SUPPLEMENTARY MATERIAL

Plants of the Russian Federation Pharmacopeia: an unexhausted natural products research opportunity?

Evgeny Chupakhin[a], Olga Babich[a,b], Alexander Prosekov[b], Lyudmila Asyakina[b], Maxim Gureev[c], and Mikhail Krasavin[a,d,*]

[a]*Immanuel Kant Baltic Federal University, Kaliningrad, 236016 Russian Federation;* [b]*Kemerovo State University, Kemerovo 650000 Russian Federation;* [c]*I.M. Sechenov First Moscow State Medical University, Moscow 119991, Russian Federation;* [d]*Saint Petersburg State University, Saint Petersburg, 199034 Russian Federation*

32 medicinal plants that are unique to the Russian Pharmacopeia have 693 isolated natural products associated with them (an average of 21.66 compounds per plant). This is in contrast to the US Pharmacopeia plants that have delivered 2366 known natural products (an average of 42.25 compounds per plant).

Keywords: Natural products; Russian Pharmacopeia; unique medicinal plants; US Pharmacopeia; scaffold clustering.

Table S1. Unique plants of the Russian Pharmacopeia, their medicinal use and the associated numbers of isolated natural products reported in the literature.

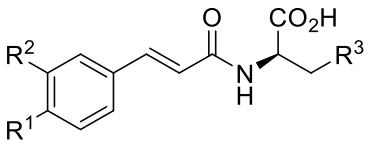
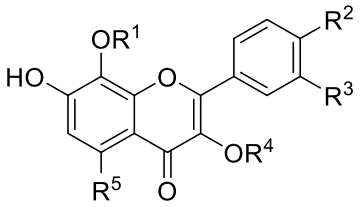
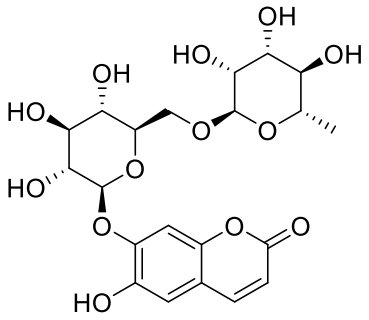
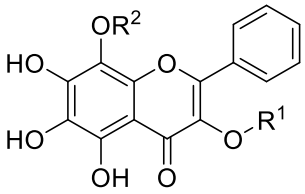
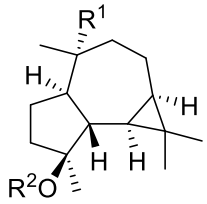
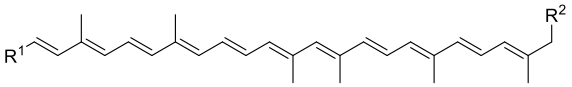
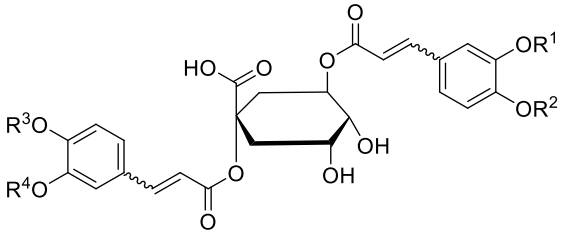
Entry	Plant Latin name	Medicinal Use	Number of isolated compounds
1	*Althaea officinalis*	Expectorant	24
2	*Calendula officinalis*	Antiseptic and antiinflammatory	72
3	*Bidens tripartita*	Antiinflammatory	8
4	*Viburnum opulus*	Diaphoretic and anti-inflammatory	8
5	*Gnaphalium uliginosum*	Hypotensive, anti-inflammatory, and choleretic	1
6	*Erythraea Centaurium*	Bitterants appetite stimulants	8
7	*Alnus incana*	Astringent	3
8	*Hypericum perforatum*	Astringent	50
9	*Bergenia crassifolia*	Astringent	4
10	*Helichrysum arenarium*	Choleretic agent	37
11	*Tanacetum vulgare*	Antihelmintic and choleretic	44
12	*Ledum palustre*	Expectorant	18
13	*Tussilago farfara*	Expectorant	24
14	*Plantago major*	Expectorant	8
15	*Pinus silvestris*	Expectorant	6
16	*Inula helenium*	Expectorant	31
17	*Polemonium caeruleum*	Expectorant	27
18	*Centaurea cyanus*	Diuretic agent	14
19	*Vaccinium vitis-idaea*	Diuretic agent	27
20	*Betula pendula*	Diuretic agent	43
21	*Adonis vernalis*	Cardiotonic agent	17
22	*Convallaria majalis*	Cardiotonic agent	36
23	*Crataegus oxyacantha*	Cardiovascular agent	9
24	*Persicaria hydropiper*	Haemostatic agent	1
25	*Anethum graveolens*	Spasmolytic agent	25
26	*Rubia tinctorum*	Spasmolytic agent	32
27	*Leonurus cardiaca*	Sedative	12
28	*Sorbus aucuparia*	Polyvitamin	17
29	*Aralia elata*	Tonic	52
30	*Rhodiola rosea*	Tonic	23
31	*Polygonum persicaria*	No pharmacological use is specified	5
32	*Thermopsis lanceolata*	No pharmacological use is specified	7
Total natural products reported in the liteature			**693**

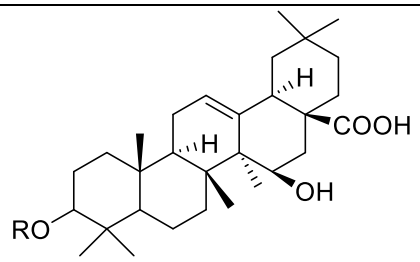
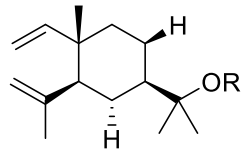
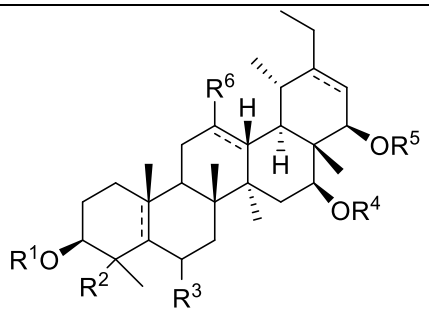
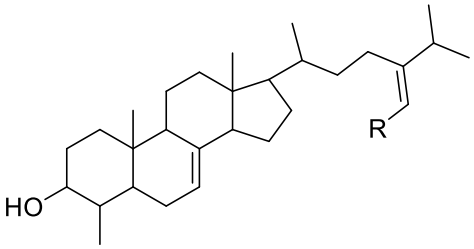
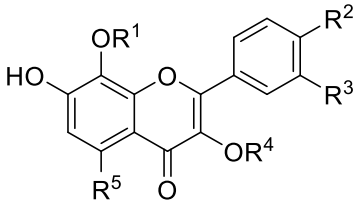
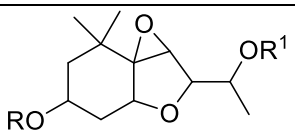
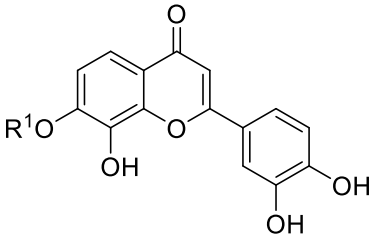
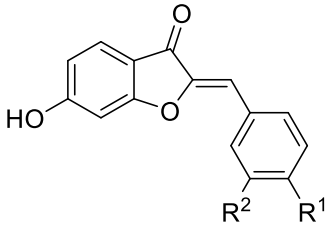
Table S2. Plants of the US Pharmacopeia and the associated numbers of isolated natural products reported in the literature.

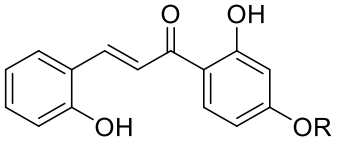
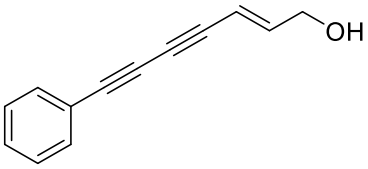
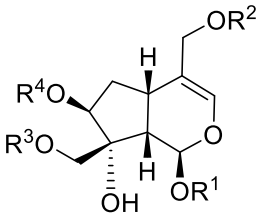
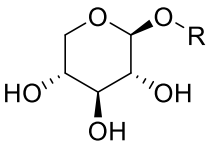
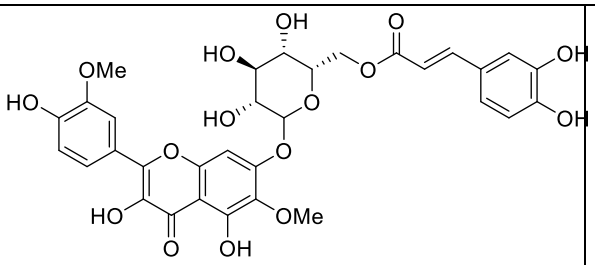
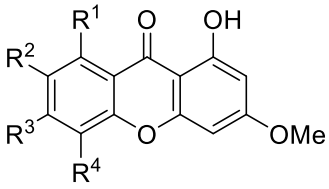
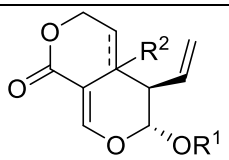
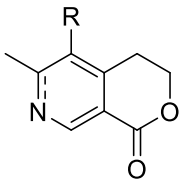
Entry	Plant Latin name	Number of isolated compounds
1	*Achillea millefolium*	42
2	*Aesculus hippocastanum*	62
3	*Aletris farinosa*	2
4	*Allium sativum*	96
5	*Angelica archangelica*	36
6	*Arctium lappa*	89
7	*Arctostaphylos uva-ursi*	8
8	*Arnica montana*	45
9	*Atropa belladonna*	17
10	*Bacopa monnieri*	33
11	*Caulophyllum thalictroides*	15
12	*Centella asiatica*	52
13	*Chamaelirium luteum*	21
14	*Chamaemelum nobile*	9
15	*Chimaphila umbellata*	2
16	*Clematis chinensis*	27
17	*Codonopsis pilosula*	41
18	*Crataegus laevigata*	1
19	*Crataegus monogyn*	7
20	*Curcuma longa*	90
21	*Datura stramonium*	26
22	*Digitalis purpurea*	74
23	*Echinacea angustifolia*	27
24	*Echinacea purpurea*	46
25	*Ephedra sinica*	31
26	*Equisetum arvense*	23
27	*Ginkgo biloba*	98
28	*Ganoderma lucidum*	259
29	*Hamamelis virginiana*	8

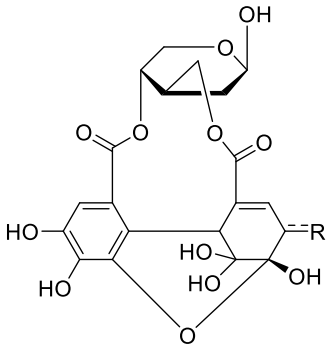
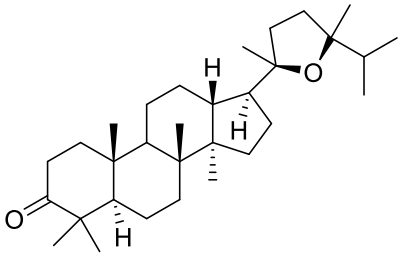
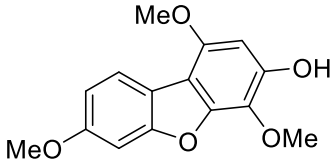
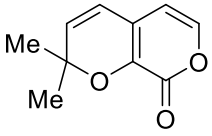
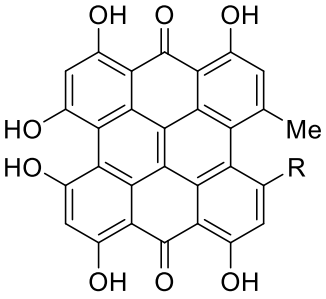
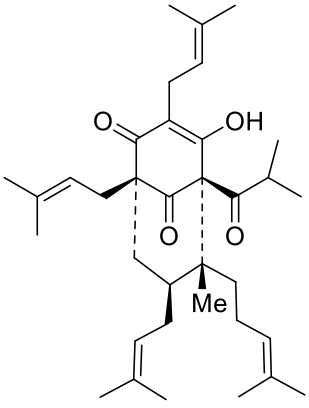
30	*Humulus lupulus*	160
31	*Hydrastis canadensis*	16
32	*Illicium anisatum*	29
33	*Lycium chinense*	92
34	*Matricaria recutita*	2
35	*Melissa officinalis*	30
36	*Mentha pulegium*	7
37	*Mitchella repens*	0
38	*Panax quinquefolius*	3
39	*Parthenium integrifolium*	1
40	*Phyllanthus emblica*	75
41	*Plantago lanceolata*	4
42	*Rauvolfia serpentina*	0
43	*Rumex crispus*	3
44	*Scutellaria lateriflora*	10
45	*Silybum marianum*	38
46	*Symphytum officinale*	10
47	*Tanacetum parthenium*	24
48	*Teucrium chamaedrys*	27
49	*Trifolium pratense*	42
50	*Urtica dioica*	31
51	*Urtica urens 0*	0
52	*Vaccinium myrtillus*	12
53	*Valeriana officinalis*	93
54	*Vitex agnus-castus*	27
55	*Withania somnifera*	149
56	*Zingiber officinale*	194
Total		**2366**

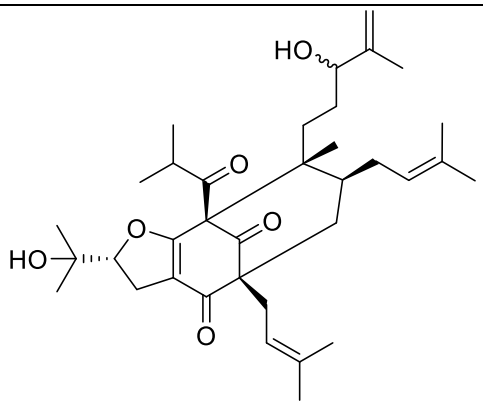
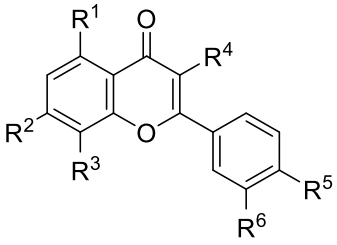
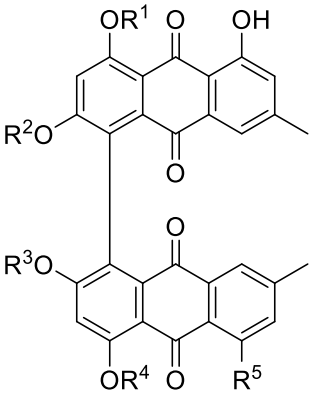
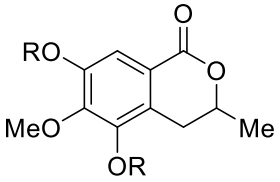
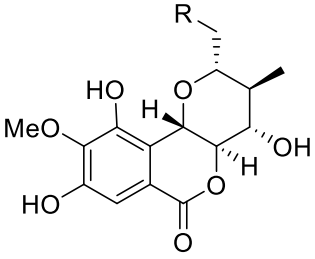
Table S3. Unique scaffolds representing the natural products isolated from the plants of the Russian Pharmacopeia.

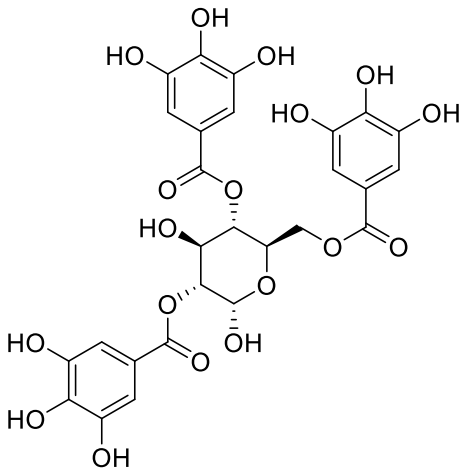
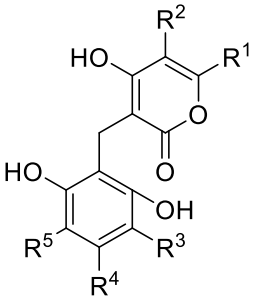
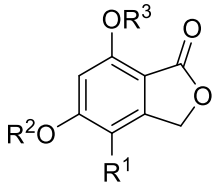
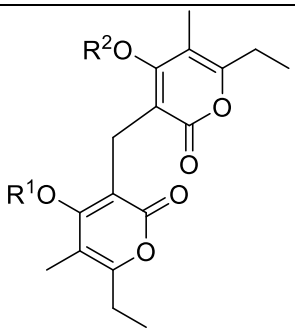
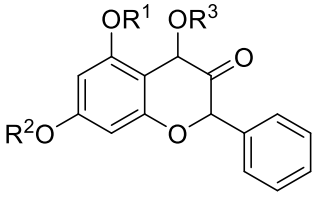
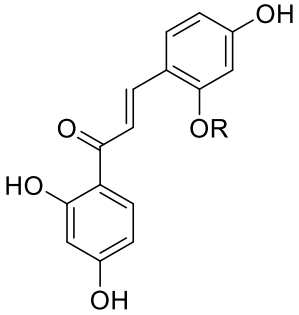
Entry	Scaffold structure	Literature reference	Number of analogs
Althaea officinalis			
1		Sendker et al. 2017	2
2		Sendker et al. 2017; Gudej 1991	17
3		Sendker et al. 2017	1
4		Pakrokh 2015; Deters et al. 2010	4
Calendula officinalis			
5		D'Ambrosio et al. 2015	6
6		Buckingham 1993	6
7		Buckingham 1993	4

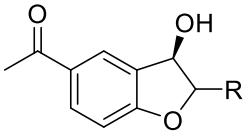
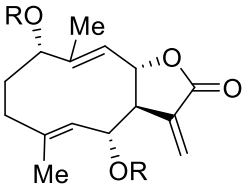
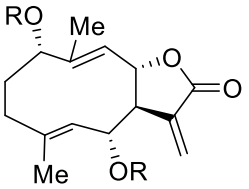
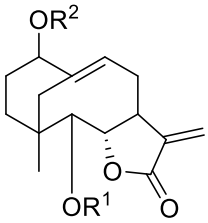
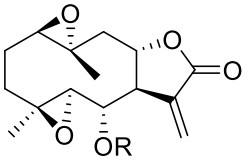
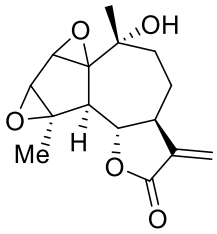
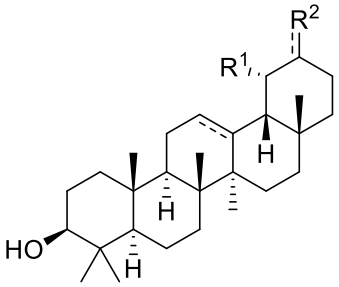
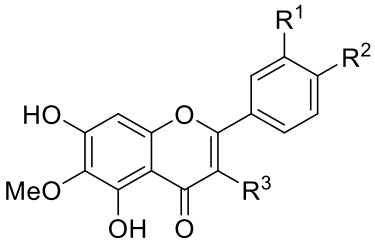
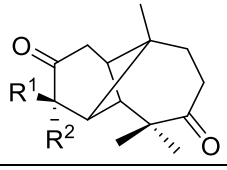
8		Wojciechowski et al. 1971	23
9		D'Ambrosio et al. 2015	2
10		Śliwowski et al. 1973	24
11		Śliwowski et al. 1973	2
12		Ukiya et al. 2006	2
13		D'Ambrosio et al. 2015	3
Bidens tripartite			
14		Wolniak et al. 2007	3
15		Venkateswarlu et al. 2004	2

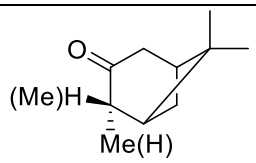
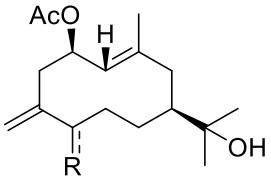
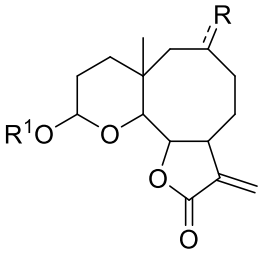
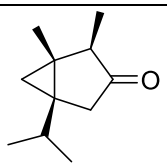
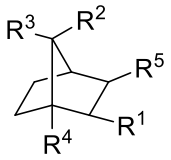
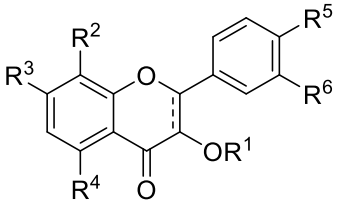
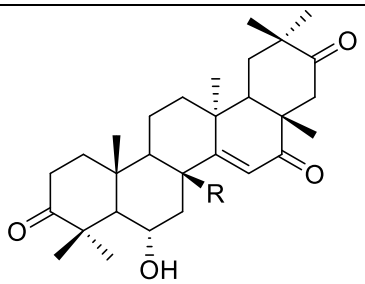
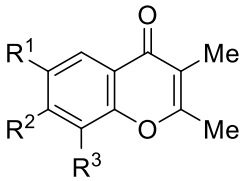
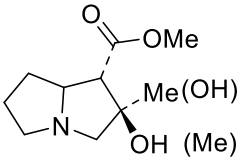
16		Xianrui and Qiao 2016	2
17		Venkateswarlu et al. 2004	1
Viburnum opulus			
18		Tomassini et al. 1997; Fukuyama et al. 2004	7
19		Fukuyama et al. 2004	1
Gnaphalium uliginosum			
20		Zheng et al. 2013; Shikov et al.2010	1
Erythraea Centaurium			
21		van der Sluis and Labadie 1985	4
22		Šiler et al. 2014	2
23		Pan et al. 2016	2
Alnus incana			

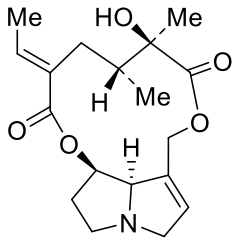
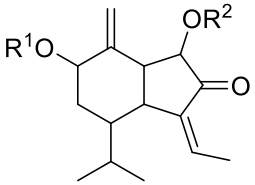
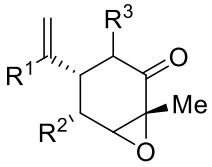
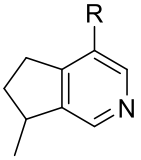
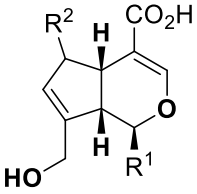
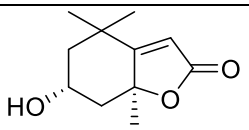
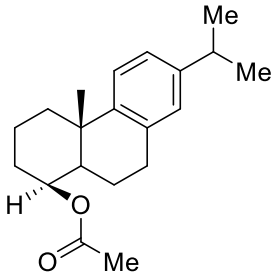
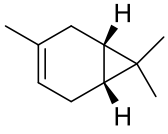
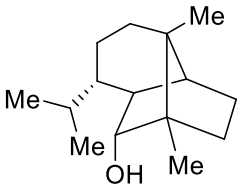
24		Khvorost et al. 1989	2
25		Labriola and Ourisson 1973	1
Hypericum perforatum			
26		Shiu and Gibbons 2009	4
27		Shiu and Gibbons 2009	3
28		Shiu and Gibbons 2009	5
29		Guo, et al. 2019	8

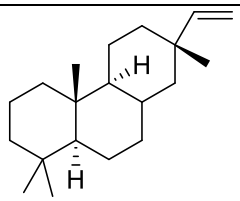
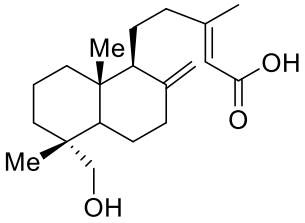
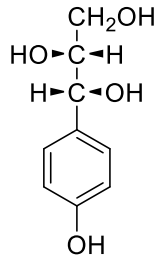
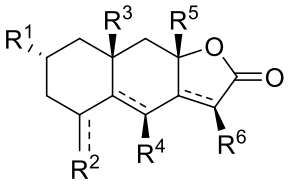
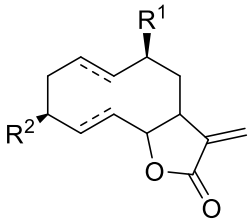
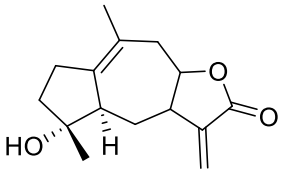
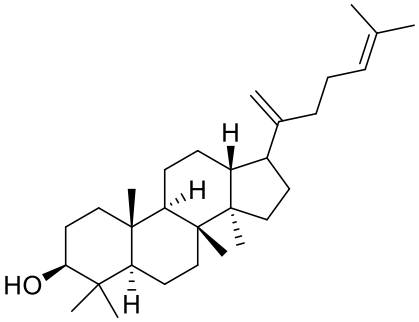
30		Guo et al. 2019	18
31		Buckingham 2015	7
32		Buckingham 2015	5
Bergenia crassifolia			
33		Barry 2002	2
34		Xin-Min et al. 1987	1

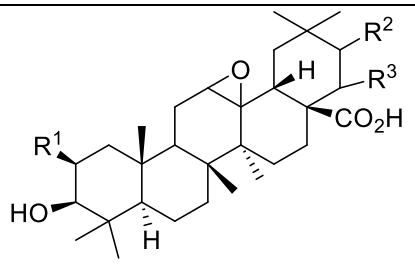
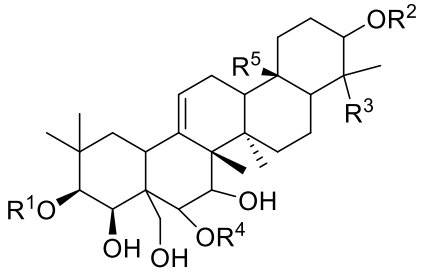
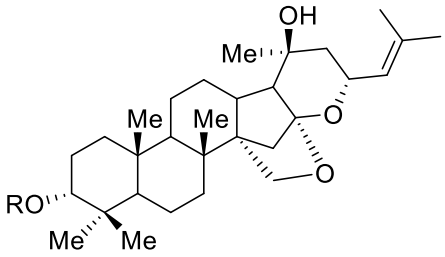
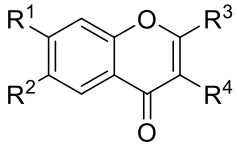
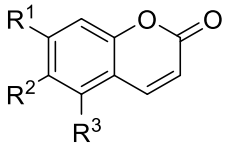
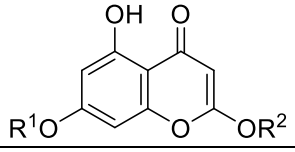
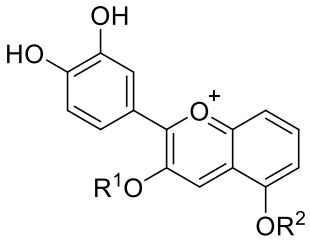
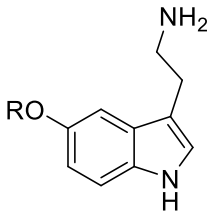
35		Xin-Min et al. 1987	1
Helichrysum arenarium			
36		Babotă et al. 2018	2
37		Babotă et al. 2018	7
38		Akaberi et al. 2019	4
39		Akaberi et al. 2019	5
40		Akaberi et al. 2019	7

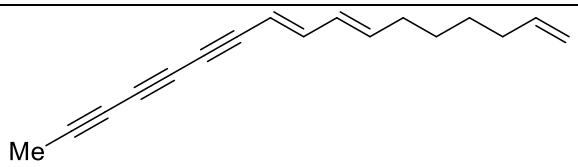
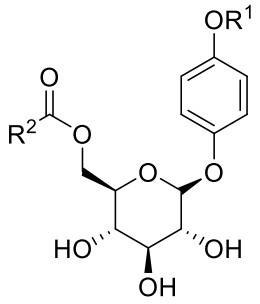
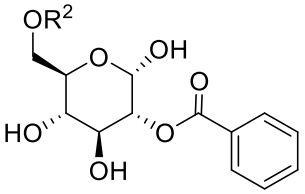
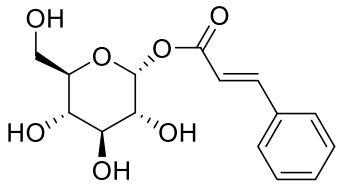
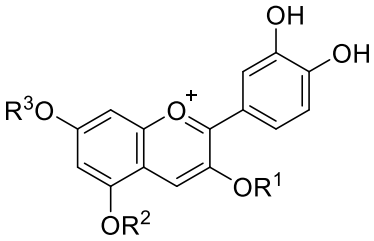
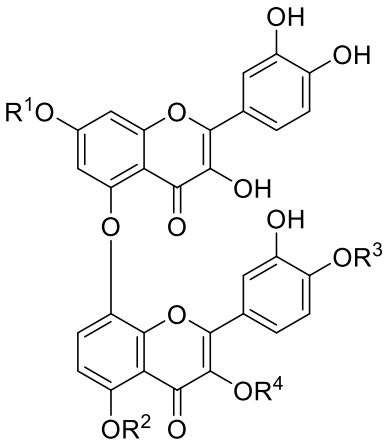
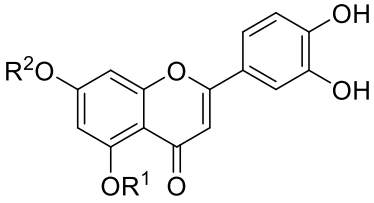
41		D'Abrosca et al. 2016	4
42		Sanz and Marco 2004; Chandra et al.1987	8
Tanacetum vulgare			
43		Sanz et al. 2004; Chandra et al. 1987	5
44		Appendino et al. 1982	6
45		Triana et al. 2013	3
46		Dusmatova et al. 2019	3
47		Wiłkomirski et al. 1992	2
48		Williams et al. 1995	6
49		Ognyanov et al. 1983	2

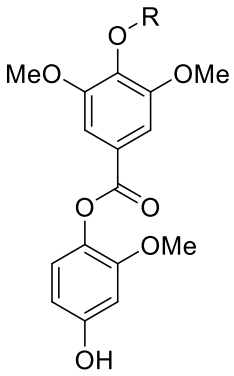
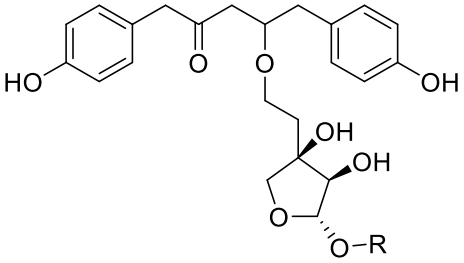
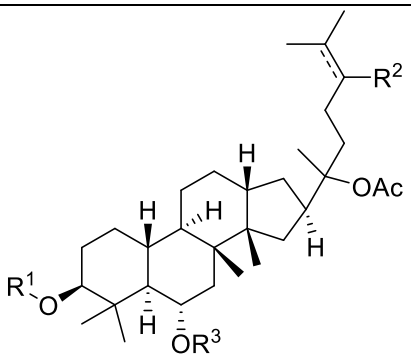
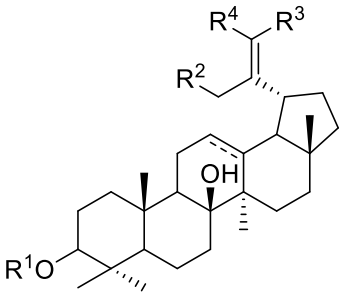
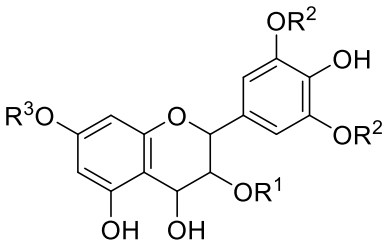
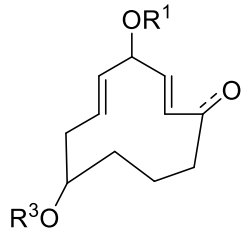
50		Ognyanov et al. 1983	2
51		Appendino et al. 1983	8
52		Mojarrad et al. 2019	3
53		Mojarrad et al. 2019	1
54		Mojarrad et al. 2019	3
Ledum palustre			
55		Mikhailova and Rybalko 1980; Chosson et al. 1998	12
56		Jiang et al. 2010	6
Tussilago farfara			
57		Kuo and Lin 1999	2
58		Schoental 1970	4

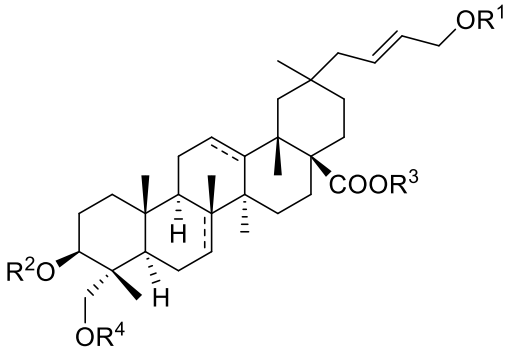
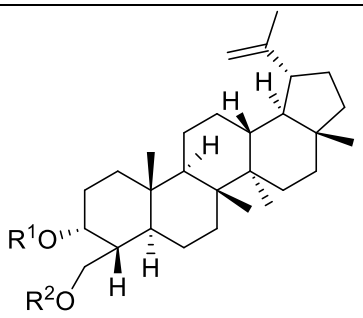
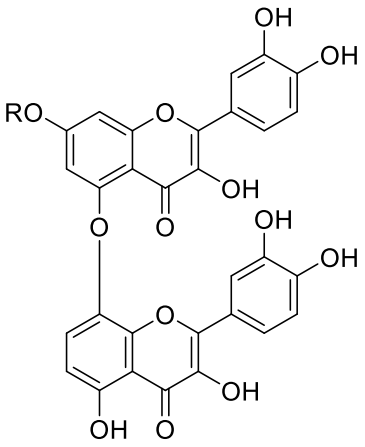
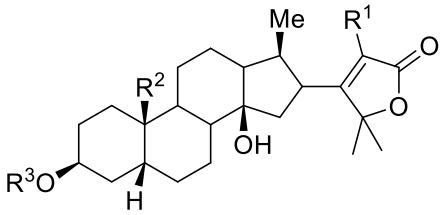
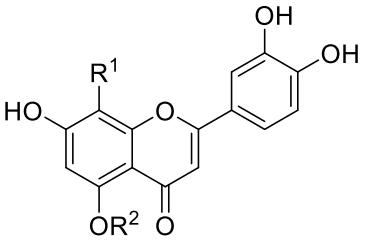
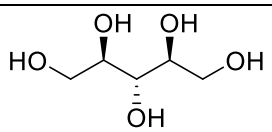
59		Jiang et al. 2009	5
60		Yaoita et al.1999	7
61		Ryu et al.1999; Park et al. 2008	6
Plantago major			
62		Schneider 1990	2
63		Taskova et al.1999; Handjieva et al. 1991	5
64		Pailer and Haschke-Hofmeister 1969	1
Pinus silvestris			
665		Shmidt and Pentegova 1969	1
66		Banthorpe and Ekundayo 1976	1
67		Westfelt et al. 1966	1

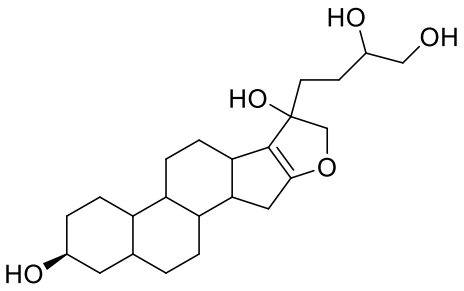
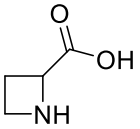
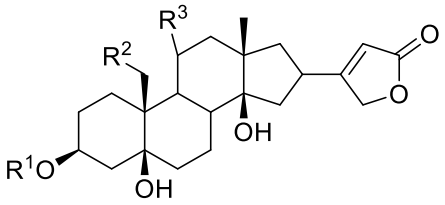
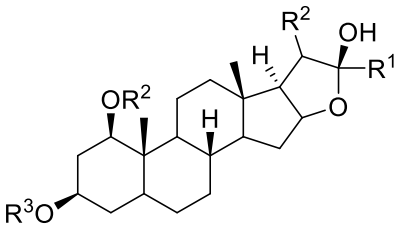
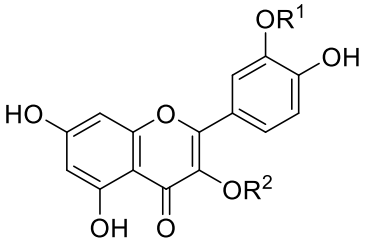
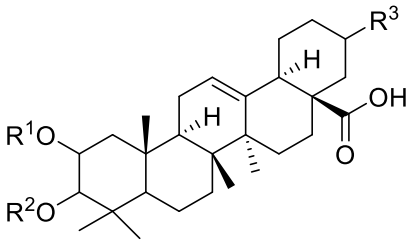
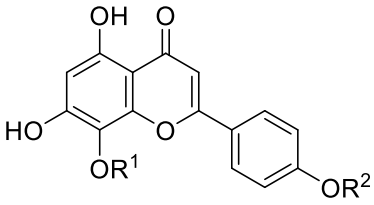
68		Mason et al. 2002	1
69		Norin et al. 1971	1
70		Lundgren et al. 1985	1
Inula helenium			
71		Zaima et al. 2014	18
72		Zaima et al. 2014	11
73		Zaima et al. 2014	1
74		Yoshioka and Yamada 1963	1
Polemonium caeruleum			

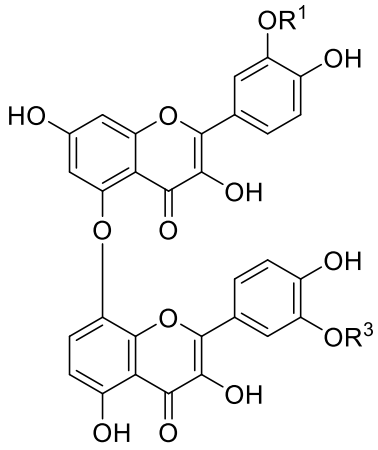
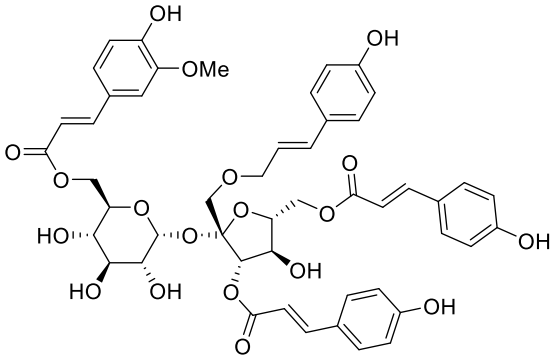
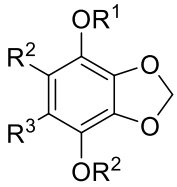
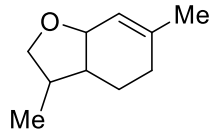
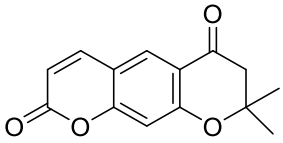
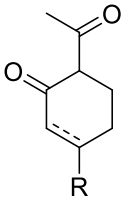
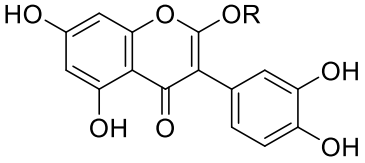
75		Reznicek et al. 1993	4
76		Reznicek et al. 1993	12
77		Reznicek et al. 1993	4
78		Smith et al. 1977	5
79		Smith et al. 1977	2
Centaurea cyanus			
80		Litvinenko and Bubenchikova 1988	7
81		Takeda et al. 2005	3
82		Sarker et al. 2001	3

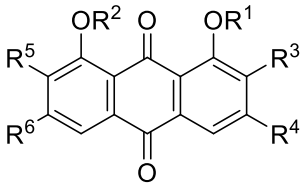
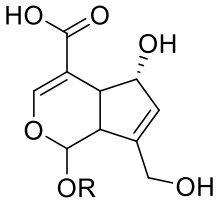
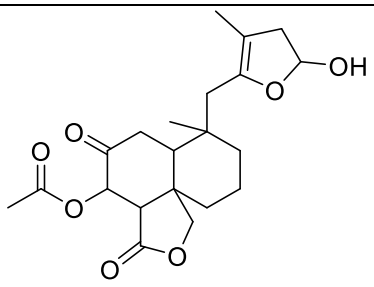
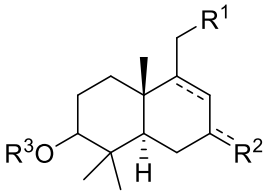
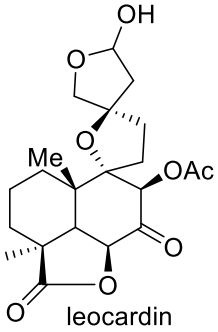
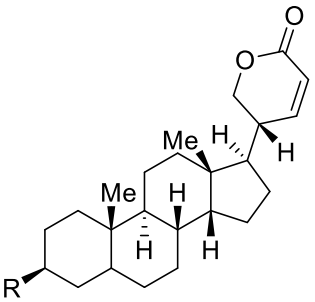
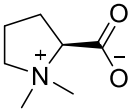
83		Takeda et al. 2005	1
Vaccinium vitis-idaea			
84		Kurkin et al. 2017	4
85		Heimhuber et al. 1990	3
86		Jurikova et al. 2019	4
87		Jurikova et al. 2019	6
88		Buckingham 2015	8
89		Buckingham 2015	2
Betula pendula			

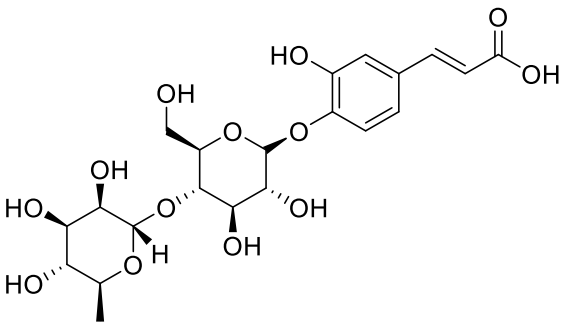
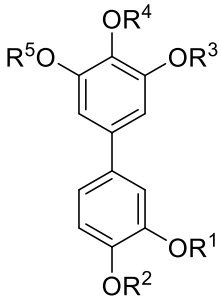
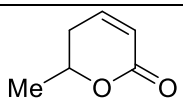
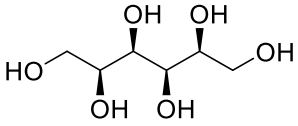
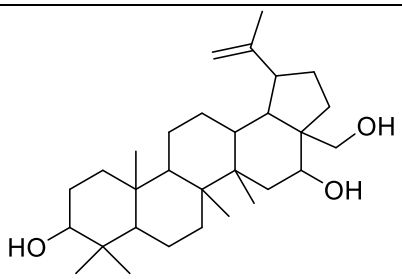
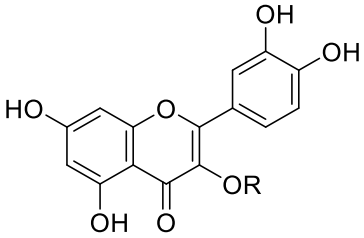
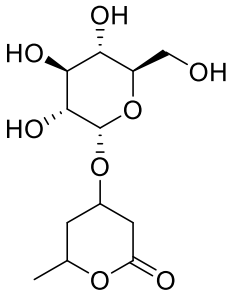
90		Liimatainen et al. 2012	6
91		Liimatainen et al. 2012	4
92		Rastogi et al. 2015	12
93		Rastogi et al. 2015	3
94		Rastogi et al. 2015	3
95		Rastogi et al. 2015	7

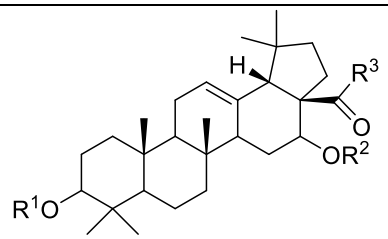
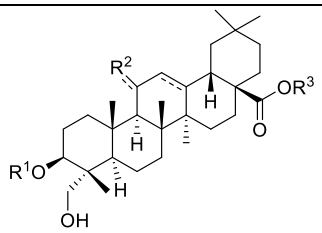
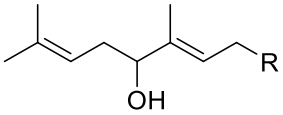
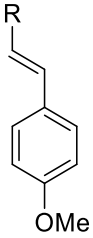
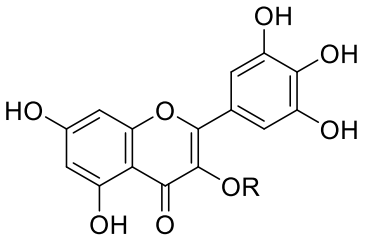
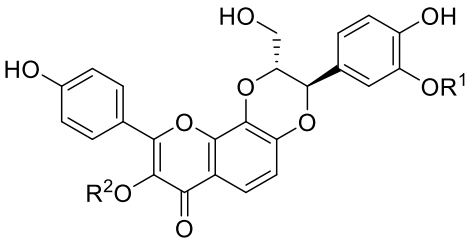
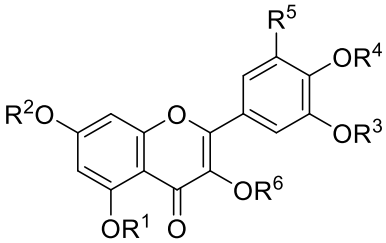
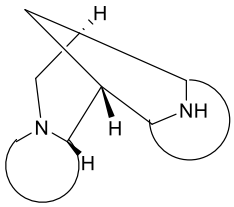
96		Rastogi et al. 2015	2
97		Rastogi et al. 2015	3
98		Rastogi et al. 2015	3
Adonis vernalis			
99		Pauli et al. 2004; Peter and Max 1980	8
100		Wagner et al. 1975	7
101		Wagner et al. 1975	1

102		Winkler and Wichtl 1986	1
Convallaria majalis			
103		Leete et al. 1974	1
104		Matsuo et al. 2017; Reyle et al. 1950	19
105		Tschesche et al. 1974; Matsuo et al. 2017	12
106		Matsuo et al. 2017	4
Crataegus oxyacantha			
107		Orhan 2016	5
108		Orhan 2016	1

109		Orhan 2016	3
Persicaria hydropiper			
110	 Vanicoside B	Kim et al. 2019	1
Anethum graveolens			
111		Chahal et al. 2017	2
112		Chahal et al. 2017	1
113		Chahal et al. 2017	1
114		Chahal et al. 2017	12
115		Chahal et al. 2017	9
Rubia tinctorum			

116		Derksen et al. 2002	24
117		Derksen et al. 2002	8
Leonurus cardiac			
118		Zhang et al. 2018; Brieskorn and Hofmann 1979	
119		Papanov et al. 1998	2
120	 leocardin	Malakov et al.1985	1
121		Schultz and Haack 1961	7
122		Ritter et al. 2010	1

123		Tschesche et al. 1980	1
Sorbus aucuparia			
124		Kokubun et al. 1995	5
125		Zymone et al. 2018	1
126		Zymone et al. 2018	1
127		Zymone et al. 2018	1
128		Zymone et al. 2018	7
129		Zymone et al. 2018	2
Aralia elata			

130		Song et al, 2001; Satoh et al. 1994	25
131		Yoshikawa et al. 1996	27
Rhodiola rosea			
132		Wiedenfeld et al. 2007	12
133		Marchev et al. 2017	4
134		Wiedenfeld et al. 2007	5
135		Wiedenfeld et al. 2007	2
Polygonum persicaria			
136		Buckingham 2015	5
Thermopsis lanceolata			
137		Vinogradova et al. 1971	6

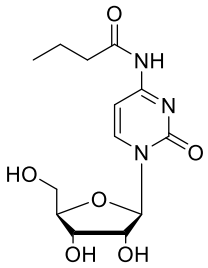
138		Vinogradova, et al. 1971	1
Total			693

Figure S1. Hierarchical clustering dendrogram.

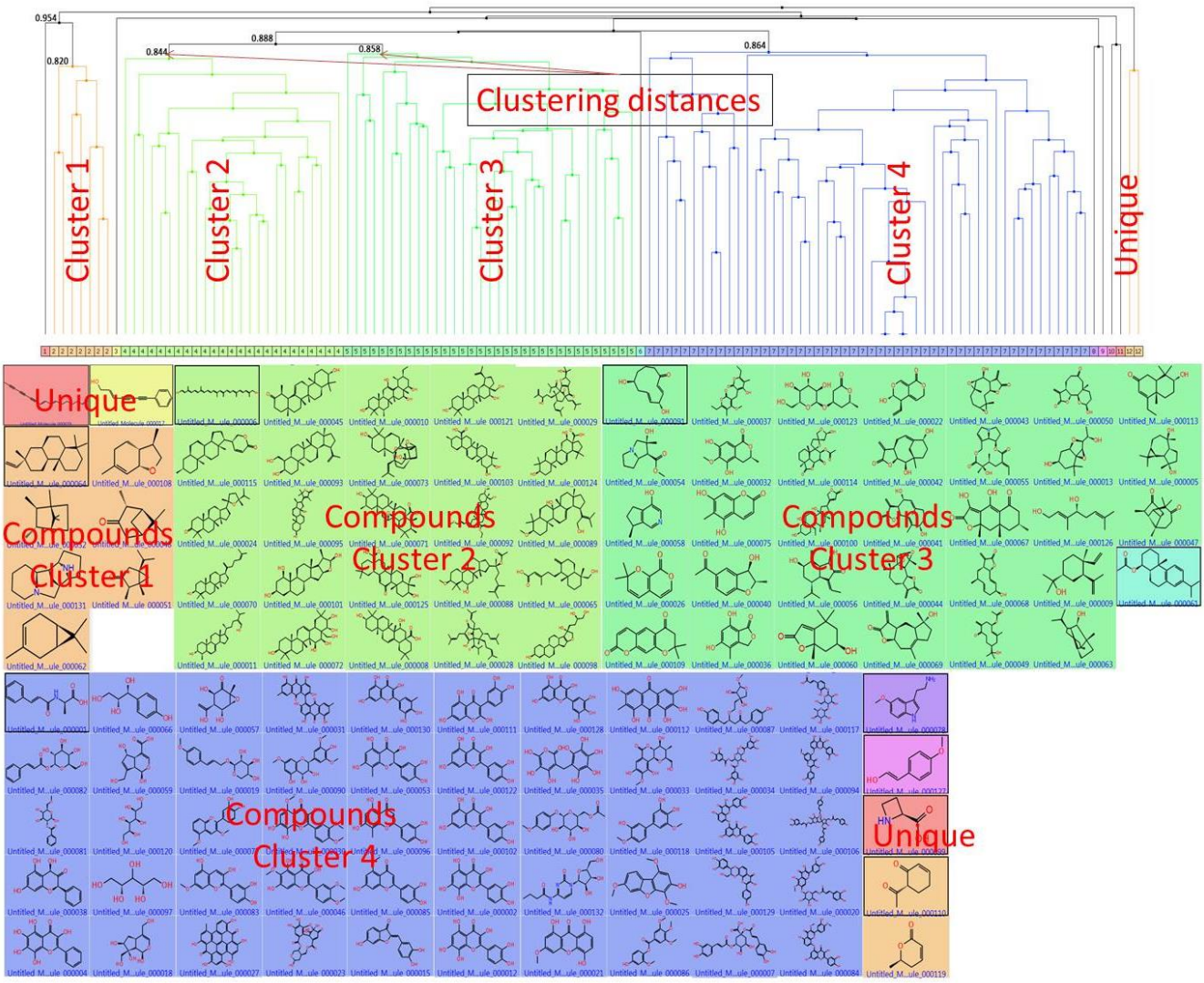
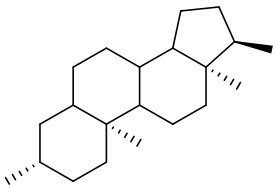
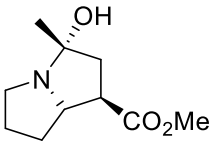


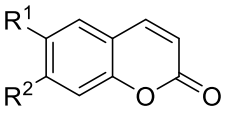
Figure S2. Four most populated scaffold clusters (represented by the central scaffold in each cluster).



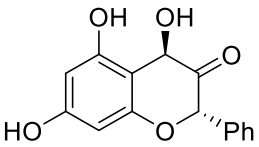
Saponins
(25 scaffolds of 138)



Alkaloids
(28 scaffolds of 138)

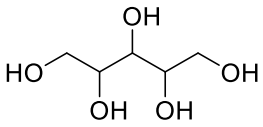


Coumarins
(5 scaffolds out of 138)

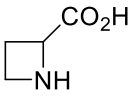


Flavonoids
(50 scaffolds of 138)

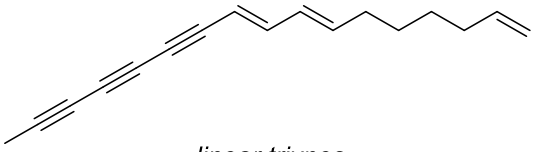
Figure S3. Three least populated scaffold clusters (i. e. the only scaffold in each cluster).



polyol
(Table S3, entry 101)



azetidine-2-carboxylic acid
(Table S3, entry 103)



linear triynes
(Table S3, entry 83)

References

Akaberi M, Danton O, Tayarani-Najaran Z, Asili J, Iranshahi M, Emami SA, Hamburger M. 2019. HPLC-Based Activity Profiling for Antiprotozoal Compounds in the Endemic Iranian Medicinal Plant Helichrysum oocephalum. J Nat Prod. 82:958–969.

Appendino G, Gariboldi P, Nano MG. 1983. Tanacetols A and B, non-volatile sesquiterpene alcohols, from Tanacetum vulgare. Phytochemistry. 22:509–512.

Appendino G, Gariboldi P , Nano GM. 1982. Crispolide, an unusual hydroperoxysesquiterpene lactone from Tanacetum vulgare. Phytochemistry.21:1099–1102.

Babotă M, Mocan A, Vlase L, Crișan O, Ielciu I, Gheldiu A-M, Vodnar D, Crișan G, Păltinean R. 2018. Phytochemical Analysis, Antioxidant and Antimicrobial Activities of Helichrysum arenarium L. Moench. and Antennaria dioica L. Gaertn. Flowers. Molecules. 23:409.

Banthorpe DV, Ekundayo O. 1976. Biosynthesis of +-car-3-ene in *Pinus* species. Phytochemistry. 15:109–112.

Brieskorn CH, Hofmann R. 1979. Labiatenbitterstoffe: ein clerodanderivat aus *Leonurus cardiaca* L. Tetrahedron Lett. 20:2511–2512.

Buckingham J, Munasinghe VRN. 1953. Dictionary of Flavonoids with CD-ROM 1st Edition. CRC Press March 13.

Buckingham J. 1993. Dictionary of Natural Products. Chapman and Hall/CRC December 2.

Chahal K, Kaur R, Kumar A, Bhardwaj U. 2017. Chemistry and biological activities of *Anethum graveolens* L. J. Pharmacogn. Phytochem. 6:295–306.

Chandra A, Misra LN, Thakur RS. 1987. Germacranolides and an alkyl glucoside from *Tanacetum vulgare*. Phytochemistry. 26:1463–1465.

Chosson E, Chaboud A, Chulia A, Raynaud J. 1998. Dihydroflavonol glycosides from rhododendron ferrugineum. Phytochemistry. 49:1431–1433.

Barry RD. 2002. Isocoumarins. Developments Since 1950. Chem. Rev. 64:229–260.

D'Abrosca B, Buommino E, Caputo P, Scognamiglio M, Chambery A, Donnarumma G, Fiorentino A. 2016. Phytochemical study of *Helichrysum italicum* Roth G. Don: Spectroscopic elucidation of unusual amino-phlorogucinols and antimicrobial assessment of secondary metabolites from medium-polar extract. Phytochemistry. 132:86–94.

D'Ambrosio M, Ciocarlan A, Colombo E, Guerriero A, Pizza C, Sangiovanni E, Dell'Agli M. 2015. Structure and cytotoxic activity of sesquiterpene glycoside esters from *Calendula officinalis* L.: Studies on the conformation of viridiflorol. Phytochemistry. 117:1–9.

Derksen GC, Niederländer HA, van Beek TA. 2002. Analysis of anthraquinones in Rubia tinctorum L. by liquid chromatography coupled with diode-array UV and mass spectrometric detection. J Chromatogr A. 978:119–127.

Deters A, Zippel J, Hellenbrand N, Pappai D, Possemeyer C, Hensel A. 2010. Aqueous extracts and polysaccharides from Marshmallow roots *Althea officinalis* L.: Cellular internalisation and stimulation of cell physiology of human epithelial cells in vitro. J. Ethnopharmacol. 127:62–69.

Dusmatova DE, Bobakulov KM, Mukhamatkhanova RF, Turgunov KK, Terenteva EO, Tsay EA, Sham'yanov ID, Tashkhodzhaev B, Azimova SS, Abdullaev ND. 2019. Isolation of cytotoxic sesquiterpene lactones from the *Tanacetopsis karataviensis* Kovalevsk. Nat Prod Res. 30:1–10. doi:10.1080/14786419.2019.1647423

Pauli FG, Junior P, Berger S, Matthiesen U. 2004. Alepposides, Cardenolide Oligoglycosides from *Adonis aleppica*. J Nat Prod. 56:67–75.

Sanz FJ, Marco AJ. 2004. Nmr Studies of Tatridin A and Some Related Sesquiterpene Lactones from *Tanacetum vulgare*. J Nat Prod. 54:591–596.

Fukuyama Y, Minoshima Y, Kishimoto Y, Chen IS, Takahashi H, Esumi T. 2004. Iridoid glucosides and p-coumaroyl iridoids from *Viburnum luzonicum* and their cytotoxicity. J Nat Prod. 67:1833–1838.

Gudej J. 1991. Flavonoids, phenolic acids and coumarins from the roots of *Althaea officinalis*. Planta Med. 57**:**284–285.

Guo Y, Zhang N, Duan X, Cao Y, Xue Y, Luo Z, Zhu H, Chen C, Wang J, Zhang Y. 2019. Hyperforatins L–U: prenylated acylphloroglucinols with a terminal double bond from *Hypericum perforatum* L. St John's Wort. Phytochemistry. 164:41–49.

Handjieva N, Spassov S, Bodurova G, Saadi H, Popov S, Pureba O, Zamjansana J. 1991. Majoroside, an iridoid glucoside from *Plantago major*. Phytochemistry. 30:1317–1318.

Heimhuber B, Wray V, Galensa R, Herrmann K. 1990. Benzoylglucoses from two *Vaccinium* species. Phytochemistry. 29:2726–2727.

Jae-Ha R, Yeon SJ, Dong HS. 1999. A new bisabolene epoxide from *Tussilago farfara*, and inhibition of nitric oxide synthesis in LPS-activated macrophages. J Nat Prod. 62:1437-1438.

Jiang J, He J, Feng Z, Zhang P. 2010. Two new quinochalcones from the florets of *Carthamus tinctorius*. Org Lett. 12:2951–2954.

Jiang Z, Feng L, Jennifer JLG, Lijun Y, Sam FYL, Eng SO, Choon NO. 2009. Determination of senkirkine and senecionine in *Tussilago farfara* using microwave-assisted extraction and pressurized hot water extraction with liquid chromatography tandem mass spectrometry. Talanta. 79:539–546.

Jurikova T, Skrovankova S, Mlcek J, Balla S, Snopek L. 2019. Bioactive compounds, antioxidant activity, and biological effects of European cranberry *Vaccinium oxycoccos*. Molecules. 24:24-45.

Khvorost OP, Serbia AG, Komissarenko NF, Gordienko VG. 1989. Ellagotannins derived from *Alnus glutinosa* L. Gaertn. and *Alnus incana* L. Moench barks. Khim-Farm Zh. 23:445.

Kim D, Wang CY, Hu R, Lee JY, Luu TT, Park HJ, Lee SK. 2019. Antitumor activity of Vanicoside B isolated from *Persicaria dissitiflora* by targeting CDK8 in triple-negative breast cancer cells. J Nat Prod. 82:3140-3149

Kokubun T, Harborne JB, Eagles J, Waterman PG. 1995. Dibenzofuran phytoalexins from the sapwood of cotoneaster acutifolius and five related species. Phytochemistry. 38:57–60.

Kuo YH, Lin B-Y. 1999. A new dinorxanthane and chromone from the root of Tithonia diversifolia. Chem Pharm Bull. 47:428

Kurkin VA, Ryazanova TK, Platonov IA, Pavlova LV. 2017. Determination of arbutin in *Vaccinium vitis-idaea* L. Leaves. Pharm Chem J. 51:281–284.

Labriola R, Ourisson G. 1973. Synthese et configuration de l'alnincanone. Tetrahedron. 2105–2114.

Leete E, Davis GE, Hutchinson CR, Woo KW, Chedekel MR. 1974. Biosynthesis of azetidine-2-carboxylic acid in *Convallaria majalis*. Phytochemistry. 13:427–433.

Liimatainen J, Karonen M, Sinkkonen J, Helander M, Salminen JP. 2012. Phenolic Compounds of the inner bark of *Betula pendula*: seasonal and genetic variation and induction by wounding. J Chem Ecol. 38:1410–1418.

Litvinenko VI, Bubenchikova VN. 1988. Phytochemical study of *Centaurea cyanus*. Chem Nat Compd. 24:672–674.

Lundgren LN, Shen Z, Theander O, Hordvik A, Wold S, Elguero J. 1985. The constituents of conifer needles. Dilignol glycosides from *Pinus massoniana* Lamb. Acta Chem Scand. 39B:241–248.

Malakov P, Papanov G, Jakupovic J, Grenz M, Bohlmann F. 1985. The structure of leocardin, two epimers of a diterpenoid from *Leonurus cardiaca.* Phytochemistry. 24:2341–2343.

Marchev AS, Aneva IY, Koycheva IK, Georgiev MI. 2017. Phytochemical variations of *Rhodiola rosea* L. wild-grown in Bulgaria. Phytochem Lett. 20:386–390.

Mason JN, Lawrence RV, Gough LJ. 2002. Presence of sandaracopimaric and Δ89-isopimaric acids in *Pine Oleoresin*. J Org Chem. 31:320–321.

Matsuo Y, Shinoda D, Nakamaru A, Kamohara K, Sakagami H, Mimaki Y. 2017. Steroidal glycosides from *Convallaria majalis* whole plants and their cytotoxic activity. Int J Mol Sci. 18:2358.

Mikhailova NS, Rybalko KS. 1980. Chemical constitution of *Ledum palustre*. Chem Nat Compd. 16:131–135.

Mojarrad M, Hosseini SS, Sonboli A. 2019. Chemical diversity of the essential oils of twenty populations of *Tanacetum polycephalum* Sch. Bip. from Iran. Nat Prod Res. 33:1379–1382.

Norin T, Sundin S, Theander O, Lindberg AA, Lagerlund I, Ehrenberg L. 1971. The constituents of conifer needles. IV. Dehydropinifolic acid, a diterpene acid from the needles of *Pinus silvestris* L. Acta Chem Scand. 25:607–610.

Ognyanov I, Todorova M, Dimitrov V, Ladd J, Irngartinger H, Kurda E, Rodewald H. Cis-longipinane-2,7-dione, a sesquiterpene diketone in flowers of *Tanacetum vulgare*. Phytochemistry. 22**:**1775–1777.

Orhan IE. 2016. Phytochemical and pharmacological activity profile of *Crataegus oxyacantha* L. hawthorn - a cardiotonic herb. Curr Med Chem. 25:4854–4865.

Pailer M, Haschke-Hofmeister E. 1969. Inhaltsstoffe uas *Plantago major*. Planta Med. 17:139–145.

Pakrokh GP. 2015. The extraction process optimization of antioxidant polysaccharides from Marshmallow *Althaea officinalis* L. roots. Int J Biol Macromol. 75:51–57.

Pan Y, Zhao YL, Zhang J, Li W-Y, Wang Y-Z. 2016. Phytochemistry and pharmacological activities of the genus *Gentiana* Gentianaceae. Chem Biodivers. 13:107–150.

Papanov G, Malakov P, Tomova K. 1998. 19-hydroxygaleopsin, a labdane diterpenoid from *Leonurus cardiaca*. Phytochemistry 47:139–141.

Park HR, Yoo MY, Seo JH, Kim IS, Kim NY, Kang JY, Cui L, Lee C-S, Lee C-H, Lee H S. 2008. Sesquiterpenoids isolated from the flower buds of *Tussilago farfara* L. inhibit diacylglycerol acyltransferase. J Agric Food Chem. 56:10493–10497

Peter J, Max W. 1980. 3-epi-periplogenin: ein neues cardenolid aus *Adonis vernalis*. Phytochemistry. 19:2193–2197.

Reyle K, Meyer K, Reichstein T. 1950. Partialsynthese von Convallatoxin. Glykoside und Aglykone, 61. Mitteilung. Helv Chim Acta. 33:1541–1546.

Reznicek G, Jurenitsch J, Kubelka W, Schröder H, Haslinger E, Schöpke T, Hitter K. 1993. A new ester saponin from *Polemonium caeruleum*. Planta Med. 59:A612

Ritter, M, Melichar K, Strahler S, Kuchta K, Schulte J, Sartiani L, Cerbai E, Mugelli A, Mohr FW, Rauwald HW, Dhein S. 2010. Cardiac and electrophysiological effects of primary and refined extracts from *Leonurus cardiaca* L. Ph.Eur.. Planta Med. 76:572–582.

Rastogi S, Pandey MM, Kumar SRA. 2015. Medicinal plants of the genus *Betula*—traditional uses and a phytochemical–pharmacological review. J Ethnopharmacol. 159:62–83.

Sarker SD, Laird A, Nahar L, Kumarasamy Y, Jaspars M. 2001. Indole alkaloids from the seeds of *Centaurea cyanus* Asteraceae. Phytochemistry. 57:1273–1276.

Satoh Y, Sakai S, Katsumata, M, Nagasao M, Miyakoshi M, Ida Y, Shoji J. 1994. Oleanolic acid saponins from root-bark of *Aralia elata*. Phytochemistry. 36:147–152.

Schneider G. 1990. Arzneidrogen, Ein Kompendium für Pharmazeuten, Biologien und Chemiker. Wissenschaftsverlag, Mannheim, Germany, p. 131.

Schoental R. 1970. Hepatotoxic activity of retrorsine, senkirkine and hydroxysenkirkine in newborn rats, and the role of epoxides in carcinogenesis by pyrrolizidine alkaloids and aflatoxins. Nature. 227:401-402.

Schultz OE, Haack HJ. 1961. Isolation and assay for the clarification of the composition of three glycoside bitter principles from *Leonurus cardiaca*. Arzneim Forsch. 11:830-835.

Sendker J, Böker I, Lengers I, Brandt S, Jose J, Stark T, Hofmann T, Fink C, Abdel-Aziz H, Hensel A. 2017. Phytochemical characterization of low molecular weight constituents from marshmallow roots *Althaea officinalis* and inhibiting effects of the aqueous extract on human hyaluronidase-1. J Nat Prod. 80:290–297.

Shikov AN, Kundracikova M, Palama TL, Pozharitskaya ON, Kosman VM, Makarov VG, Galambosi B, Kim HJ, Jang YP, Choi YH, et al. 2010. Phenolic constituents of *Gnaphalium uliginosum* L. Phytochem Lett. 3:45–47.

Shiu WKP, Gibbons S. 2009. Dibenzofuran and pyranone metabolites from Hypericum revolutum ssp. revolutum and *Hypericum choisianum*. Phytochemistry. 70:403–406.

Shmidt EN, Pentegova VA. 1969. Neutral fraction of the oleoresin of *Pinus silvestris* - II. dehydroabietinol acetate. Chem Nat Compd. 5:161.

Šiler B, Zivković S, Banjanac T, Cvetković J, Nestorović Živković J, Cirić A, Soković M, Mišić D. 2014. Centauries as underestimated food additives: antioxidant and antimicrobial potential. Food Chem. 147:367–376.

Śliwowski J, Dziewanowska K, Kasprzyk Z. 1973. Ursadiol: a new triterpene diol from *Calendula officinalis* flowers. Phytochemistry. 12:157–160.

Smith DM, Glennie CW, Harborne JB, Williams CA. 1977. Flavonoid diversification in the polemoniaceae. Biochem Syst Ecol. 5:107–115.

Venkateswarlu S, Panchagnula GK, Subbaraju GV. 2004. Synthesis and antioxidative activity of 3′,4′,6,7-tetrahydroxyaurone, a metabolite of *Bidens frondosa*. Bioscience Biotechnology and Biochemistry. 6810:2183-2185.

Song S-J, Nakamura N, Ma C-M, Hattori M, Xu S-X. 2001. Five saponins from the root bark of *Aralia elata*. Phytochemistry. 56:491–497.

Takeda K, Osakabe A, Saito S, Furuyama D, Tomita A, Kojima Y, Yamadera M, Sakuta M. 2005. Components of protocyanin, a blue pigment from the blue flowers of *Centaurea cyanus*. Phytochemistry. 66:1607–1613.

Taskova R, Handjieva N, Evstatieva L, Popov S. 1999. Iridoid glucosides from *Plantago cornuti*, *Plantago major* and *Veronica cymbalaria*. Phytochemistry. 52:1443–1445.

Tomassini L, Foddai S, Nicoletti M, Cometa MF, Palazzino G, Galeffi C. Iridoid glucosides from *Viburnum ayavacense*. Phytochemistry. 46:901–905.

Triana, J, Eiroa JL, Morales M, Pérez FJ, Brouard I, Marrero MT, Estévez S, Quintana J, Estévez F, Castillo QA, León F.2013. A chemotaxonomic study of endemic species of genus *Tanacetum* from the Canary Islands. Phytochemistry. 92:87–104.

Tschesche R, Diederich A, Jha HC. 1980. Caffeic acid 4-rutinoside from Leonurus cardiaca. Phytochemistry. 19:2783.

Tschesche R, Güttel HW, Josst G. 1974. Desmosterol als biogenetische vorstufe für convallamarogenin. Phytochemistry. 13:137–139.

Ukiya M, Akihisa T, Yasukawa K, Tokuda H, Suzuki T, Kimura Y. 2006. Anti-inflammatory, anti-tumor-promoting, and cytotoxic activities of constituents of Marigold *Calendula officinalis* Flowers. J Nat Prod. 69:1692–1696.

van der Sluis WG, Labadie RP. 1985. Polyoxygenated xanthones of *Centaurium littorale*. Phytochemistry. 24:2601–2605.

Vinogradova VI, Iskandarov S, Yunusov SY. 1971. An investigation of the alkaloids of *Thermopsis lanceolata*. Chem Nat Compd. 7:440–442.

Wagner H, Rosprim L, Galle K. 1975. Endgültige struktur von adonivernith aus *Adonis vernalis*. Phytochemistry. 14:1089–1091.

Westfelt L, Mandell L, Ekwall P, Møller J, Sjöberg B, Bunnenberg E, Djerassi C, Records R. 1966. High-boiling neutral constituents from the wood of *Pinus sylvestris* L. Acta Chem Scand. 20:2829–2840.

Wiedenfeld H, Dumaa M, Malinowski M, Furmanowa M, Narantuya S. 2007. Phytochemical and analytical studies of extracts from *Rhodiola rosea* and *Rhodiola quadrifida*. Pharmazie. 62:308–311.

Wiłkomirski B, Kucharska E. Triterpene chemotypes of some polish populations of *Tanacetum vulgare*. Phytochemistry 31:3915–3916.

Williams CA, Hoult JRS, Harborne JB, Greenham J, Eagles J. 1995. A biologically active lipophilic flavonol from *Tanacetum parthenium*. Phytochemistry. 38:267–270.

Winkler C, Wichtl M. 1986. Neue Cardenolide aus Adonis vernalis. Planta Med.52:68–70.

Wojciechowski Z, Jelonkiewicz-Konador A, Tomaszewski M, Jankowski J, Kasprzyk Z. 1971. The structure of glycosides of oleanolic acid isolated from the roots of *Calendula officinalis*. Phytochemistry. 10:1121–1124.

Wolniak M, Tomczykowa M, Tomczyk M, Gudej J, Wawer I. 2007. Antioxidant activity of extracts and flavonoids from *Bidens tripartita*. Acta Poloniae Pharmaceutica - Drug Research. 447-447

Xianrui L, Qiao X. 2016. Separation and identification of phenolic compounds in *Bidens pilosa* L. by ultra high performance liquid chromatography with quadrupole time-of-flight mass spectrometry. J Sep Sci. 39:1853–1862.

Xin-Min C, Yoshida T, Hatano T, Fukushima M, Okuda T. 1987. Galloylarbutin and other polyphenols from *Bergenia purpurascens*. Phytochemistry 26:515–517.

Yaoita Y, Kamazawa H, Kikuchi M. Structures of new oplopane-type sesquiterpenoids from the flower buds of *Tussilago farfara* L. Chem Pharm Bull. 47:705–707.

Yoshikawa M, Murakami T, Harada E, Murakami N, Yamahara J, Matsuda H. 1996. Bioactive saponins and glycosides. VI. Elatosides A and B, potent inhibitors of ethanol absorption, from the bark of *Aralia elata* SEEM. Araliaceae: the structure-requirement in oleanolic acid glucuronide-saponins for the inhibitory activity. Chem Pharm Bull Tokyo. 44:1915–1922.

Yoshioka I, Yamada Y. 1963. Isolation of dammaradienyl acetate from *Inula helenium.* Yakugaku Zasshi. 83:801-802

Zaima K, Wakana D, Demizu Y, Kumeta Y, Kamakura H, Maruyama T, Kurihara M, Goda Y. Isoheleproline: a new amino acid-sesquiterpene adduct from *Inula helenium*. J Nat Med. 68:432–435.

Zhang R-H, Liu ZK, Yang DS, Zhang XJ, Sun HD, Xiao WL. 2018. Phytochemistry and pharmacology of the genus *Leonurus*: The herb to benefit the mothers and more. Phytochemistry. 147:167–183.

Zheng X, Wang W, Piao H, Xu W, Shi H, Zhao C. 2013. The genus *Gnaphalium* L. Compositae: phytochemical and pharmacological characteristics. Molecules.18:8298–8318.

Zymone K, Raudone L, Raudonis R, Marksa M, Ivanauskas L, Janulis V. 2018. Phytochemical profiling of fruit powders of twenty *Sorbus* L. *Cultivars*. Molecules 23:2593-2610.