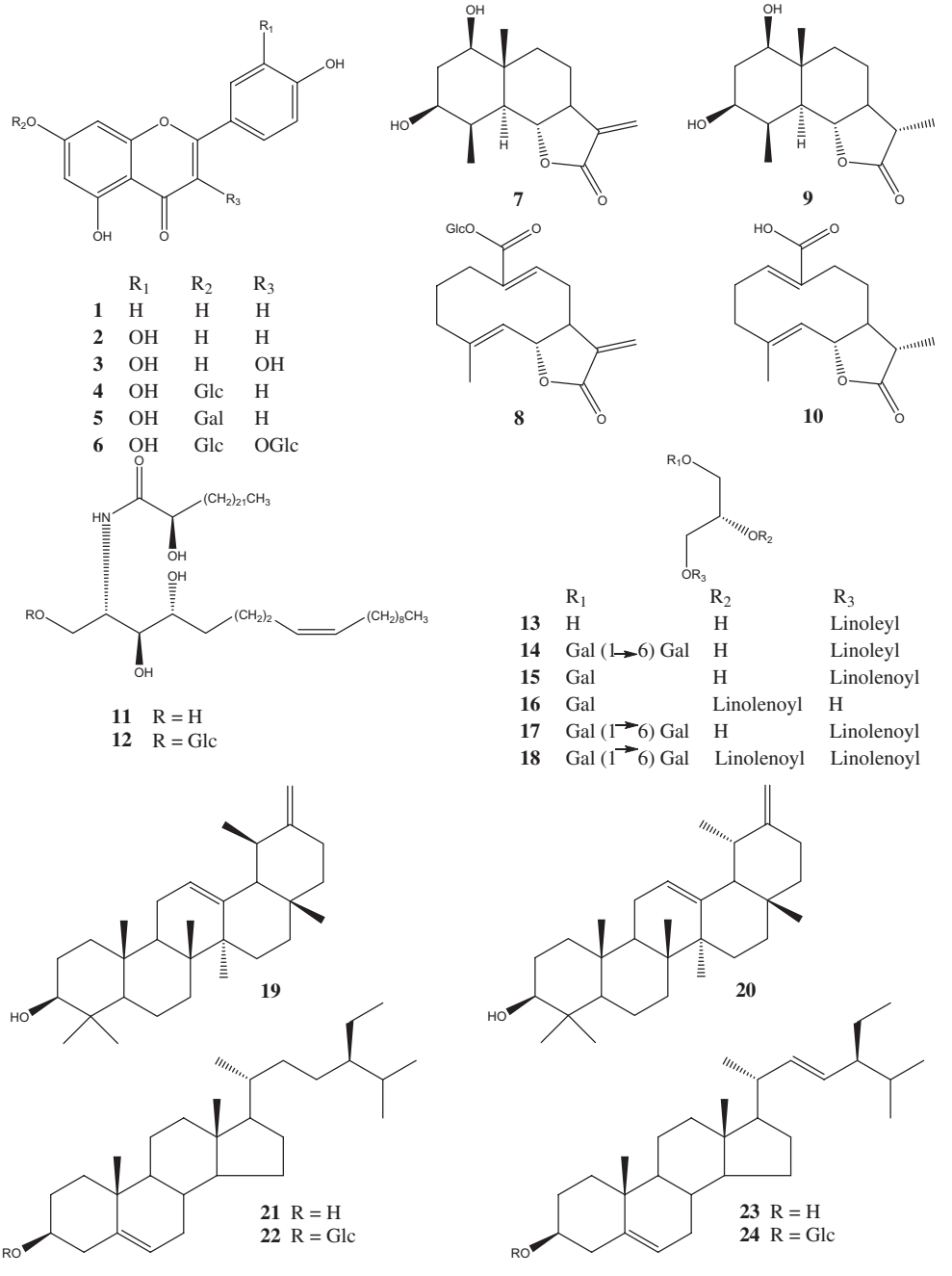

Figure 1. Structures of compounds **1**–**24** from the aerial parts of *T. mongolicum*.

were previously only reported from *T. mongolicum* (Kim et al. 2011), so the discovery of compounds (**7** and **10**) may serve as a specific marker of *T. mongolicum*.

All sphingolipids (**11** and **12**) and glycerols (**13**–**18**) were isolated from *T. mongolicum* for the first time. Gynuramide II (**11**) and phytolacca cerebroside (**12**) are ceramide-type sphingolipids, which are novel for the genus *Taraxacum* and the Asteraceae family. They were previously isolated from the families Fabaceae and Lamiaceae (Li et al. 2013). Three glycerols,

(2*S*)-3-linolenoylglycerol β-D-galactopyranoside (**15**), (2*S*)-2-linolenoylglycerol β-D-galactopyranoside (**16**), and (2*S*)-23-bis-linolenoylglycerol 6-*O*-(α-D-galactopyranosyl)-β-D-galactopyranoside (**18**), were reported from the family Asteraceae for the first time; 1-linoleylglycerol (**13**), gingerglycolipid B (**14**) and gingerglycolipid A (**17**) are found in other species of the Asteraceae family, such as *Sonchus arvensis* (Baruah et al. 1983). Thus, the isolation of sphingolipids and glycerols may have chemotaxonomic importance for *T. mongolicum*. Among the isolated triterpenoids and sterols (**19**–**24**), gigantursenol A (**19**) is novel for the Asteraceae family, which was previously isolated from *Calotropis gigantean* (Ali & Gupta 1999).

3. Conclusion

In our study, the methanol extract of the *T. mongolicum* aerial parts was subjected to various separation procedures and 24 compounds were isolated. Of them, nine compounds were isolated from *T. mongolicum* and the genus *Taraxacum* and six compounds were isolated from the Asteraceae family for the first time. Flavonoids (**1**–**6**) and sesquiterpenes (**7**–**10**) are considered as specific markers of *Taraxacum* species, some of them (**5**, **6**, **7** and **10**) can be considered chemotaxonomic markers of *T. mongolicum*. Overall, the results of this study indicate the taxonomic importance of a wide range of phytochemical compounds that complement the current chemotaxonomic profile of the family Asteraceae.

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