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Review Article

Phytoconstituents, Traditional Uses, and Biological Potential of *Edgeworthia* genus

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Abstract

Edgeworthia genus (family Thymelaeaceae) plants are used traditionally for high-quality paper manufacturing, as well as for treating various ailments such as hyperlipidemia, diabetes, hypertension, obesity, cardiovascular and eye diseases, neuralgia, arthralgia, muscle tension, pain, bruise, hoarseness, and swelling. These plants possess diverse pharmacological activities: antidiabetic, anti-obesity, anti-osteoporosis, cardiac and reno-protective, polymerase β lyase inhibition, and anti-HIV. This genus is rich in diverse chemical constituents such as flavonoids, coumarins, terpenoids, alkaloids, and phenolics. The current work aimed to review the reported literature on this genus, including secondary metabolites and their bioactivities. A literature search (1974–September 2024) was conducted on different databases (Google Scholar, Web of Science, Scopus, and PubMed), as well as scientific publishers (Springer, Wiley, Taylor & Francis, Elsevier, JACS, and Bentham). More than 240 compounds were characterized mainly from *E. chrysantha* and *E. gardneri*. The reported studies identified bioactive compounds such as daphnoretin, a coumarin with anti-osteoporotic and α-glucosidase inhibitory activities; biflavonoids like daphnodorin dimers with strong α-glucosidase inhibition; and macrocyclic daphnane orthoesters showing potent anti-HIV effects. The reported findings pointed out the significance of *Edgeworthia* species that support their traditional and medicinal uses. However, further investigations to explore the toxicity profiles, mechanisms of action, and possible clinical applications of this genus are required.

Introduction

Medicinal plants have been considered crucial for thousands of years for human health.[1] They are the main source of remedies and the basis of many traditional medicine practices throughout the world. Medicinal plants can effectively alleviate human ailments and diseases and have advantageous health-promoting effects.[2-5] Additionally, plants are valuable sources that generate a vast array of secondary metabolites. Plants and/or their secondary metabolites represent the basis of the many foods, agrochemical, cosmetic, perfume, and pharmaceutics industries.[2-5]

Thymelaraceae family is composed of 45 genera with about 900 species and includes two major subfamilies, Thymelaeoideae and Octolepidoideae. Subfamily Thymelaeoideae consists of three tribes: Synandrodaphneae, Aquilarieae, and Daphneae that are known to produce coumarins and flavonoids of different skeletons.[6,7] *Edgeworthia* genus is a member of Daphneae tribe, comprising five species: *E. chrysantha* Lindl. (Synonyms: *E. papyrifera* Siebold & Zucc; *E. tomentosa* (Thunb.) Nakai), *E. gardneri* (Wall.) Meisn., *E. albiflora* Nakai, *E. longipes* Lace, and *E. eriosolenoides* K. M. Feng & S. C. Huang. They grow in Southeastern United States, China, Japan, Korea, and India.[8,9] Among the genus members, *E. gardneri* and *E. chrysantha* are the most studied species of this genus. *Edgeworthia* plants are cultivated as ornamentals in urban settings due to their ease of propagation.[7] Also, they are utilized as raw material for the production of rayon and high-

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quality papers like banknotes as they contain abundant low-lignin fibers with a wide range of traditional uses.[7] Phytochemical investigations of this genus revealed the identification of various phyto-constituents, including flavonoids, coumarins, lignans, triterpenes, and steroids with promising biological properties.[10-13] To the best of our knowledge, no published work has comprehensively reviewed the available data on this genus. The current work aimed to discuss the reported literature on this genus including traditional uses, phyto-constituents, and biological properties to highlight its potential traditional and pharmacological significance.

Methodology

The literature search was carried out through different databases (Google-Scholar, Web of Science, Scopus, and PubMed) and scientific publishers (Springer, Wiley Online Library, Taylor & Francis, Elsevier, JACS, and Bentham). The following keywords were used: "*Edgeworthia* genus + NMR", "*Edgeworthia* genus + bioactive compounds", "*Edgeworthia* genus + phytochemistry", "*Edgeworthia* genus + traditional uses", "*Edgeworthia* genus + biological activity". The peer-reviewed original research articles, review articles, and scientific book chapters focusing on the traditional uses, phytochemistry, or biological/pharmacological activities of *Edgeworthia* species, published between 1974 and September 2024 were included. The non-peer-reviewed publications, conference abstracts without full data, articles not focused on *Edgeworthia*, studies lacking phytochemical or biological activity information, and publications in languages other than English without an available English translation were excluded. This review comprises 61 references published between 1974 and September 2024. The relevant articles were selected, and data were extracted and categorized by compound class and biological activity. Tables were compiled to summarize the reported compounds, their sources, and biological activities.

Results

Traditional Uses and Geographical Distribution of Edgeworthia Plants

The *Edgeworthia* plants are commonly found throughout Asia, with China is the main source. *Edgeworthia gardneri* (Wall.) Meisn. grows in Darjeeling`s Birch Hill and Middle-Hill areas, where its fruits are employed as fish poison, whereas stems and roots are utilized for bubo treatment in China.[10] It occurs in the Himalayan region, in northern India and from Nepal to Bhutan and western China. *E. gardneri* is also found in northwest Yunnan Province and at high altitude in eastern Tibet. Its dried flower buds are marketed as precious Tibetan floral tea, named "Lu luohua" for alleviating many illnesses such as hyperlipidemia,[14-16] diabetes,[14,17,18] hypertension,[11] obesity,[14,15] and cardiovascular diseases.[19,2011]

Edgeworthia chrysantha Lindl. (Oriental paperbush) is a deciduous shrub, having distinctive three-pronged branches. *E. chrysantha* flowers are fragrant tubular yellow spherical clusters covered in white silky hairs that give them a frosted look. The flowers bloom in early spring and winter, making them a commonly used decorative plant. It is vastly found in Asia countries, including southern and central China, Japan, Nepal, and Korea. In China, it is predominantly present in Shanxi Province, Henan Province, and some other areas along the Chang Jiang southern side (the Yangtze River).[12] The plant bark fibers are traditionally utilized for artificial cotton, banknotes, and paper, as they contain abundant low-lignin fibers.[21] This species is also cultivated in the southern region of USA.[22]

In China, its alabastrum is employed to treat eye-related conditions such as swelling, nocturnal emissions, delacrimation, ophthalmalgia, and Nephelium.[23] Whilst the roots and barks, known locally as "Zhu Shima" in southern China, are valued in folk medicine for their analgesic and anti-inflammatory effects, [21] as well as stem and root are applied to relieve the muscle tension, pain, and swelling, and heal rheumatism and injuries.[23] Also, roots and buds are used for treating bruises, hoarseness, neuralgia, arthralgia, and eye diseases such as visual impairment, photophobia, and epiphora.[24] *E. chrysantha* is applied to cure rheumatalgia or bone fracture as Flora Reipublicae Popularis Sinicae. Tujia ethnic population in western Hunan Province prepares daily consumed herbal tea by gathering the flower buds, drying them, and then soaking them in hot water to remove obstruction, enhance digestion, and tranquilize the mind.[12]

Botanical Characteristics

Edgeworthia species are distinguished by having tightly bunched fragrant flowers and fibrous stems. The morphological characters of these plants were listed in Table 1 (Figure 1).

Extraction and Isolation of the Secondary Metabolites

Chromatographic separation and analysis using various chromatographic techniques such as SiO_2,[23] Sephadex LH-20,[21] Diaion HP-20,[17] AB-8 macroporous resin, gas chromatography (GC),[31] PTLC (preparative thin layer chromatography), high-performance liquid chromatography (HPLC),[32] HSCCC (high-speed counter-current chromatography),[33] MEKC (micellar electrokinetic capillary chromatography),[33] ultraperformance liquid chromatography-quadrupole time-of-flight mass spectrometry (UPLC-Q-TOF-MS/MS),[32] LC-ESI-MS/MS,[34] and ESI-MS/MS[34] in addition to spectral, CD (circular dichroism), X-ray, and chemical methods led to the separation and characterization of numerous structurally defined bioactive metabolites, primarily coumarins, flavonoids, lignans, and diterpenoids, from various plant parts including roots, stems, bark, flower buds, and leaves.

In 2006, Wang and Cheng developed micellar MEKC method that provided a rapid, efficient, and reliable

Table 1. Morphological characters of *Edgeworthia* plants[25-30]

Part	*E. chrysantha*	*E. gardneri*	*E. eriosolenoides*	*E. albiflora*
Stem/shoot	Shrubs to 0.7-1.5 m tall, deciduous, branching usually trichotomous. Branchlets brown, strong, stout, usually pubescent when young.	Trees small, to 3-4 m tall. Stem brownish red Branchlets glabrous or sparsely sericeous at apex	Shrubs, branching trichotomous. Branchlets brown, pubescent.	Shrubs to 1-5 m tall, branching usually trichotomous. Branchlets brownish yellow, slender; leaf scars visible, ca. 2 mm wide
Leaves	Leaves falling before anthesis; leaf blade oblong, lanceolate, or oblanceolate, 8-20 × 2.5-5.5 cm, both surfaces whitish gray sericeous, more densely so abaxially, base gradually narrowed, cuneate, apex apiculate; lateral veins 10-13 pairs, slender, curved, pubescent.	Petiole 4-8 mm, puberulous. leaf blade narrowly elliptic to elliptic-lanceolate, 6-10 × 2.5-3.4 cm, both surfaces appressed pubescent, base cuneate, apex acute; lateral veins 8 or 9 pairs, conspicuous	Petiole 0.6-1 mm, appressed sericeous leaf blade green adaxially, grayish green abaxially, elliptic to elliptic-lanceolate, 5.5-15 × 1.7-4.7 cm, thinly papery, both surfaces sparsely appressed sericeous, more densely so abaxially, base gradually narrowed, apex acuminate; lateral veins 10-13 pairs, conspicuous, reticulate veins visible	Leaves lasting 2 years; petiole 2-10 mm, pubescent; leaf blade green adaxially, grayish green abaxially, oblanceolate, 3.5-15 × 1-6 cm, abaxially glabrous or puberulous along midrib, adaxially glabrous, base gradually narrowed, margin slightly revolute, apex acute; lateral veins 8-10 pairs, conspicuous
Inflorescences	Inflorescences terminal and axillary, capitate, 30-50-flowered; peduncle 1-2 cm, grayish white hirsute; bracts ca. 10, pilose	Inflorescences terminal and axillary, capitate, 3.5-4 cm in diam., 30-50-flowered; peduncle pendulous, 2-2.5(-5) cm, white sericeous at anthesis, glabrescent; bracts caducous, leaflike, narrowly lanceolate.	Inflorescences axillary, capitate, 10-17-flowered; peduncle 1.5-2 cm, densely sericeous	Inflorescences subterminal on branches, capitate, 30-50-flowered; peduncle 0.5-2.3 cm, densely sericeous
Flower	Flower fragrant; calyx yellow inside, 13-20 × 4-5 mm; tube exterior densely white sericeous, lobes 4, ovate-lanceolate, ca. 3.5 × 3 mm; Anthers subovoid, ca. 2 mm. Disk shallowly cup-shaped, margin irregular; ovary ovoid, ca. 4 × 2 mm, apex sericeous, style glabrous, ca. 2 mm; stigma globose, ca. 3 mm	Flower fragrant; calyx yellow or white ca. 15 mm, exterior densely white sericeous, lobes 4, yellow adaxially, ovate, ca. 3.5 × 2.5 mm, abaxially densely sericeous, apex acute or rounded; Disk scale lacerate; Ovary ellipsoid, ca. 5 mm, uniformly densely grayish white sericeous; style pubescent, ca. 2 mm; Stigma globose, ca. 3 mm	Calyx ca. 20 × 1.5 mm, exterior densely white shiny sericeous, lobes 4, ovate-lanceolate, ca. 4 × 1.5 mm; anthers lanceolate, ca. 1.5 mm; disk shallowly cup-shaped; ovary ellipsoid, ca. 3 mm, apex white sericeous; style filiform, ca. 3 mm; stigma clavate, ca. 2 mm	Calyx white inside, ca. 14 mm, exterior densely white sericeous, lobes 4, broadly ovate, 2.5-3 × ca. 1 mm, apex acute; anthers oblong, ca. 1.5 mm, base rounded. Disk lacerate; ovary ellipsoid, ca. 3.5 mm, apex fascicled white sericeous; style puberulous, ca. 3 mm; stigma clavate, ca. 2 mm
Drupe	Drupe ellipsoid, ca. 8 × 3.5 mm, apex pubescent	Drupe ovoid, densely sericeous		Drupe ovoid, ca. 4 mm, apex sericeous

Edgeworthia chrysantha

Edgeworthia gardneri

Figure 1. Photos of *Edgeworthia chrysantha* (https://plants.ces.ncsu.edu/plants/edgeworthia-chrysantha/) and *Edgeworthia gardneri* (https://efloraofindia.com/efi/edgeworthia-gardneri/)

method for separating and analyzing **12**, **48**, and **53** in the *E. chrysantha* alabastrum.[21] HSCCC demonstrated efficient isolation of **5** (12.9% yield) and **25** (6.6% yield) from *E. chrysantha* stems with over 95% purity by HPLC analysis[33] and **47** (yield 32 mg) and **53** (yield 53 mg) from *E. chrysantha* flowers EtOH extract with recovery rates of 92.2 and 92.5%, respectively) validated through HPLC purity assessment and spectral comparison with authentic standards.[35]

A study by Wen et al developed an innovative method for extracting *E. chrysantha* fresh flowers essential oils at different flowering stages using DLLME-UAE (dispersive liquid-liquid microextraction/ultrasound-assisted extraction) coupled with GC-IT MS (gas chromatography-ion trap mass spectrometry) with a DSI (direct-sample introduction) device[36] with optimal conditions including toluene,[36] acetone, and 10 min for extraction and dispersive solvents and ultrasound time, respectively. Thirty-six constituents were found, including aromatic hydrocarbons, alkanes, alcohols, alkenes, aldehydes, ketones, lipids, acids, and nitrogenous compounds, were identified, all contributing to the distinctive floral aroma of *E. chrysantha*.[36]

Gao et al. reported that the solid-phase extraction using tiliroside-imprinted polymers provided an efficient tool for **45**`s extraction (% recovery ranged from 69.3 to 73.5%) from *E. gardneri* flower EtOAc extract.[37]

Secondary Metabolites and Their Biological Activities

Coumarins

Oligocoumarins are uncommon natural compounds that have mostly been isolated from plants belonging to the Rutaceae, Thymelaeaceae, and Luguminosae families. Various studies reported the isolation of monomeric, bis-, and trimeric coumarins and their glycosides from *Edgeworthia* genus that were listed in Table 2. *Edgeworthia* species are important sources of structurally diverse and biologically active coumarins. A total of 32 coumarins, comprising both aglycones and glycosidic derivatives, were reported from various species of the *Edgeworthia* genus, primarily *E. chrysantha* and *E. gardneri,* reflecting the genus's substantial phytochemical diversity. These compounds were identified from different plant parts such as stems, barks, roots, flower buds, and flowers. Twenty coumarins were separated from *E. chrysantha*, followed by *E. gardneri*, with around ten coumarins.

Kim et al. reported that *E. chrysantha* major constituent: **2** dose-dependently activated osteoblast proliferation and prohibited osteoclast differentiation (IC_{50} 9.94 μM) in ovariectomized mice, suggesting *E. chrysantha* and **2** as a functional food to treat osteoporosis and increase bone strength (Figure 2).[57] Compounds **5**, **7**, and **9** obtained from *E. gardneri*`s methylethyl ketone extract that demonstrated marked polymerase-β lyase inhibition (IC_{50} 43.0 μg/mL (122.3 μM), 32.1 μg/mL (94.8 μM), and 7.3 μg/mL (22.5 μM), respectively). Compound **5** also showed α-glucosidase and α-amylase-inhibition activity.[32] Compound **9** was found to potentiate bleomycin cytotoxicity towards A-549 cells by inhibiting the repair of bleomycin-caused DNA (deoxyribonucleic acid) damage (Figure 3).[51] Besides, *E. chrysantha* major coumarins: **2** and **9** exhibited anti-inflammatory and analgesic activities, whereas **12** (doses 100 and 200 mg/kg) showed only analgesic effects.[23] Compounds **7** and **9** showed potent activity versus α-glucosidase (IC_{50}s 49.6 and 18.7 μg/mL, respectively), having **9** was a noncompetitive inhibitor compared to acarbose (IC_{50} 465 μg/mL).[42] *E. chrysantha* metabolite, **16** remarkably raised 2-NBDG (2-[N-(7- nitrobenz-2-oxa-1,3- diazol-4-yl)amino]-2-deoxy-D-glucose) glucose uptake into 3T3-L1 adipocytes.[45] On the other hand, **5, 12, 14**, and **25** were moderately active against α-glucosidase (IC_{50} 86–780 μg/mL), suggesting *E. gardneri* coumarins more powerful α-glucosidase inhibitors.[42] Additionally, **25** from *E. gardneri* EtOAc extract was reported as new PPARγ (Peroxisome Proliferator-Activated Receptor γ) and PPARβ (Peroxisome Proliferator-Activated Receptor β) agonist that activated PPARβ and PPARγ (Figure 4).[55]

Flavonoids and Their Glycosides

A total of 44 flavonoids have been reported from *Edgeworthia* species, as documented in peer-reviewed literature and confirmed by the Dictionary of Natural Products (DNP). These flavonoids include flavones, isoflavones, and flavonols and their C- or O-glycosides were identified from *Edgeworthia* species, mainly from *E. chrysantha* and *E. gardneri*. *E. gardneri* and *E. chrysantha* contributed over 97% of the identified flavonoids, including tiliroside, kaempferol derivatives, rutin, isoquercetin, apigenin, quercetin, and catechins. These compounds were isolated from the flowers, stems, and twigs, with some detected in the bark, alabastrum, and whole plant extracts (Table 3; Figures 5-10). In addition, biflavonoids such as daphnodorin dimers **33–40** that feature a three-carbon ring connectivity of phenyl ring-A subunit in one moiety and C–C linkage of ring A with another moiety, were isolated (Figure 6).[18] Compounds **33–40** (IC_{50}s 0.4–20 μM) demonstrated significantα-glucosidase inhibitory activity, whereas **33–36** displayed powerful inhibition (IC_{50} 1.09, 2.13, 0.41, and 0.96 μM, respectively) than **37–40** (IC_{50} 3.14, 11.2, 4.0, and 19.0 μM, respectively), in comparison to acarbose (IC_{50} 73.6 μM).[18] Zhang et al. reported that **45** from *E. gardneri* demonstrated notable noncompetitive α-amylase inhibition potential (IC_{50} 12.1 μM and Ki 9.72 μM). It suppressed intestinal α-amylase in mice with a consequent reduction in postprandial peak in the oral sucrose-tolerance test.[58] Also, *E. gardneri* lower-regulated the transcriptional factors related to adipogenesis as C/EBPα and PPARγ and diminished the accumulated triglyceride and lipid accumulations during the differentiation stage.[50] It raised ACC (acetyl-CoA carboxylase) and AMPK (MP-Activated Protein Kinase) phosphorylation, suggesting that the extract produced anti-adipogenic action through modulating the AMPK signaling pathway. Tiliroside (**45)** was identified as the main component of the extract that could contribute to the anti-obesity activity of the extract.[50] Cai et al reported that **45** separated from *E. chrysantha* buds exhibited potential reno-protective property (Figures 7).[59] It restored kidney functions by lowering blood urea nitrogen, serum creatinine, and renal damage markers: kidney injury molecule 1 and neutrophil gelatinase-associated lipocalin levels in acute kidney injury mice models. Additionally, it remarkably amended cisplatin-produced ferroptosis in HK2 cells through NRF2 activation. Thus, **45** boosted ferroptosis inhibition and GPX4/NRF2 pathway activation via the NRF2-KEAP1 PPI disruption.[59] Ma et al reported that **45**, **47**, **48**, and **53** revealed notable α-glucosidase inhibitory activity (IC_{50}s 179–253 μg/mL), compared to acarbose (IC_{50} 465 μg/mL).[17] It was noted that 3`-OH, methyl ester, and free 7-OH groups raised activity.[17] In the *in-vivo* test, **45** (dose 300 mg/kg) remarkably declined the postprandial glucose level, and did not affect fasting glucose level in normal

Table 2. List of coumarins isolated from genus *Edgeworthia*

Compound Name	M. Wt.	Mol. formula	Extract type	Species, plant part, and location	Ref.
Triumbellin (**1**)	482	$C_{27}H_{14}O_9$	75% EtOH	*Edgeworthia chrysantha* Lindl, stems and barks, Nancang, Jiangxi, China	38
Edgeworoside A (**2**)	628	$C_{33}H_{22}O_{13}$	MeOH	*Edgeworthia chrysantha* Lindl, roots and stems, Osaka, Japan	39
	-	-	75% EtOH	*Edgeworthia chrysantha* Lindl, roots and barks, Nancang, Jiangxi, China	23
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
	-	-	95% EtOH	*Edgeworthia chrysantha* Lindl, flower buds, Lishui, Zhejiang, China	41
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	42
	-	-	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
Edgeworoside B (**3**)	614	$C_{32}H_{22}O_{13}$	MeOH	*Edgeworthia chrysantha* Lindl, roots and stems, Osaka, Japan	44
	-	-	90% EtOH	*Edgeworthia chrysantha* Lindl, whole plant, Medicinal Plant Garden, College of Pharmacy, Seoul National University, Goyang-si, Gyeonggi-do, Korea	45
[8,8`-bi-2*H*-1-Benzopyran]-2,2`-dione,7`-(α-D-glucopyranosyloxy)-7-hydroxy-3-[(2-oxo-2*H*-1-benzopyran-7-yl)oxy] = 7``-*O*-(β-D-Glucopyranosyl)-triumbelletin (**4**)	644	$C_{33}H_{24}O_{14}$	75% EtOH	*Edgeworthia chrysantha* Lindl, stems and barks, Nancang, Jiangxi, China	38
	-	-	90% EtOH	*Edgeworthia chrysantha* Lindl, whole plant, Medicinal Plant Garden, College of Pharmacy, Seoul National University, Goyang-si, Gyeonggi-do, Korea	45
Daphnoretin (**5**)	352	$C_{19}H_{12}O_7$	$CHCl_3$	*Edgeworthia gardneri* (Wall.) Meissn, stem-bark, Middle-Hill and Birchill, Darjeeling, India	10
	-	-	EtOAc	*Edgeworthia gardneri* (Wall.) Meissn, stem-bark, Middle-Hill and Birchill, Darjeeling, India	46
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, roots and stems, Osaka, Japan	39
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Osaka, Japan	47
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, China	48
	-	-	70% EtOH	*Edgeworthia chrysantha* Lindl, flowers, China	49
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, stem-bark, Bhutan	49
	-	-	EtOAc	*Edgeworthia chrysantha* Lindl, barks and stems, Hangzhou, Zhejiang, China	33
	-	-	75% EtOH	*Edgeworthia chrysantha* Lindl, stems and barks, Nancang, Jiangxi, China	38
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
	-	-	95% EtOH	*Edgeworthia chrysantha* Lindl, flower buds, Lishui, Zhejiang, China	41
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	42
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Huisheng, China	50
	-	-	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
	-	-	90% EtOH	*Edgeworthia chrysantha* Lindl, whole plant, Medicinal Plant Garden, College of Pharmacy, Seoul National University, Goyang-si, Gyeonggi-do, Korea	45
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
7-*O*-Acetyl daphnoretin (**6**)	394	$C_{21}H_{14}O_8$	EtOAc	*Edgeworthia gardneri* (Wall.) Meissn, stem-bark, Middle-Hill and Birchill, Darjeeling, India	46
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Osaka, Japan	47
Edgeworthin (**7**)	338	$C_{18}H_{10}O_7$	$CHCl_3$	*Edgeworthia gardneri* (Wall.) Meissn, stem-bark, Middle-Hill and Birchill, Darjeeling, India	10
	-	-	Methyl ethyl ketone	*Edgeworthia gardneri* (Wall.) Meissn, stem-bark, Bhutan	51
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	42
Rutamontine (**8**)	352	$C_{19}H_{12}O_7$	75% EtOH	*Edgeworthia chrysantha* Lindl, stems and barks, Nancang, Jiangxi, China	38
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
Edgeworin (**9**)	322	$C_{18}H_{10}O_6$	MeOH	*Edgeworthia chrysantha* Lindl, roots and stems, Osaka, Japan	39
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, roots and stems, Osaka, Japan	44
	-	-	Methyl ethyl ketone	*Edgeworthia gardneri* Meisner, stem-bark, Bhutan	51
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, roots and barks, Nancang, Jiangxi, China	23
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	42
Daphnorin (**10**)	514	$C_{25}H_{22}O_{12}$	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
Daphneretusin A (**11**)	500	$C_{24}H_{20}O_{12}$	90% EtOH	*Edgeworthia chrysantha* Lindl, whole plant, Medicinal Plant Garden, College of Pharmacy, Seoul National University, Goyang-si, Gyeonggi-do, Korea	45

Table 2. Continued.

Compound Name	M. Wt.	Mol. formula	Extract type	Species, plant part, and location	Ref.
Edgeworoside C (**12**)	468	$C_{24}H_{20}O_{10}$	MeOH	*Edgeworthia chrysantha* Lindl, roots and stems, Osaka, Japan	44
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, China	48
	-	-	*n*-Butanol	*Edgeworthia chrysantha* Lindl, barks and stems, Hangzhou, Zhejiang, China	52
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, roots and barks, Nancang, Jiangxi, China	23
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, alabastrum, Hangzhou, Zhejiang, China	21
	-	-	95% EtOH	*Edgeworthia chrysantha* Lindl, flower buds, Lishui, Zhejiang, China	41
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	42
	-	-	70% EtOH	*Edgeworthia chrysantha* Lindl, flowers, China	49
	-	-	90% EtOH	*Edgeworthia chrysantha* Lindl, whole plant, Medicinal Plant Garden, College of Pharmacy, Seoul National University, Goyang-si, Gyeonggi-do, Korea	45
	-	-	EtOAc	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	53
7-Hydroxyl-odesmethoxyrutarensin = 6``-*O*-(3-Hydroxy-3-methylglutaryl)-daphneretusin A (**13**)	644	$C_{30}H_{28}O_{16}$	75% EtOH	*Edgeworthia chrysantha* Lindl, barks and stems, Nancang, Jiangxi, China	54
	-	-	90% EtOH	*Edgeworthia chrysantha* Lindl, whole plant, Medicinal Plant Garden, College of Pharmacy, Seoul National University, Goyang-si, Gyeonggi-do, Korea	45
Daphnoretin 5-*O*-β-D-glucopyranosyl-(1 → 2)-β-D-glucopyranoside (**14**)	692	$C_{31}H_{32}O_{18}$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	42
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	49
Rutarensin (**15**)	658	$C_{31}H_{30}O_{16}$	MeOH	*Edgeworthia chrysantha* Lindl, roots and stems, Osaka, Japan	44
	-	-	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
Hymexelsin (**16**)	486	$C_{21}H_{26}O_{13}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
8-[3-(2,4-Benzenediol)-propionic acid methyl ester]-coumarin-7-β-D-glucoside (**17**)	518	$C_{25}H_{26}O_{12}$	75% EtOH	*Edgeworthia chrysantha* Lindl, barks and stems, Nancang, Jiangxi, China	54
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
Gardnerol A (**18**)	356	$C_{19}H_{16}O_7$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
Gardnerol B (**19**)	504	$C_{24}H_{24}O_{12}$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
Daphneticin (**20**)	386	$C_{20}H_{18}O_8$	75% EtOH	*Edgeworthia chrysantha* Lindl, stems and barks, Nancang, Jiangxi, China	38
Skimmin (**21**)	324	$C_{15}H_{16}O_8$	75% EtOH	*Edgeworthia chrysantha* Lindl, stems and barks, Nancang, Jiangxi, China	38
Cniforin A (**22**)	374	$C_{20}H_{22}O_7$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Edgeworic acid (**23**)	342	$C_{18}H_{14}O_7$	95% EtOH	*Edgeworthia chrysantha* Lindl, flower buds, Lishui, Zhejiang, China	41
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
2*H*-1-Benzopyran-2-one = Coumarin (**24**)	146	$C_9H_6O_2$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Umbelliferone (**25**)	162	$C_9H_6O_3$	MeOH	*Edgeworthia chrysantha* Lindl, roots and stems, Osaka, Japan	39
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, China	48
	-	-	70% EtOH	*Edgeworthia chrysantha* Lindl, flowers, China	49
	-	-	EtOAc	*Edgeworthia chrysantha* Lindl, barks and stems, Hangzhou, Zhejiang, China	33
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
	-	-	95% EtOH	*Edgeworthia chrysantha* Lindl, flower buds, Lishui, Zhejiang, China	41
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	55
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	42
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
4-Methylumbelliferone (**26**)	176	$C_{10}H_8O_3$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	20
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Limettin (**27**)	206	$C_{11}H_{10}O_4$	MeOH	*Edgeworthia chrysantha* Lindl, roots and stems, Osaka, Japan	39
	-	-	95% EtOH	*Edgeworthia chrysantha* Lindl, flower buds, Lishui, Zhejiang, China	41
Daphnetin (**28**)	178	$C_9H_6O_4$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	42
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
7,8-Dihydroxy-4-methylcoumarin (**29**)	192	$C_{10}H_8O_4$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Scopoletin (**30**)	192	$C_{10}H_8O_4$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Psoralen (**31**)	186	$C_{11}H_6O_3$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Bergapten (**32**)	216	$C_{12}H_8O_4$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56

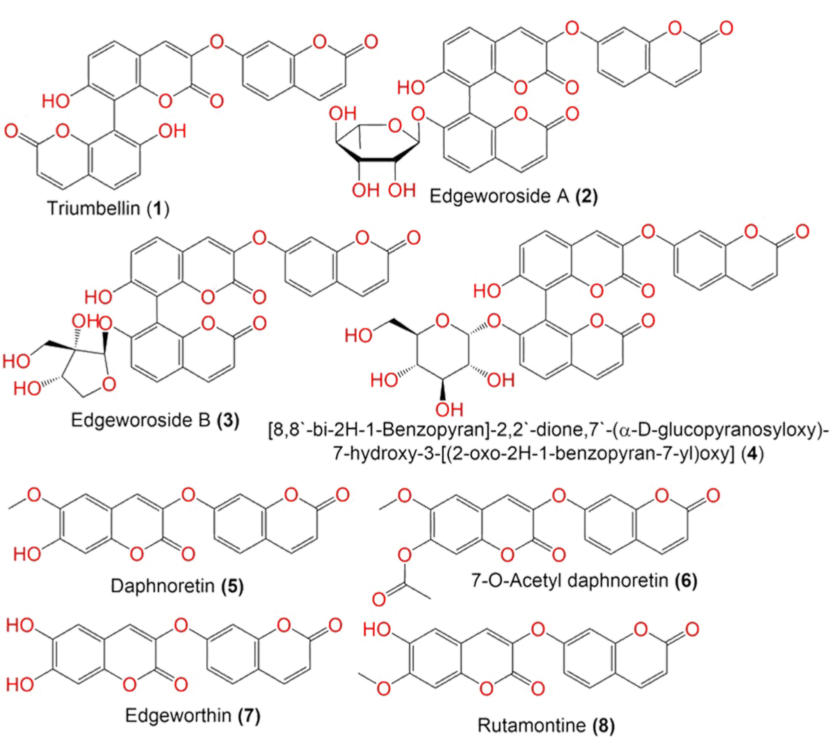

Figure 2. Chemical structures of coumarins (**1**–**8**) from *Edgeworthia* genus

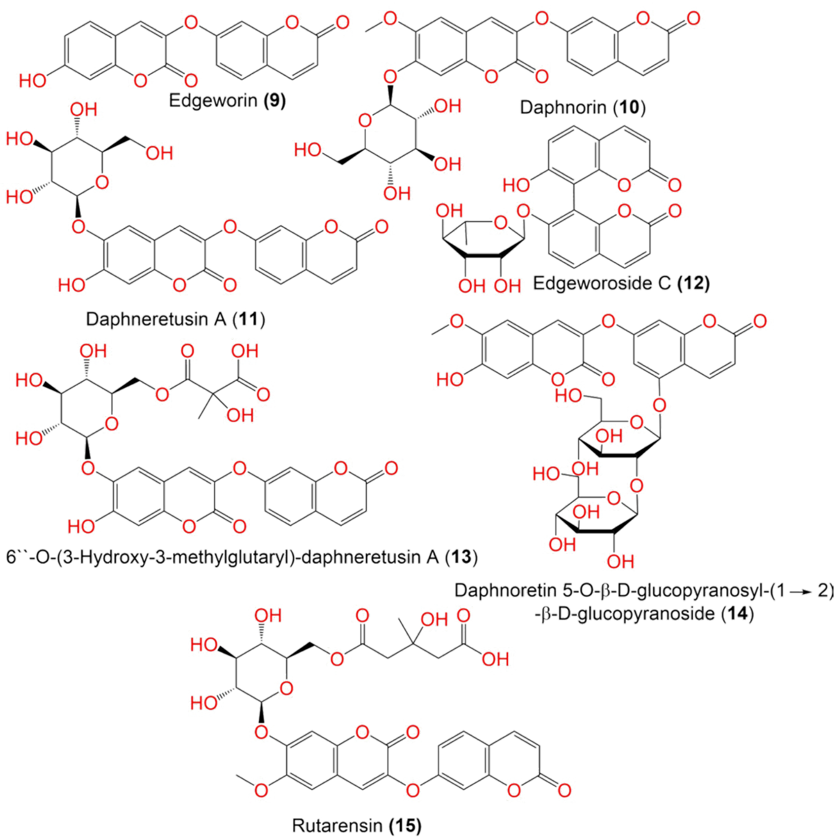

Figure 3. Chemical structures of coumarins (**9**–**15**) from *Edgeworthia* genus

mice.[17] On the other hand, **45** prohibited the intestinal α-glucosidase and minimized fasting glucose level in the STZ-produced diabetic mice. In contrast to glibenclamide it revealed hypoglycemic efficacy in diabetic mice but not in normal mice, indicating that **45** did not directly act through insulin release.[17] Further, **45**, **59**, **61**, and **66** had α-glucosidase inhibition activities (IC_{50}s 1071.6 to 22.3 μM) and **53** showed α-amylase-inhibition (IC_{50} 55.5 μM), suggesting coumarins and flavonoids accountable for *E. gardneri* activity (Figures 8-10).[32] Compounds **66** and **67**

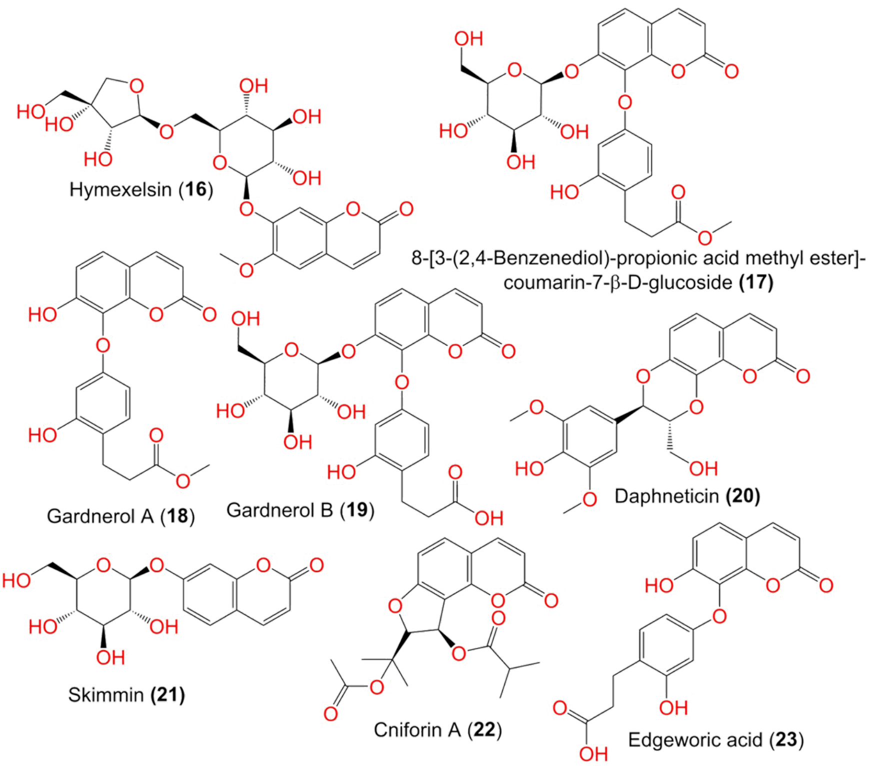

Figure 4. Chemical structures of coumarins (**16–23**) from *Edgeworthia* genus

(IC_{50} 56.2 and 5.1 µg/mL, respectively) exhibited powerful α-glucosidase inhibitory activity, whereas **67** was the most active.[17] A study by Zhuang et al revealed that **67** (conc > 10 µM/L) from *E. gardneri* flower remarkably boosted insulin secretion in MIN-6 cells through ERK1/2/Ca^{2+}signaling pathway.[60] Also, it suppressed palmitic acid-caused cell apoptosis by restoring the integrity of the damaged mitochondrial membrane, repressing caspase-3, -9, and -12 activation, and raising the Bcl-2/BAX ratio.[60]

Organic Acids and Esters

Chlorogenic, ferulic, caffeic, hydroxycinnamic, benzoic, salicylic, and gallic acid were identified from *E. gardneri* and *E. chrysantha* (Figure S1; Table 4). While esters such as methyl salicylate, benzyl acetate, vanillin isobutyrate, and methyl benzoate were purified from *E. chrysantha* and *E. tomentosa* flowers (Figure S2).

Aldehydes, Phenols, Lignans, Chromans, and Aromatic Alcohols

Three aldehydes were identified from *E. gardneri* (1 compound) and *E. chrysantha* (2 compounds) flowers. Phenolic glycosides (**105–117**), lignans ((+)-lariciresinol, neosesamin, ciwujiatone, and interiotherin C), and chromans (cnidimol B and isoophiopogonone A) were separated mainly from *E. gardneri* flowers, while alcohols (α-cumyl and benzyl alcohols) were identified from *E. chrysantha* flowers (Table 5; Figure S2). Compounds **85**, **104**, and **114** displayed α-glucosidase inhibitory activity (IC_{50}s 279, 486, and 957 µg/mL, respectively), in comparison to acarbose (IC_{50} 465 µg/mL).[17]

Terpenoids

A total of 45 terpenoids were reported from *Edgeworthia* species, mainly from *E. chrysantha*, *E. gardneri*, and *E. tomentosa*, including monoterpenes, sesquiterpenes, and macrocyclic daphnane orthoesters (Table 6). Mcrocyclic daphnane orthoesters: **124–130** were separated by Asada et al. from *E. chrysantha* flower buds that belong to a 1-alkyldaphnane class possessing a C14-macrocyclic ring, which consists of an aliphatic chain at C-1 linked to the C-14,13,9-orthoester moiety (Table 5, Figure 11 and Figures S3-S5).[34] Additionally, **129** and **130** were detected in the flowers and stems of *E. chrysantha,* respectively by LC-ESI-MS/MS that were separated by Diaion HP-20/HPLC and elucidated by ESI-MS/MS fragmentation and spectral analyses.[24] Besides, **124–128** separated from *E. chrysantha* were examined for their anti-HIV-1 activity towards HIV-infected MT4 cells using the CellTiter-Glo Luminescent Cell Viability Assay.[34] Compounds **125**, **127**, and **128** demonstrated significant anti-HIV activity (EC_{50}s 29.3, 8.4, and 2.9 nM, respectively), whereas **127** and **128** exhibited more powerful anti-HIV activity than **124–126**, suggesting that a cyclopentanone unit in the A-ring enhanced the activity. Also, the C-18 isobutyryloxy moiety boosted the activity (**128** vs **127**).[34] Another study by Otsuki et al. revealed that **124–130** exhibited anti-HIV activity (EC_{50}s 0.10–7.03 µM), whereas **124** (EC_{50} 1.61 µM) and **128** (EC_{50} 0.10 µM) displayed promising activity. It was noted that the C-12 acetyloxy moiety replacement with an OH group and the presence of C-18 2-methylbutyloxy moiety reduced activity.[24]

Cao et al analyzed using GC-MS the *E. chrysantha*

Table 3. List of flavonoids isolated from genus *Edgeworthia*

Compound Name	M. Wt.	Mol. Formula	Extract type	Species, Plant part, and Location	Ref.
Edgechrin A (**33**)	1050	$C_{60}H_{42}O_{18}$	H_2O/acetone 3:7	*Edgeworthia chrysantha* Lindl, stems and twigs, Guangxi, China	18
Edgechrin B (**34**)	1066	$C_{60}H_{42}O_{19}$	H2O/acetone 3:7	*Edgeworthia chrysantha* Lindl, stems and twigs, Guangxi, China	18
Edgechrin C (**35**)	1050	$C_{60}H_{42}O_{18}$	H2O/acetone 3:7	*Edgeworthia chrysantha* Lindl, stems and twigs, Guangxi, China	18
Edgechrin D (**36**)	1050	$C_{60}H_{42}O_{18}$	H2O/acetone 3:7	*Edgeworthia chrysantha* Lindl, stems and twigs, Guangxi, China	18
Daphnodorin A (**37**)	526	$C_{30}H_{22}O_{9}$	H2O/acetone 3:7	*Edgeworthia chrysantha* Lindl, stems and twigs, Guangxi, China	18
	-	-	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
Daphnodorin B (**38**)	542	$C_{30}H_{22}O_{10}$	H_2O/acetone 3:7	*Edgeworthia chrysantha* Lindl, stems and twigs, Guangxi, China	18
	-	-	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
Daphnodorin C (**39**)	526	$C_{30}H_{22}O_{9}$	H_2O/acetone 3:7	*Edgeworthia chrysantha* Lindl, stems and twigs, Guangxi, China	18
Daphnodorin I (**40**)	542	$C_{30}H_{22}O_{10}$	H_2O/acetone 3:7	*Edgeworthia chrysantha* Lindl, stems and twigs, Guangxi, China	18
	-	-	90% EtOH	*Edgeworthia chrysantha* Lindl, whole plant, Medicinal Plant Garden, College of Pharmacy, Seoul National University, Goyang-si, Gyeonggi-do, Korea	45
Wikstrol A (**41**)	542	$C_{30}H_{22}O_{10}$	90% EtOH	*Edgeworthia chrysantha* Lindl, whole plant, Medicinal Plant Garden, College of Pharmacy, Seoul National University, Goyang-si, Gyeonggi-do, Korea	45
Wikstrol B (**42**)	542	$C_{30}H_{22}O_{10}$	90% EtOH	*Edgeworthia chrysantha* Lindl, whole plant, Medicinal Plant Garden, College of Pharmacy, Seoul National University, Goyang-si, Gyeonggi-do, Korea	45
5`-Methoxy-bilobetin (**43**)	582	$C_{32}H_{22}O_{11}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Apocynin B (**44**)	468	$C_{24}H_{20}O_{10}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Tiliroside (**45**)	594	$C_{30}H_{26}O_{13}$	MeOH	*Edgeworthia chrysantha* Lindl, flowers, China	48
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, China	48
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Huisheng, China	50
	-	-	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
	-	-	H_2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	61
	-	-	EtOAc	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	53
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	20
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Kaempferol 3-(3``-*p*-coumarylglucoside (**46**)	594	$C_{30}H_{26}O_{13}$	H_2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	15
Kaempferol-3-*O*-rutinoside=Nicotiflorin (**47**)	594	$C_{27}H_{30}O_{15}$	EtOH	*Edgeworthia chrysantha* Lindl, flowers, Hangzhou, Zhejiang, China	35
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Tsukuba, Jappan	62
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Kaempferol-3-*O*-β-D-glucoside=Astragalin (**48**)	448	$C_{21}H_{20}O_{11}$	MeOH	*Edgeworthia chrysantha* Lindl, alabastrum, Hangzhou, Zhejiang, China	21
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, China	48
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, China	48
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Tsukuba, Jappan	62
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Huisheng, China	50
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Kaempferol-3-neohesperidoside (**49**)	594	$C_{27}H_{30}O_{15}$	H_2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	15
Isovitexin-4`-O-glucoside (**50**)	594	$C_{27}H_{30}O_{15}$	H_2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	15
Isovitexin-2``-O-arabinoside (**51**)	564	$C_{26}H_{28}O_{14}$	H_2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	15
Buddlenoid A (**52**)	594	$C_{30}H_{26}O_{13}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32

Table 3. Continued.

Compound Name	M. Wt.	Mol. Formula	Extract type	Species, Plant part, and Location	Ref.
Rutin (**53**)	610	$C_{27}H_{30}O_{16}$	MeOH	*Edgeworthia chrysantha* Lindl, alabastrum, Hangzhou, Zhejiang, China	21
	-	-	EtOH	*Edgeworthia chrysantha* Lindl, flowers, Hangzhou, Zhejiang, China	35
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Tsukuba, Jappan	62
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
	-	-	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
	-	-	H_2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	61
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Quercetin -3-*O*--D-glucoside = Isoquercetin (**54**)	464	$C_{21}H_{20}O_{12}$	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Tsukuba, Jappan	62
Apigenin-7-*O*-rhamnoside (**55**)	416	$C_{21}H_{20}O_{9}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Rhamnocitrin-3-(6``-acetylglucoside) (**56**)	504	$C_{24}H_{24}O_{12}$	H_2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	15
6``-*O*-Acetyldaidzin (**57**)	458	$C_{23}H_{22}O_{10}$	H_2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	15
Acacetin-7-*O*-(6``-*O*-acetyl)-β-D-glucopyranoside (**58**)	488	$C_{24}H_{24}O_{11}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Isoorientin (**59**)	448	$C_{21}H_{20}O_{11}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Neocomplanoside (**60**)	504	$C_{24}H_{24}O_{12}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Chrysin (**61**)	254	$C_{15}H_{10}O_{4}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Apigenin (**62**)	270	$C_{15}H_{10}O_{5}$	75% EtOH	*Edgeworthia chrysantha* Lindl, stems and barks, Nancang, Jiangxi, China	38
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
7-Hydroxy-4`-methoxyflavone (**63**)	268	$C_{16}H_{12}O_{4}$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
Luteolin (**64**)	286	$C_{15}H_{10}O_{6}$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	20
Gardenin C (**65**)	404	$C_{20}H_{20}O_{9}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Kaempferol (**66**)	286	$C_{15}H_{10}O_{6}$	MeOH	*Edgeworthia chrysantha* Lindl, flowers, China	48
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Tsukuba, Jappan	62
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Quercetin (**67**)	302	$C_{15}H_{10}O_{7}$	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Tsukuba, Jappan	62
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	60
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	20
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
8-Hydroxygalangin 7-methyl ether 8-acetate (**68**)	342	$C_{18}H_{14}O_{7}$	H_2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	15
Catechin (**69**)	290	$C_{15}H_{14}O_{6}$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	20
(-)-Epicatechin (**70**)	290	$C_{15}H_{14}O_{6}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Dihydrokaempferol (**71**)	288	$C_{15}H_{12}O_{6}$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	49
			MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Citflavanone (**72**)	338	$C_{20}H_{18}O_{5}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Isoliquiritigenin (**73**)	256	$C_{15}H_{12}O_{4}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
(3*R*)-2`, 3`,7-Trihydroxy-4`-methoxyisoflavanone (**74**)	302	$C_{16}H_{14}O_{6}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Glycitein (**75**)	284	$C_{16}H_{12}O_{5}$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Daidzein (**76**)	254	$C_{15}H_{10}O_{4}$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56

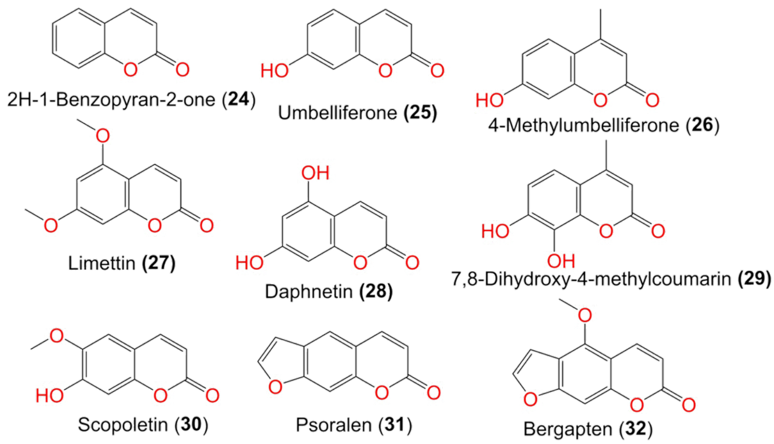

Figure 5. Chemical structures of coumarins (**24**–**32**) from *Edgeworthia* genus

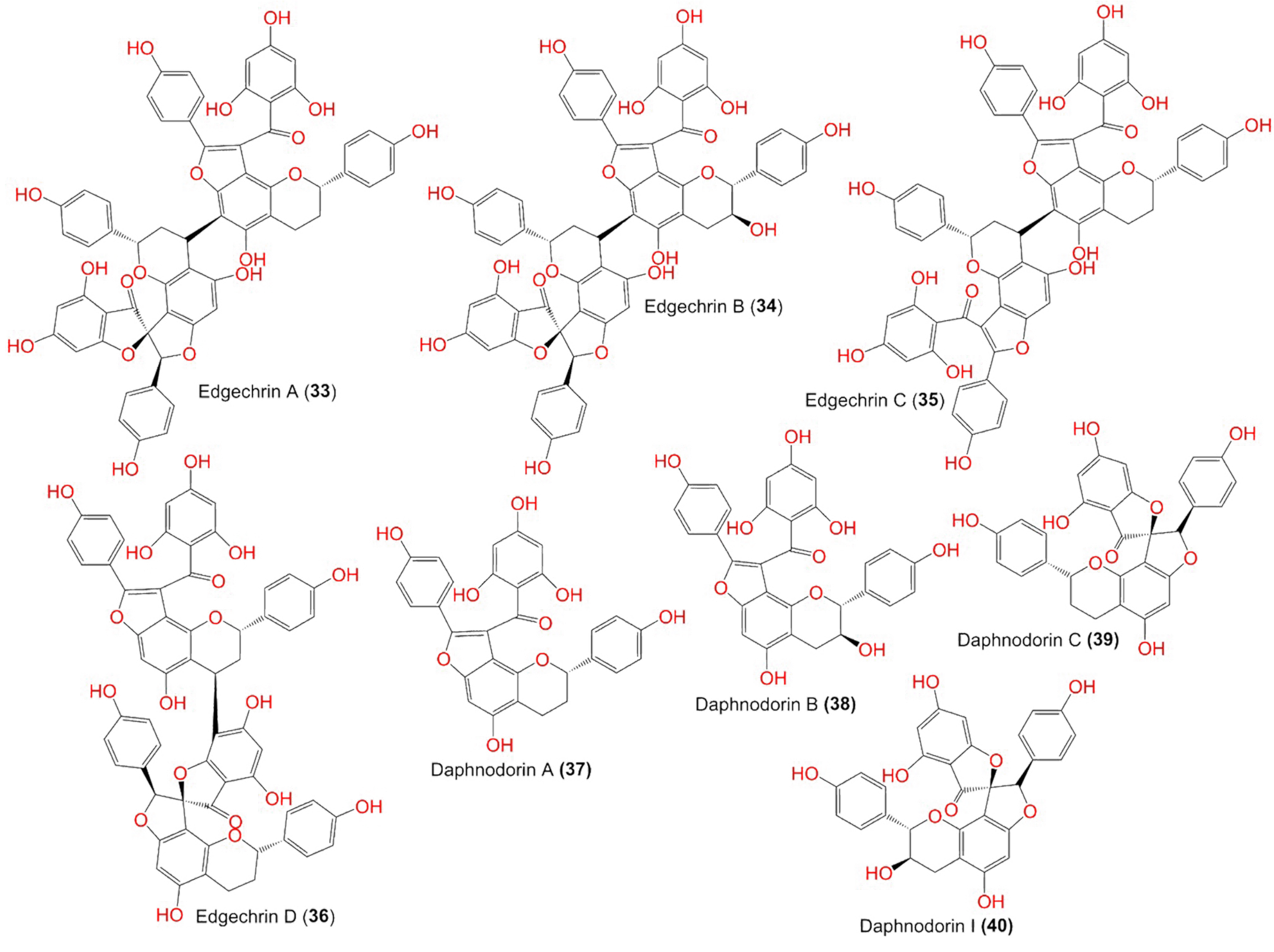

Figure 6. Chemical structures of flavonoids (**33**–**40**) from *Edgeworthia* genus

flowers essential oil after extraction by diethyl ether and isolation through steam distillation. A total of 61 volatile compounds were identified, constituting 60.14% of the volatile fraction, with notable constituents including 1,1′-oxybisdecane, 7-bromomethyl-7-pentadecene, and tert-hexadecanethiol.[63] The GC-MS analysis of *E. tomentosa* flowers revealed 38 constituents, accounting for 98% of the essential oil. The major components included terpenoids, making up 36.47% of the oil, with key compounds such as carvone, carveol, and β-caryophyllene. Sesquiterpenes and monoterpenes contributed 21.63% and 14.84%, respectively. Additionally, various fatty acids and hydrocarbons, including decanal and octadecanoic acid, as well as phenolic compounds such as methyl benzoate and vanillin isobutyrate were detected.[31] It was found that *E. tomentosa* essential oil demonstrated wide-spectrum antibacterial capacity versus various bacterial strains of Gram-positive and Gram-negative types with MBC and MIC values ranging between 26.0–71.0 and 7.8–62.5 µg/mL, respectively, whereas the powerful bacteriostatic

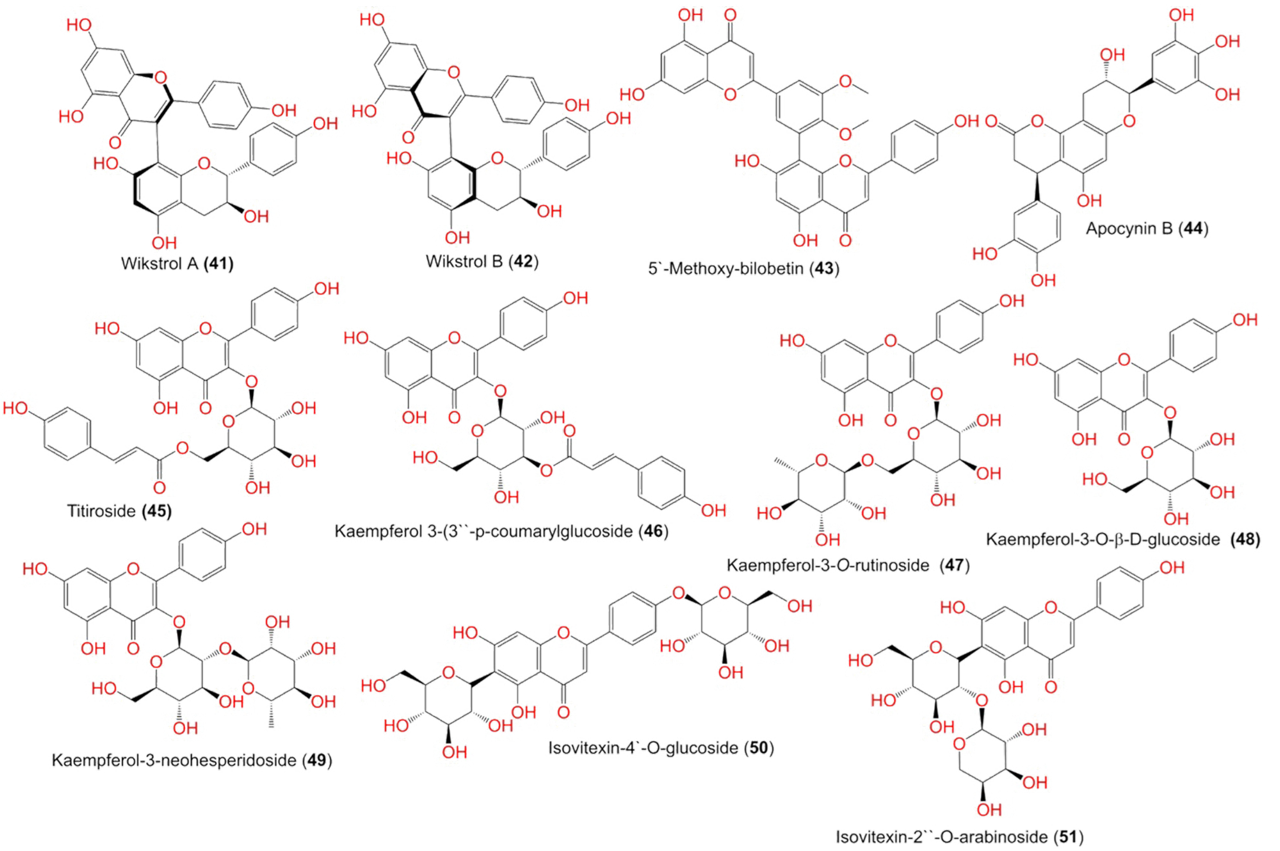

Figure 7. Chemical structures of flavonoids (**41–51**) from *Edgeworthia* genus

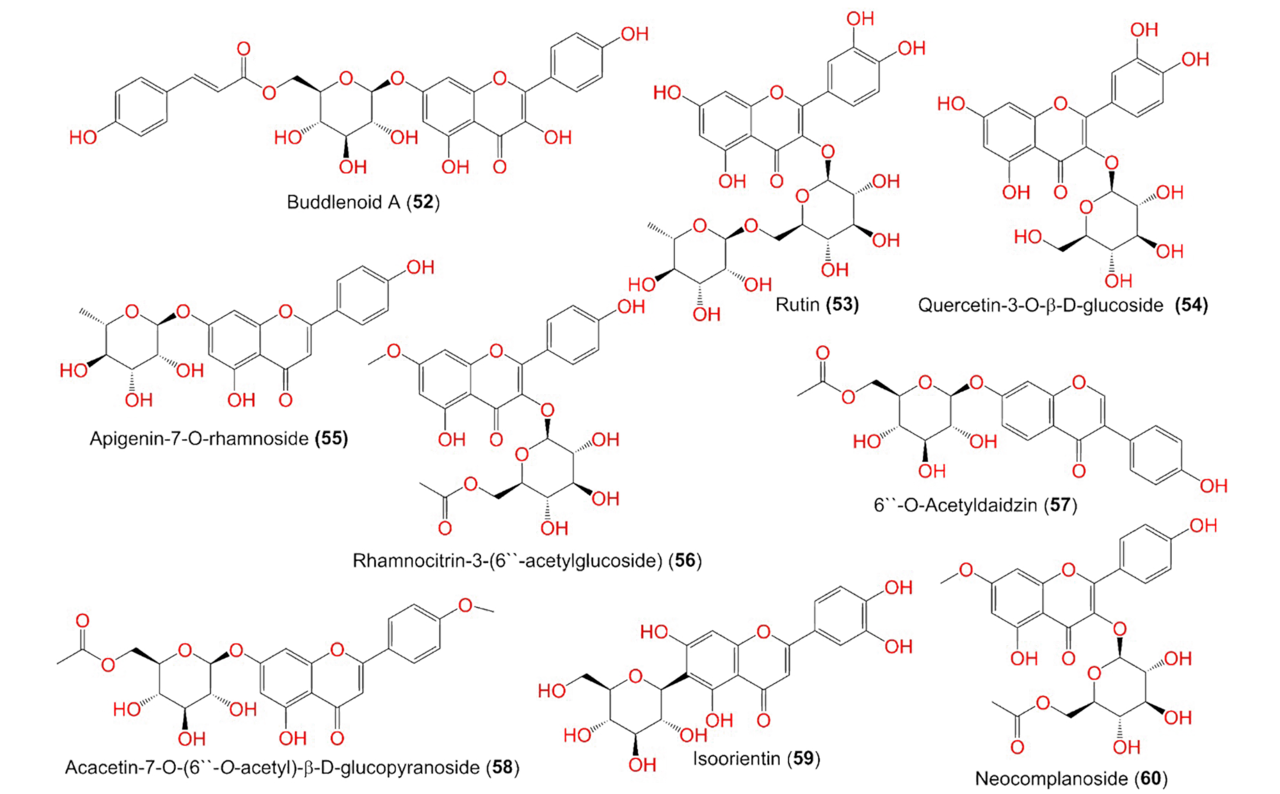

Figure 8. Chemical structures of flavonoids (**52–60**) from *Edgeworthia* genus

efficacy was noted versus *Diplococcus pneumonia*.[31] The powerful antibacterial capacity was attributed to its high monoterpene and sesquiterpene constituents; **150**, **144**, **138**, and **149** (8.81, 6.96, 3.45, and 3.34%, respectively).[31]

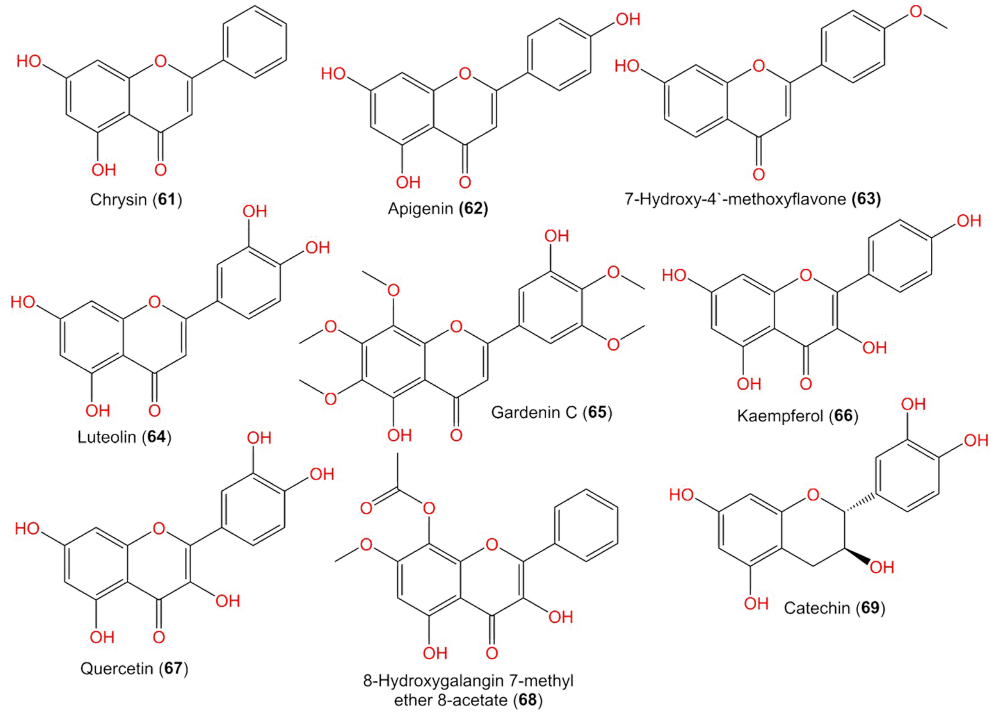

Figure 9. Chemical structures of flavonoids (**61**–**69**) from *Edgeworthia* genus

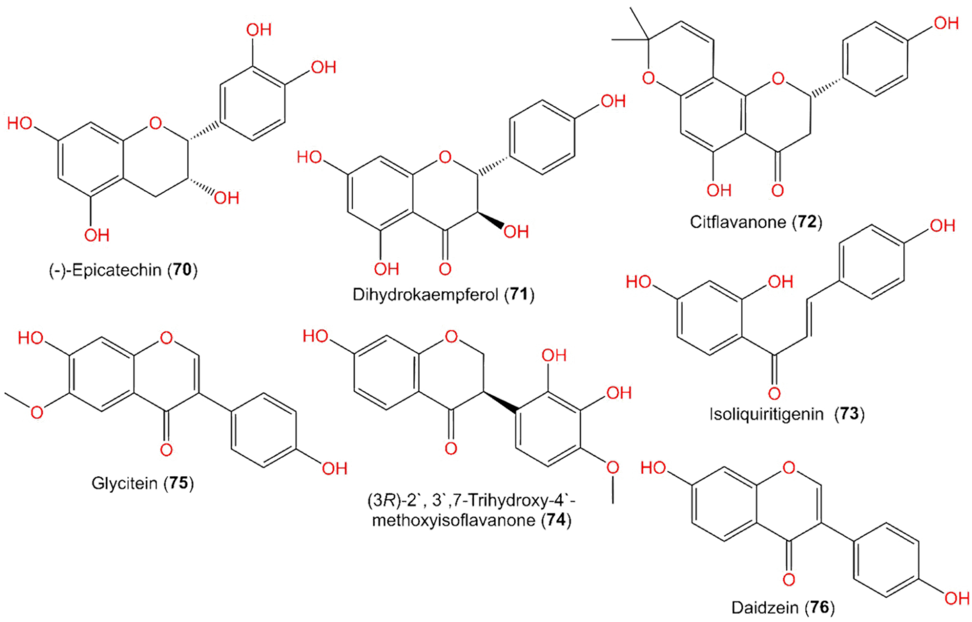

Figure 10. Chemical structures of flavonoids (**70**–**76**) from *Edgeworthia* genus

Sterols, Alkaloids, and Nitrogenous Compounds

Four sterols were reported, including chrysanthosides that are sterol acylglucosides identified from *E. chrysantha* flower that were characterized as sitosterol-3-*O*-6-linoleoyl (**169**) and sitosterol-3-*O*-6-linolenoyl-β-D-glucopyranosides (**168**) (Table 7; Figure S6).[47] Additionally, compounds **166** and **167** were obtained from *E. gardneri* flowers. *E. chrysantha*`s flower EtOAc extract at concentrations of 100 ppm and 10 ppm killed *Oryzia latipes* (Killie-fish) after 1 minutes and 28 hours, respectively, while the n-butanol extract did not affect the same fish.[47] Compounds **168** and **169** (Conc. 0.1 ppm) exhibited powerful piscicidal effectiveness, they caused death to *Oryzia latipes* killie-fish within 3 hr.[47] Notably, 16 alkaloids and nitrogenous compounds were reported exclusively from *E. gardneri*, including berberine,[56] cytisine,[56] scopolamine, swainonine,[56] gentialutine,[56] and trigonelline[56] (Table 7; Figure S7).

Fatty Acids

Additionally, 20 fatty acids were reported predominantly from *E. gardneri* and *E. tomentosa* (Table 8; Figure S8).

Table 4. List of organic acids and esters isolated from genus *Edgeworthia*

Compound Name/Chemical Class	M. Wt.	Mol. Formula	Extract type	Species, Plant part, and Location	Ref.
Organic acids					
Chlorogenic acid (**77**)	354	$C_{16}H_{18}O_9$	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
	-	-	H2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	61
	-	-	H2O	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Chengdu, China	15
Chlorogenic acid methyl ester (**78**)	368	$C_{17}H_{20}O_9$	MeOH	*Edgeworthia papyrifera (Edgeworthia chrysantha)*, bark and wood, Gyeonggi, Korea	43
Neochlorogenic acid (**79**)	354	$C_{16}H_{18}O_9$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Methyl-3-*O*-(4``-hydroxy-3``,5``-dimethoxybenzoyl)-chlorogenate (**80**)	548	$C_{26}H_{28}O_{13}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
3-Feruloylquinic acid (**81**)	368	$C_{17}H_{20}O_9$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Ningposide D (**82**)	368	$C_{17}H_{20}O_9$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
trans-P-Hydroxycinnamic acid (**83**)	164	$C_9H_8O_3$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
Ferulic acid (**84**)	194	$C_{10}H_{10}O_4$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	20
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Caffeic acid (**85**)	180	$C_9H_8O_4$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
3-*O*-Acetyl-caffeic acid (**86**)	222	$C_{11}H_{10}O_5$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Benzoic acid (**87**)	122	$C_7H_6O_2$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
4-Hydroxybenzoic acid (**88**)	138	$C_7H_6O_3$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
Salicylic acid (**89**)	138	$C_7H_6O_3$	EtOAc	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	53
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	20
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Gallic acid (**90**)	170	$C_7H_6O_5$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	20
(2,4,5-trihydroxy-phenyl)-glyoxylic acid (**91**)	198	$C_8H_6O_6$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	20
Capillartemisin B (**92**)	316	$C_{19}H_{29}O_4$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Coumalic acid (**93**)	140	$C_6H_4O_4$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Xanthene-9-carboxylic acid (**94**)	226	$C_{14}H_{10}O_3$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Esters					
Vanillin isobutyrate (**95**)	222	$C_{12}H_{14}O_4$	Essential oils	*Edgeworthia tomentosa* (Thunb.) Nakai *(Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Phenethyl acetate (**96**)	164	$C_{10}H_{12}O_2$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
			Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Methyl benzoate (**97**)	136	$C_8H_8O_2$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
			Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Benzyl acetate (**98**)	150	$C_9H_{10}O_2$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
			Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Ethyl caffeate (**99**)	208	$C_{11}H_{12}O_4$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Dimethyl phthalate (**100**)	194	$C_{10}H_{10}O_4$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Methyl salicylate (**101**)	152	$C_3H_8O_3$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
			Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31

Table 5. List of aldehydes, phenols, lignans, chromans, and aromatic alcohols isolated from genus *Edgeworthia*

Compound name/chemical class	M. Wt.	Mol. formula	Extract type	Species, plant part, and location	Ref.
Aldehydes					
Benzeneacetaldehyde (**102**)	120	C_8H_8O	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
Benzaldehyde (**103**)	106	C_7H_6O	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
4-Hydroxybenzaldehyde (**104**)	122	$C_7H_6O_2$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
Phenols					
Zingerone 4-*O*-β-D-glucopyranoside (**105**)	356	$C_{17}H_{24}O_8$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Coniferin (**106**)	342	$C_{16}H_{22}O_8$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
Syringin (**107**)	372	$C_{17}H_{24}O_9$	*n*-Butanol	*Edgeworthia chrysantha* Lindl, barks and stems, Hangzhou, Zhejiang, China	52
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
Eugenol rutinoside (**108**)	472	$C_{22}H_{32}O_{11}$	EtOAc	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	53
2,6-Dimethoxy-4-(2-propen-1-yl)phenyl-6-O-(6-deoxy-α-L-mannopyranosyl)-β-D-glucopyranoside (**109**)	502	$C_{23}H_{34}O_{12}$	EtOAc	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	53
Dimethyl lithospermate (**110**)	566	$C_{29}H_{26}O_{12}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Erythro-dihydroxyde-hydrodiconiferyl alcohol (**111**)	392	$C_{20}H_{24}O_8$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
2-Methyl-1,4-Benzenediol (**112**)	124	$C_7H_8O_2$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Phloroglucinol (**113**)	126	$C_6H_6O_3$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Lignans					
(+)-Lariciresinol (**114**)	360	$C_{20}H_{24}O_6$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	17
Neosesamin (**115**)	384	$C_{21}H_{20}O_7$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Ciwujiatone (**116**)	434	$C_{22}H_{26}O_9$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Interiotherin C (**117**)	556	$C_{30}H_{36}O_{10}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Chromans					
5,6,7-Trihydroxy-3-(4`-hydroxybenzyl) chromone (**118**)	300	$C_{16}H_{12}O_6$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Cnidimol B (**119**)	292	$C_{15}H_{16}O_6$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
6-Formyl-isoophiopogonanone A (**120**)	356	$C_{19}H_{16}O_7$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Isoophiopogonone A (**121**)	328	$C_{18}H_{16}O_6$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Aromatic alcohols					
Benzyl alcohol (**122**)	108	C_7H_8O	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
α-Cumyl alcohol (**123**)	136	$C_9H_{12}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36

Table 6. List of terpenoids isolated from genus *Edgeworthia*

Compound name	M. Wt.	Mol. formula	Extract type	Species, plant part, and location	Ref.
Edgeworthianin A (**124**)	658	$C_{36}H_{50}O_{11}$	MeOH	*Edgeworthia chrysantha* Lindl, flower buds, Hunan, China	34
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers and stems, Chiba, Japan	24
Edgeworthianin B (**125**)	744	$C_{40}H_{56}O_{13}$	MeOH	*Edgeworthia chrysantha* Lindl, flower buds, Hunan, China	34
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers and stems, Chiba, Japan	24
Edgeworthianin C (**126**)	778	$C_{43}H_{54}O_{13}$	MeOH	*Edgeworthia chrysantha* Lindl, flower buds, Hunan, China	34
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers and stems, Chiba, Japan	24
Edgeworthianin D (**127**)	644	$C_{36}H_{52}O_{10}$	MeOH	*Edgeworthia chrysantha* Lindl, flower buds, Hunan, China	34
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers and stems, Chiba, Japan	24
Edgeworthianin E (**128**)	730	$C_{40}H_{58}O_{12}$	MeOH	*Edgeworthia chrysantha* Lindl, flower buds, Hunan, China	34
	-	-	MeOH	*Edgeworthia chrysantha* Lindl, flowers and stems, Chiba, Japan	24
Edgeworthianin F (**129**)	702	$C_{38}H_{54}O_{12}$	MeOH	*Edgeworthia chrysantha* Lindl, flowers and stems, Chiba, Japan	24
Edgeworthianin G (**130**)	758	$C_{41}H_{58}O_{13}$	MeOH	*Edgeworthia chrysantha* Lindl, flowers and stems, Chiba, Japan	24

Table 6. Continued.

Compound name	M. Wt.	Mol. formula	Extract type	Species, plant part, and location	Ref.
Cimidahuside Ⅰ (**131**)	690	$C_{39}H_{62}O_{10}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Picfeltarraenin Ⅹ (**132**)	664	$C_{36}H_{56}O_{11}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Bufotalinin (**133**)	414	$C_{24}H_{30}O_6$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Bruceine I (**134**)	436	$C_{22}H_{28}O_9$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Digiprolactone (**135**)	196	$C_{11}H_{16}O_3$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Chamigrenal (**136**)	218	$C_{15}H_{22}O$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Bullatantriol (**137**)	256	$C_{15}H_{28}O_3$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
γ-Terpinene (**138**)	136	$C_{10}H_{16}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
α-Pinene (**139**)	136	$C_{10}H_{16}$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
β-Pinene (**140**)	136	$C_{10}H_{16}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Carvone (**141**)	150	$C_{10}H_{14}O$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Carveol (**142**)	152	$C_{10}H_{16}O$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
γ-Myrcene (**143**)	136	$C_{10}H_{16}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
β-Ocimene (**144**)	136	$C_{10}H_{16}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
β-cis-Ocimene (**145**)	136	$C_{10}H_{16}$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
Jasmone (**146**)	164	$C_{11}H_{16}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
	-	-	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
β-Caryophyllene (**147**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
α-Cubebene (**148**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
β-Cubebene (**149**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
β-Elemene (**150**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
γ-Elemene (**151**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
β-Cedrene (**152**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
α-Farnesene (**153**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
β-Farnesene (**154**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
trans-Farnesol (**155**)	222	$C_{15}H_{26}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
α-Humulene (**156**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Trans-Nerolidol (**157**)	222	$C_{15}H_{26}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
	-	-	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Gurjunene (**158**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
δ-Cadinene (**159**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
β-Phellandrene (**160**)	136	$C_{10}H_{16}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Lemonol (**161**)	154	$C_{10}H_{18}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
Geranyl acetate (**162**)	196	$C_{12}H_{20}O_2$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
α-Longifolene (**163**)	204	$C_{15}H_{24}$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
1,4-Dimethylindanyl acetate (**164**)	204	$C_{13}H_{16}O_2$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
Dihydroactinidiolide (**165**)	180	$C_{11}H_{16}O_2$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36

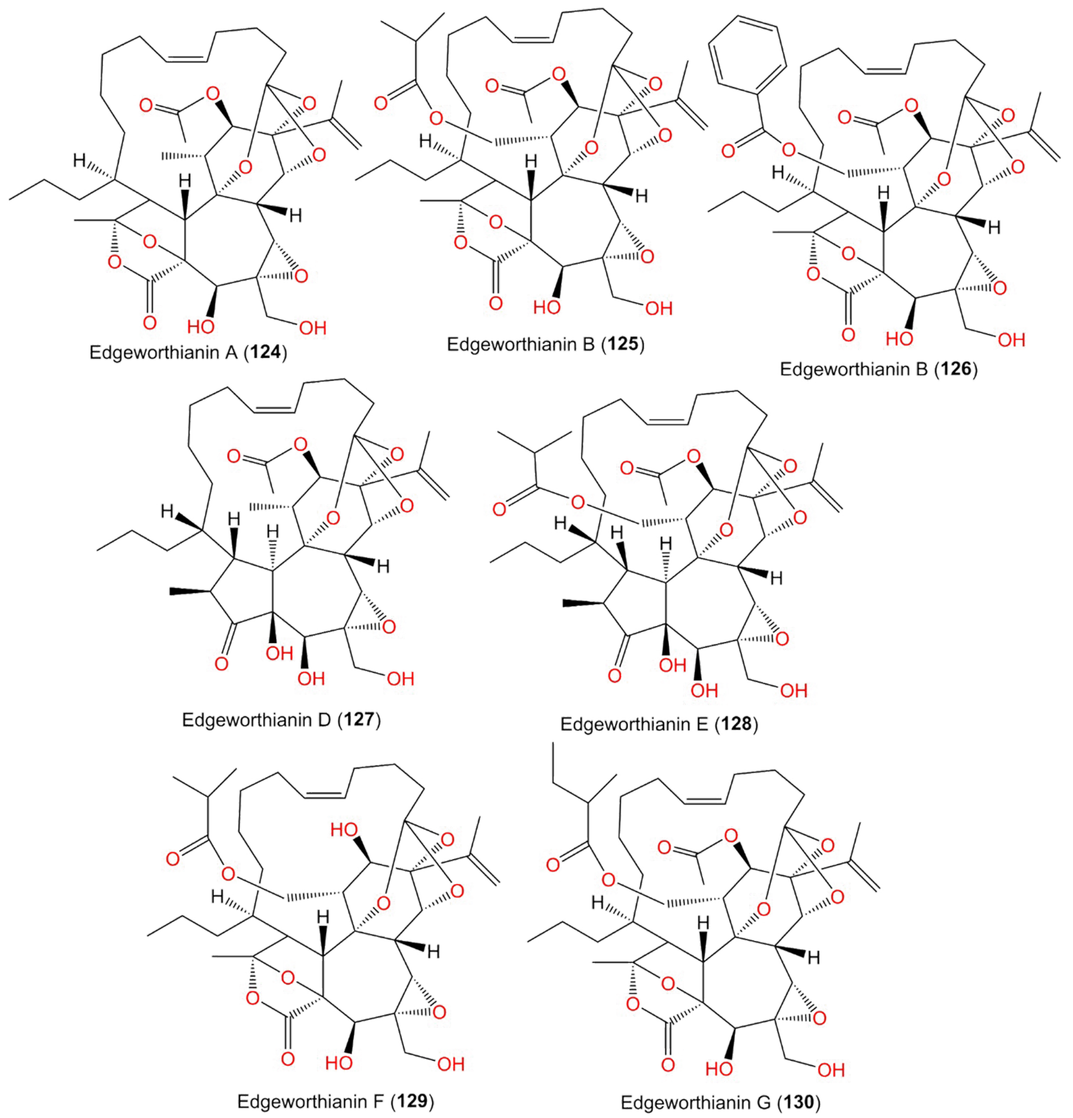

Figure 11. Chemical structures of terpenoids (**124**–**130**) from *Edgeworthia* genus

Among them, **186** activated PPARβ and PPARγ, suggesting its PPARγ and PPARβ agonistic potential.[55]

Aliphatic Aldehydes, Hydrocarbons, Esters, Alcohols, and Other Metabolites

Further, hydrocarbons (6 compounds), aldehydes (6 compounds), esters (8 compounds), alcohols (5 compounds), and other metabolites were reported from this genus (Figures S9-S11; Table 9). Interestingly, compound **241** from *E. gardneri* alcohol extract exhibited in vitro α-glucosidase inhibition, comparable to acarbose.[53]

Bioactivities of Edgeworthia Plant Extracts

Edgeworthia gardneri flowers were reported to exhibit significant anti-hyperglycemic, antioxidant, and α-glucosidase inhibitory capacities.[11,32] Ma et al demonstrated that *E. gardneri* flowers extract exhibited potent α-glucosidase inhibitory activity (IC_{50} 267.0 µg/mL) than acarbose (IC_{50} 465 µg/mL).[17] Similarly, Gao et al assessed the *in-vitro* PPARγ/β dual agonist activity of different *E. gardneri* flower extracts, fractions, and metabolites. It was noted that n-BuOH, n-hexane, and EtOAc extracts remarkably activated PPARβ and PPARγ, respectively, with EtOAc extract showing the highest activity.[55] In addition, the extract promoted insulin secretion comparable to quercetin, however, it demonstrated more notable anti-apoptotic potential than quercetin.[60] Further, the flower water extract demonstrated inhibition of lipo-toxicity, as well as it notably enhanced glucose uptake and consumption in palmitate-treated HepG2 cells.[61] Also, it increased glycogen content, suppressed endogenous glucose production, and lessened intracellular TG content in PA-treated HepG2 cells. These effects were related to GSK3β/IRS-1/FoxO1 signaling pathway regulation and promoted GLUT4 and GLUT2 transporters translocation.[61] A study by Chengfei et al reported that *E. gardneri* extract upregulated AMPK and LPL mRNA expression, while downregulated SREBP1c, PPARγ, and Fas mRNA expression. This led to alleviate lipid and glucose metabolism disorders in KKAy mice through LPL/PPARγ regulation and Fas/AMPK/SREBP1c pathway activation.[15] In-vivo, *E. gardneri* flower H_2O

Table 7. List of sterols, alkaloids, and nitrogenous compounds isolated from genus *Edgeworthia*

Compound name/chemical class	M. Wt.	Mol. formula	Extract type	Species, plant part, and location	Ref.
Sterols					
β-Sitosterol (**166**)	414	$C_{29}H_{50}O$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
β-Daucosterol (**167**)	576	$C_{35}H_{60}O_6$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
Sitosterol-3-*O*-6-linolenoyl-β-D-glucopyranosides (**168**)	836	$C_{53}H_{88}O_7$	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Osaka, Japan	47
Sitosterol-3-*O*-6-linolenoyl (**169**)	674	$C_{47}H_{78}O_2$	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Osaka, Japan	47
Alkaloids and nitrogenous compounds					
β-Adenosine (**170**)	267	$C_{10}H_{13}N_5O_4$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
	-	-	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Cys (trioxidation)-Pro (**171**)	266	$C_8H_{14}N_2O_6S$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Pro-Ile (**172**)	228	$C_{11}H_{20}N_2O_3$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
GLu-His (**173**)	284	$C_{11}H_{16}N_4O_5$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
9-Propyl-acridine (**174**)	221	$C_{16}H_{15}N$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
7-*O*-Isopentenyl-8-fagarine (**175**)	313	$C_{18}H_{19}NO_4$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
(3*S*)-1,2,3,4-Tetrahydro-β-carboline-3-carboxylic acid (**176**)	216	$C_{12}H_{12}N_2O_2$		*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	49
Flazin (**177**)	308	$C_{17}H_{12}N_2O_4$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Gentialutine (**178**)	147	$C_{10}H_{13}N$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Berberine (**179**)	336	$C_{20}H_{18}NO_4$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Swainonine (**180**)	173	$C_8H_{15}NO_3$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Trigonelline (**181**)	137	$C_7H_7NO_2$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Scopolamine (**182**)	303	$C_{17}H_{21}NO_4$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Cytisine (**183**)	190	$C_{11}H_{14}N_2O$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Gln-Asp (**184**)	261	$C_9H_{15}N_3O_6$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
DL-Arginine (**185**)	174	$C_6H_{14}N_4O_2$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24

extract (3 g/kg/day) noticeably reduced blood glucose level by 30.0%.[56] Furthermore, it improved lipid metabolism, insulin sensitivity, and the function and morphology of adipose tissues, pancreas, and liver in diabetic mice and modulated the gut microbiota. Thus, this extract modulated gut microbiota constitution and enhanced short-chain fatty acid contents, suggesting its potential to improve lipid and glucose metabolic disturbances through gut microbiota reshaping in diabetic mice.[56] Additionally, the flower hexane extract improved the impaired β-cells by activating AKT, reducing caspase-3 gene transcription level and ROS generation, and suppressing FOXO1and JNK activation STZ (streptozotocin)-high-fat diet diabetic mice model.[16] Cardioprotective capacity of *E. gardneri* flowers were also reported. A 30% ethanol fraction of *E. gardneri* flowers remarkably weakened myocardial infarct size, improved cardiac function, and attenuated post-infarction adverse cardiac remodeling and inflammation in rats.[20] Its cardioprotective potential was due to repressing the activation of ERK, p38 MAPK, and NF-kB signaling pathways, counteracting inflammatory injury to the ischemic heart. Hence, *E. gardneri* has the potential to manage ischemic cardiovascular illness and attenuate endothelial inflammation.[20] Similarly, *E. gardneri* flower 60%EtOH extract was reported to combat ischemia/reperfusion-produced inflammation and its associated cardiac injury in rats by prohibiting endothelium activation via lessening NF-κB, c-JNK, extracellular-regulated protein kinase, and p38 mitogen-activated protein kinase signaling pathways.[19] Additionally, *E. gardneri*`s methylethyl ketone extract exhibited notable polymerase β lyase inhibition activity in an in-vitro assay employing purified human polymerase β enzyme, where inhibition was assessed by monitoring the incorporation of radiolabeled nucleotides into synthetic DNA substrates, indicating its potential for DNA repair modulation.[32]

Both aqueous extracts of *E. chrysantha* and *E. gardneri* (dose 200 mg/kg/orally) lowered blood glucose in diabetic mice during an oral glucose tolerance test.[12] *E. chrysantha* barks and roots chloroform fractions exhibited notable anti-inflammation and analgesic properties, additionally 75% EtOH and chloroform fractions lessened LPS-stimulated NO formation in RAW264.7 cells.[23] Notably, *E. chrysantha* extract demonstrated potent α-glucosidase inhibitory (IC_{50} 21.4 μg/mL) potential than acarbose (IC_{50} 73.6 μM).[18] Furthermore, *E. chrysantha* flower buds MeOH extract was found to show notable anti-HIV (EC_{50} 4.1 μg/mL) potential.[34] A study by Kim et al. revealed that *E. chrysantha* twigs and leaves extract reduced osteoclastic marker blood levels in ovariectomized mice and

Table 8. List of fatty acids isolated from genus *Edgeworthia*

Compound Name	M. Wt.	Mol. Formula	Extract type	Species, Plant part, and Location	Ref.
Pentadecanoic acid (**186**)	242	$C_{15}H_{30}O_2$	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	40
	-	-	70% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	55
	-	-	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Tridecanoic acid (**187**)	214	$C_{13}H_{26}O_2$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Hexadecanoic acid (**188**)	256	$C_{16}H_{32}O_2$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Sebacic acid (**189**)	202	$C_{10}H_{18}O_4$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Jasmonic acid (**190**)	210	$C_{12}H_{18}O_3$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
9*S*,11*R*,15*S*-Trihydroxy-5*Z*-prostanoic acid (**191**)	356	$C_{20}H_{36}O_5$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Sanleng acid (**192**)	330	$C_{18}H_{34}O_5$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
12-Methyl-tetradecanoic acid (**193**)	242	$C_{15}H_{30}O_2$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Mevalonic acid (**194**)	148	$C_6H_{12}O_4$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
3-Hydroxy-3-methylglutaric acid (**195**)	162	$C_6H_{10}O_5$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
α-Linolenic acid (**196**)	278	$C_{18}H_{30}O_2$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Palmitoleic acid (**197**)	254	$C_{16}H_{30}O_2$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Linoleic acid (**198**)	280	$C_{18}H_{32}O_2$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
	-	-	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Stearic acid (**199**)	284	$C_{18}H_{36}O_2$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
trans-Vaccenic acid (**200**)	282	$C_{18}H_{34}O_2$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Arachidonic acid (**201**)	304	$C_{20}H_{32}O_2$	EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	56
Nonanoic acid (**202**)	158	$C_9H_{18}O_2$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Octadecanoic acid (**203**)	284	$C_{18}H_{36}O_2$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Oleic acid (**204**)	282	$C_{18}H_{34}O_2$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
n-Decanoic acid (**205**)	172	$C_{10}H_{20}O_2$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36

maintained the trabecular bone structure and volume.[57] In another *in-vitro* study by the same group, *E. chrysantha* stem extract prohibited RANKL-caused RAW 264.7 cells osteoclast differentiation and boosted MC3T3-E1 cells differentiation to osteoblast-like cells.[43]. The extract also reduced elevated bone resorption biomarkers; tartrate-resistant acid phosphatase and pyridinoline (48.1 and 25.6 %, respectively), while preventing bone loss mediated by ovariectomy in mice.[43]

Acute Toxicity

A study by Hu et al revealed that 75% EtOH extract of *E. chrysantha* bark and roots, along with various fractions, showed no acute toxicity at doses up to 5 g/kg. After 7 days of observation, the mice maintained normal body weight, and no common side effects such as mild diarrhea, weight loss, or depression were observed.[23] Although the tested *Edgeworthia* extracts were reported to be safe, these findings are based on limited experimental data. Thus, comprehensive toxicity evaluations are warranted to confirm safety profiles and to support potential pharmacological applications.

Discussion

Edgeworthia species chemically characterized by structurally varied coumarins. Among the 32 coumarins reported from various species of the *Edgeworthia* genus, daphnoretin is most frequently reported coumarin, documented in 16 different studies. It was isolated from *E. chrysantha* and *E. gardneri* collected from different regions including Japan, China, India, Bhutan, and Korea, suggesting it as chemotaxonomic marker of *E. chrysantha* and *E. gardneri*. Glycosylated and dimeric coumarins such as **2** and **12** were also commonly found. Additionally, rare oligocoumarin **1** and its glycoside **4** and the unique coumarins **18** and **19** were identified exclusively in *E. chrysantha* and *E. gardneri*, respectively, indicating unique biosynthetic pathways of these species. These unique biosynthetic pathways of these species are suggested based on their phytochemical profiling, which revealed the production of rare coumarins and unusual flavonoids that are uncommon in related genera. *Edgeworthia* species, especially *E. chrysantha* and *E. gardneri* demonstrated various bioactivities, due in great part to their constituents particularly coumarins and flavonoids. Compound **2** exhibited notable anti-osteoporotic action by encouraging osteoblast proliferation and prohibiting osteoclast differentiation, suggesting its potential use in maintaining bone health. Compounds **5**, **7**, and **9** demonstrated substantial

Table 9. List of aldehydes, esters, alcohols, hydrocarbons, ethers, and other metabolites isolated from genus *Edgeworthia*

Compound name/chemical class	M. Wt.	Mol. formula	Extract type	Species, plant part, and location	Ref.
Aldehydes					
Palmital (**206**)	240	$C_{16}H_{32}O$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Decanal (**207**)	156	$C_{10}H_{20}O$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Dodecyl aldehyde (**208**)	184	$C_{12}H_{24}O$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Nonanal (**209**)	142	$C_9H_{18}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
Octadecanal (**210**)	268	$C_{18}H_{36}O$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
2,2-Dimethyl-3,4-octadienal (**211**)	152	$C_{10}H_{16}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
Esters					
Methyl 7,10-hexadecadienoate (**212**)	266	$C_{17}H_{30}O_2$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
4-Methyl ester octenoic acid (**213**)	158	$C_9H_{18}O_2$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Ethyllinolenate (**214**)	306	$C_{20}H_{34}O_2$	MeOH	*Edgeworthia gardneri* (Wall.) Meissn, flower buds, Tibet, China	24
Hexadecanoate (**215**)	270	$C_{17}H_{34}O_2$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Methyl linoleate (**216**)	294	$C_{19}H_{34}O_2$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Methyl linolenate (**217**)	292	$C_{19}H_{32}O_2$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
9-Oxononanoic acid methyl ester (**218**)	186	$C_{10}H_{18}O_3$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
10,13-Eicosadienoic acid, methyl ester (**219**)	322	$C_{21}H_{38}O_2$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
(Z)-Acetic acid-3-hexenol acetate (**220**)	142	$C_8H_{14}O_2$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Alcohols					
2-Ethyl-1-hexanol (**221**)	130	$C_8H_{18}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
cis-3-Decen-1-ol (**222**)	156	$C_{10}H_{20}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
Panaxydol (**223**)	260	$C_{17}H_{24}O_2$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Inositol (**224**)	180	$C_6H_{12}O_6$	75% EtOH	*Edgeworthia chrysantha* Lindl, stems and barks, Nancang, Jiangxi, China	38
Conduritol (**225**)	146	$C_6H_{10}O_4$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
Hydrocarbons					
Heneicosane (**226**)	296	$C_{21}H_{44}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Heptacosane (**227**)	380	$C_{27}H_{56}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Tetracosane (**228**)	338	$C_{24}H_{50}$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
trans-3-Dodecene (**229**)	168	$C_{12}H_{24}$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
4,6-Dimethyl-undecane (**230**)	184	$C_{13}H_{28}$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
4-Methyl-tetradecane (**231**)	212	$C_{15}H_{32}$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
Tert-hexadecanethiol (**232**)	258	$C_{16}H_{34}S$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, China	63
Ethers					
Hexyl octyl ether (**233**)	214	$C_{14}H_{30}O$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
Other metabolites					
(-)-Grasshopper ketone (**234**)	224	$C_{13}H_{20}O_3$	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Osaka, Japan	47
(-)-3-*O*-Acetyl-grasshopper ketone (**235**)	266	$C_{15}H_{22}O_4$	MeOH	*Edgeworthia chrysantha* Lindl, flowers, Osaka, Japan	47
2,6-Dimethoxyquinone (**236**)	168	$C_8H_8O_4$	75% EtOH	*Edgeworthia chrysantha* Lindl, stems and barks, Nancang, Jiangxi, China	38
2(4*H*)-Benzofuranone (**237**)	134	$C_8H_6O_2$	Essential oils	*Edgeworthia tomentosa (Thunb.) Nakai (Edgeworthia chrysantha)*, flowers, Zhejiang, China	31
Benzoyl chloride (**238**)	140	C_7H_5ClO	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36
O-Methyl acetophenone (**239**)	134	$C_9H_{10}O$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
4-Methoxy-2,7-dihydroxy-9,10-dihydrophenanthrene (**240**)	242	$C_{15}H_{14}O_3$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
2,4,6-Trichlorol-3-methyl-5-methoxy-phenol 1-O-β-D-glucopyranosyl-(1-6)-β-D-glucopyranoside (**241**)	564	$C_{20}H_{27}Cl_3O_{12}$	EtOAc	*Edgeworthia gardneri* (Wall.) Meissn, flowers, China	53
Emodin-8-*O*-(6'-*O*-acetyl)-β-D-glucoside (**242**)	474	$C_{23}H_{22}O_{11}$	95% EtOH	*Edgeworthia gardneri* (Wall.) Meissn, flowers, Tibet, China	32
1,1,6-Trimethyl-1,2-dihydronaphthalene (**243**)	172	$C_{13}H_{16}$	Essential oils	*Edgeworthia chrysantha* Lindl, flowers, Zhejiang, China	36

suppression of polymerase-β lyase, while compound **9** increased bleomycin's cytotoxicity through inhibition of DNA repair. Further, compound **9** had powerful α-glucosidase inhibitory activity, compound **16** improved glucose absorption in adipocytes, and compound **25** acted as a dual PPARγ/PPARβ agonist.

Besides, *E. chrysantha* and *E. gardneri* are abundant in structurally varied flavonoids that are renowned for their substantial bioactivities. Particularly, biflavonoids such as daphnodorin dimers demonstrated marked α-glucosidase inhibition. Compound **45** revealed multiple bioactivities. Its dual suppression of α-amylase and α-glucosidase, as well as its modulation of lipid metabolism and glucose uptake pathways. Also, compounds **67** had powerful α-glucosidase inhibitory activity and boosted insulin secretion. These findings reinforce *Edgeworthia* plants potential as a candidate for metabolic syndrome interventions.

E. chrysantha, *E. gardneri*, and *E. tomentosa* yielded different types of terpenoids such as macrocyclic daphnane orthoesters, monoterpenes, sesquiterpenes, and their oxygenated derivatives, highlighting the diverse biosynthetic capacity of these species. Among them, **127** and **128** showed nanomolar anti-HIV efficacy, suggesting their promise as antiviral agents. The structural features of daphnane orthoesters such as the cyclopentanone moiety and the C-18 isobutyryloxy substitution enhanced the bioactivity. *E. chrysantha* and *E. tomentosa* essential oils were rich in sesquiterpenes and monoterpenes with broad-spectrum antibacterial properties. *E. chrysantha*'s sterol acylglucosides exhibited remarkable piscicidal activity, while *E. gardneri*'s alkaloids displayed species-specific bioactivity. Compounds **186** and **241** demonstrated dual activation of PPARβ/γ and α-glucosidase inhibition, further confirming metabolic regulatory and antidiabetic potential of this genus.

The published pharmacological properties, especially for *Edgeworthia gardneri* and *E. chrysantha* underline their promising therapeutic potential and correlate with their traditional uses. For example, PPARγ/β dual agonist, α-glucosidase inhibitory, lipid-lowering, cardioprotective, and antioxidant properties support *E. gardneri* flowers usage to treat hyperlipidemia, diabetes, hypertension, obesity, and cardiovascular conditions. Similarly, its use of stem and root to cure buboes is also aligned with its anti-inflammatory capacity. *E. chrysantha* has long been used to treat eye conditions, muscle soreness, rheumatism, bruises, and fractures that align with its anti-inflammatory and analgesic activities. These correlations validate *Edgeworthia* species ethnopharmacological relevance and encourage further research into the therapeutic applications of these plants. However, the reported in-vivo doses in this work are linked to specific experimental conditions and animal models used in the reported studies. Therefore, careful consideration of safety verification and clinical validation are required to translate these doses to human applications.

The *Edgeworthia* extracts and chemical constituents' antibacterial activity has been reported against both Gram-positive and Gram-negative bacteria, including *S. aureus, B. subtilis*, and *E. coli,* with inhibition zones and MIC values, indicating moderate to strong potency. Such activity suggests possibility for further development as antibacterial agents for infections or as natural preservatives. Similarly, the piscicidal activity, suggests that secondary metabolites produced from *Edgeworthia* may be used to control pests. However, further studies on safety, toxicity, and mechanism of action are required.

Conclusion

Medicinal plants and their constituents have a crucial role in the prevention and treatment of several illnesses. The current work summarized the reported investigations of *Edgeworthia* species and their biological activities. A total of 243 compounds were identified, including flavonoids, coumarins, terpenoids, phenolics, alkaloids, lignans, organic acids, sterols, fatty acids, and chromans. Flavonoids, terpenoids, and coumarins represent the major identified metabolites (Figure 12). These compounds were separated mainly from *E. chrysantha* and *E. gardneri* obtained from different countries: China, Japan, Korea, India, and Bhutan, whereas *E. chrysantha* is the most studied species (Figure 13). Additionally, these compounds were separated from different plant parts, including roots, stems, barks, flower buds, and whole plants, whereas most of them were obtained from the flowers of these plants.

Some of them possess unique structural features such as such as the daphnane-type diterpenoid orthoester moiety, specific prenylation patterns in flavonoids, and glycosylation profiles in coumarins that can remarkably influence membrane permeability, lipophilicity, membrane permeability, and receptor-binding affinity, thereby affecting their selectivity, potency, and overall pharmacological properties.

Flavonoids, terpenoids, and coumarins represent key bioactive metabolites that might directly or indirectly contribute to the highlighted bioactivities and justify the plants' traditional uses in various cultures. Additionally, the reported data in this work revealed notable connectivity among folk uses and the validated bioactivities of these plants. These findings highlight the therapeutic potential of *Edgeworthia* species, underscoring the need for structure–activity relationship studies to guide the development of new therapeutic agents.

Despite the considerable number of reported works on this genus, there are limited or lacking studies that focus on derivatization, biosynthetic pathways, possible mechanisms, and the relationship between the bioactivity and these metabolites` structures. Also, attempts to investigate the unstudied species and evaluate the bioactivities of the untested constituents are required. Clinical trials and safety verification of these plants and their constituents are warranted before

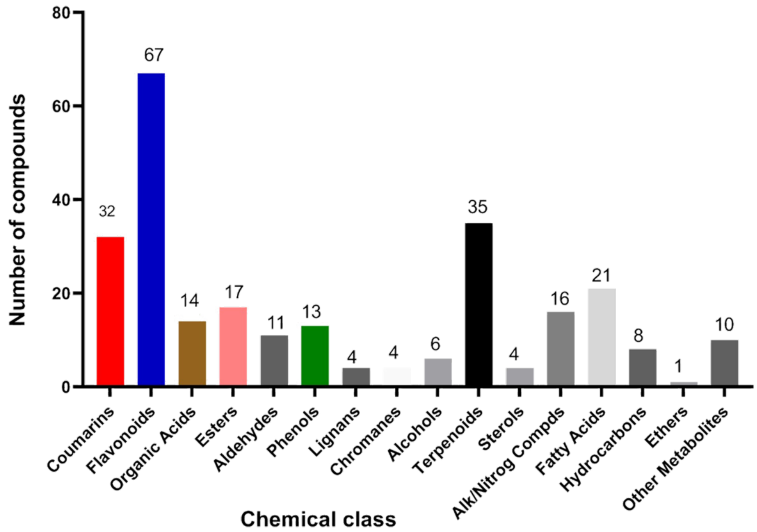

Figure 12. Number of compounds reported from different classes isolated from *Edgeworthia* species

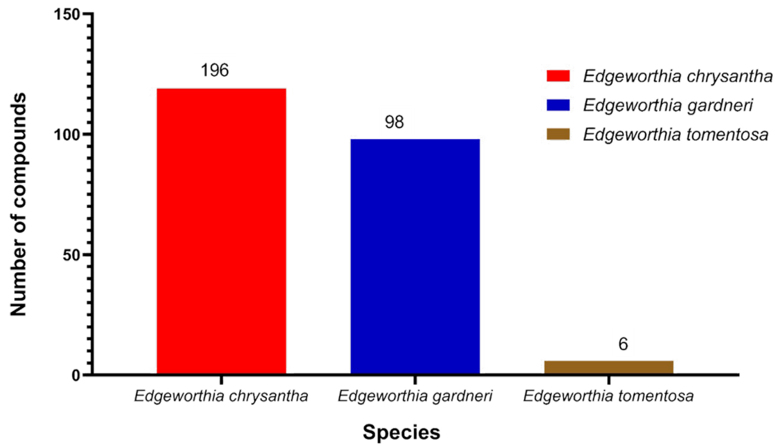

Figure 13. Number of compounds reported from *Edgeworthia* plants

their pharmacological utilization for drug discovery. Therefore, these areas should be the focus of future work on this genus.

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Competing Interests

The authors declare no conflicts of interest.

Ethical Approval

Not applicable.

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Supplementary Files

Supplementary file 1 contains Figures S1-S11.

References

1. Srivastava AK. Significance of medicinal plants in human life. In: Tewari A, Tiwari S, eds. Synthesis of Medicinal Agents from Plants. Elsevier; 2018. p. 1-24. doi: 10.1016/b978-0-08-102071-5.00001-5.

2. Khayat MT, Alharbi M, Ghazawi KF, Mohamed GA, Ibrahim SRM. *Ferula sinkiangensis* (Chou-AWei, Chinese *Ferula*): traditional uses, phytoconstituents, biosynthesis, and pharmacological activities. Plants (Basel). 2023;12(4):902. doi: 10.3390/plants12040902.
3. Abdallah HM, Mohamed GA, Ibrahim SR. *Lansium domesticum*-a fruit with multi-benefits: traditional uses, phytochemicals, nutritional value, and bioactivities. Nutrients. 2022;14(7):1531. doi: 10.3390/nu14071531.
4. Ibrahim SR, Fadil SA, Fadil HA, Hareeri RH, Abdallah HM, Mohamed GA. Ethnobotanical uses, phytochemical composition, biosynthesis, and pharmacological activities of *Carpesium abrotanoides* L. (Asteraceae). Plants (Basel). 2022;11(12):1598. doi: 10.3390/plants11121598.
5. Luqman S, Rizvi SI, Beer AM, Khare SK, Atukeren P. Efficacy of herbal drugs in human diseases and disorders. Evid Based Complement Alternat Med. 2014;2014:273676. doi: 10.1155/2014/273676.
6. Herber BE. Thymelaeaceae. In: Kubitzki K, Bayer C, eds. Flowering Plants: Dicotyledons: Malvales, Capparales and Non-Betalain Caryophyllales. Berlin, Heidelberg: Springer; 2003. p. 373-96. doi: 10.1007/978-3-662-07255-4_45.
7. Qian S, Zhang Y, Lee SY. Comparative analysis of complete chloroplast genome sequences in *Edgeworthia* (Thymelaeaceae) and new insights into phylogenetic relationships. Front Genet. 2021;12:643552. doi: 10.3389/fgene.2021.643552.
8. Plants of the World Online (POWO). Facilitated by the Royal Botanic Gardens, Kew. 2025. Availbale from: https://powo.science.kew.org/results?q=Edgeworthia Accessed June 3, 2025.
9. Borris RP, Blaskó G, Cordell GA. Ethnopharmacologic and phytochemical studies of the Thymelaeaceae. J Ethnopharmacol. 1988;24(1):41-91. doi: 10.1016/0378-8741(88)90138-9.
10. Majumder PL, Sengupta GC, Dinda BN, Chatterjee A. Edgeworthin, a new bis-coumarin from *Edgeworthia gardneri*. Phytochemistry. 1974;13(9):1929-31. doi: 10.1016/0031-9422(74)85118-6.
11. Geng Y, Yang HM, Xu HY, Shi JS. α-Glucosidase inhibitory activity of the alabastrum of *Edgeworthia gardneri* (Wall.) Meissn. J Food Sci Biotechnol. 2013;32(9):967-71.
12. Lau KM, Wong CW, Long CL, Bik-San Lau C. Anti-diabetic effects of *Edgeworthia chrysantha* and *Edgeworthia gardneri* flower buds - an ethnic herbal tea in China. Biomed J Sci Tech Res. 2020;28(5):21986-92. doi: 10.26717/bjstr.2020.28.004717.
13. Liu Y, Wu S, Miao S, Yan L, Huang Z, Fang G, et al. Effects of Edgeworthia chrysantha Lindl. Extract on BDNF and its Receptor TrkB in the Hippocampus of Depression Model Rats. Natural Product Communications. 2025;20(1):1934578X251314730. doi: 10.1177/1934578X251314730.
14. Li M, Ding L, Hu YL, Qin LL, Wu Y, Liu W, et al. Herbal formula LLKL ameliorates hyperglycaemia, modulates the gut microbiota and regulates the gut-liver axis in Zucker diabetic fatty rats. J Cell Mol Med. 2021;25(1):367-82. doi: 10.1111/jcmm.16084.
15. Chengfei Z, Lingling Q, Haiyan W, Boju S, Dan Z, Qiue Z, et al. Efficacy of aqueous extract of flower of *Edgeworthia gardneri* (Wall.) Meisn on glucose and lipid metabolism in KK/Upj-Ay/J mice. J Tradit Chin Med. 2022;42(2):187-93. doi: 10.19852/j.cnki.jtcm.20220218.001.
16. Wang YX, Zhang ZW, Ren YL, Liu M, Shi JS, Xu ZH, et al. The improvement and the mechanism of impaired islets in diabetes mellitus of *Edgeworthia gardneri* (Wall.) Meissn. Nat Prod Res Dev. 2019;31(3):506-11. doi: 10.16333/j.1001-6880.2019.3.022.
17. Ma YY, Zhao DG, Zhou AY, Zhang Y, Du Z, Zhang K. α-Glucosidase inhibition and antihyperglycemic activity of phenolics from the flowers of *Edgeworthia gardneri*. J Agric Food Chem. 2015;63(37):8162-9. doi: 10.1021/acs.jafc.5b03081.
18. Zhou T, Zhang SW, Liu SS, Cong HJ, Xuan LJ. Daphnodorin dimers from *Edgeworthia chrysantha* with α-glucosidase inhibitory activity. Phytochem Lett. 2010;3(4):242-7. doi: 10.1016/j.phytol.2010.10.001.
19. Lang X, Zhong C, Su L, Qin M, Xie Y, Shan D, et al. *Edgeworthia gardneri* (Wall.) Meisn. ethanolic extract attenuates endothelial activation and alleviates cardiac ischemia-reperfusion injury. Molecules. 2024;29(5):1068. doi: 10.3390/molecules29051068.
20. Wei D, Tang L, Su L, Zeng S, Telushi A, Lang X, et al. *Edgeworthia gardneri* (Wall.) Meisn. extract protects against myocardial infarction by inhibiting NF-κB-and MAPK-mediated endothelial inflammation. Front Cardiovasc Med. 2022;9:1013013. doi: 10.3389/fcvm.2022.1013013.
21. Wang S, Cheng Y. Separation and determination of the effective components in the alabastrum of *Edgeworthia chrysantha* Lindl. by micellar electrokinetic capillary chromatography. J Pharm Biomed Anal. 2006;40(5):1137-42. doi: 10.1016/j.jpba.2005.09.001.
22. Iwamoto A, Matsumura Y, Ohba H, Murata J, Imaichi R. Development and structure of trichotomous branching in *Edgeworthia chrysantha* (Thymelaeaceae). Am J Bot. 2005;92(8):1350-8. doi: 10.3732/ajb.92.8.1350.
23. Hu XJ, Jin HZ, Xu WZ, Chen M, Liu XH, Zhang W, et al. Anti-inflammatory and analgesic activities of *Edgeworthia chrysantha* and its effective chemical constituents. Biol Pharm Bull. 2008;31(9):1761-5. doi: 10.1248/bpb.31.1761.
24. Otsuki K, Kobayashi T, Nakamura K, Kikuchi T, Huang L, Chen CH, et al. LC-MS identification, isolation, and structural elucidation of anti-HIV macrocyclic daphnane orthoesters from *Edgeworthia chrysantha*. Fitoterapia. 2024;172:105731. doi: 10.1016/j.fitote.2023.105731.
25. Duncan WH, Mellinger M. *Edgeworthia* (Thymelaeaceae) new to the western hemisphere. Rhodora. 1972;74(799):436-9.
26. Nguyen TV, Tran DB, Sy DT, Bui HQ. *Edgeworthia tomentosa* (Thunb.) Nakai. (Thymelaeaceae): a newly recorded species for the flora of Vietnam. J Sci Technol. 2018;180(4):49-52.
27. Boesi A. Paper Plants in the Tibetan World: A Preliminary Study. Brill's Tibetan Studies Library; 2016. p. 501.
28. WFO. *Edgeworthia albiflora* Nakai. Available from: https://www.worldfloraonline.org/taxon/wfo-0000663229. Accessed June 4, 2025.
29. WFO. *Edgeworthia gardneri* (Wall.) Meisn. Available from: https://www.worldfloraonline.org/taxon/wfo-0000663233. Accessed June 4, 2025.
30. WFO. *Edgeworthia chrysantha* Lindl. Available from: http://www.worldfloraonline.org/taxon/wfo-0000663230. Accessed June 4, 2025.
31. Sun Y, Wang Z, Li B, Sharopov FS, Wang P, Sun Y, et al. Biological characteristics of *Edgeworthia tomentosa* (Thunb.) Nakai flowers and antimicrobial properties of their essential oils. Nat Prod Res. 2018;32(18):2229-32. doi: 10.1080/14786419.2017.1367785.
32. Li L, Dai Q, Zou B, Zhang Y, Zhang X, Liu L. Identification of α-glucosidase-inhibitors in *Edgeworthia gardneri* (Wall.) Meisn. using UPLC-Q-TOF-MS/MS analysis. Plant Foods Hum Nutr. 2024;79(2):381-6. doi: 10.1007/s11130-024-01158-x.
33. Yan J, Tong S, Sheng L, Lou J. Preparative isolation and purification of two coumarins from *Edgeworthia chrysantha* Lindl by high speed countercurrent chromatography. J Liq Chromatogr Relat Technol. 2006;29(9):1307-15. doi: 10.1080/10826070600598969.
34. Asada Y, Otsuki K, Morooka M, Huang L, Chen CH, Koike K, et al. Anti-HIV macrocyclic daphnane orthoesters with

an unusual macrocyclic ring from *Edgeworthia chrysantha*. J Nat Prod. 2022;85(10):2399-405. doi: 10.1021/acs.jnatprod.2c00618.

35. Tong S, Yan J, Chen G, Lou J. Purification of rutin and nicotiflorin from the flowers of *Edgeworthia chrysantha* Lindl. by high-speed counter-current chromatography. J Chromatogr Sci. 2009;47(5):341-4. doi: 10.1093/chromsci/47.5.341.
36. Wen Y, Nie J, Li ZG, Xu XY, Wei D, Lee MR. The development of ultrasound-assisted extraction/dispersive liquid–liquid microextraction coupled with DSI-GC-IT/MS for analysis of essential oil from fresh flowers of *Edgeworthia chrysantha* Lindl. Anal Methods. 2014;6(10):3345-52. doi: 10.1039/c4ay00115j.
37. Gao D, Fu QF, Wang LJ, Wang DD, Zhang KL, Yang FQ, et al. Molecularly imprinted polymers for the selective extraction of tiliroside from the flowers of *Edgeworthia gardneri* (Wall.) Meisn. J Sep Sci. 2017;40(12):2629-37. doi: 10.1002/jssc.201700240.
38. Hu XJ, Jin H, Zhang W, Yan S, Xu W, Liu RH, et al. Chemical constituents of *Edgeworthia chrysantha*. Chem Nat Compd. 2009;45(1):126-8. doi: 10.1007/s10600-009-9230-4.
39. Baba K, Tabata Y, Taniguti M, Kozawa M. Coumarins from *Edgeworthia chrysantha*. Phytochemistry. 1989;28(1):221-5. doi: 10.1016/0031-9422(89)85042-3.
40. Xu P, Xia Z, Lin Y. Chemical constituents from *Edgeworthia gardneri* (Thymelaeaceae). Biochem Syst Ecol. 2012;45:148-50. doi: 10.1016/j.bse.2012.07.031.
41. Li XN, Tong SQ, Cheng DP, Li QY, Yan JZ. Coumarins from *Edgeworthia chrysantha*. Molecules. 2014;19(2):2042-8. doi: 10.3390/molecules19022042.
42. Zhao DG, Zhou AY, Du Z, Zhang Y, Zhang K, Ma YY. Coumarins with α-glucosidase and α-amylase inhibitory activities from the flower of *Edgeworthia gardneri*. Fitoterapia. 2015;107:122-7. doi: 10.1016/j.fitote.2015.10.012.
43. Kim P, Nam YJ, Kim WJ, Kim JK, Lee G, Song MJ, et al. *Edgeworthia papyrifera* regulates osteoblast and osteoclast differentiation in vitro and exhibits anti-osteoporosis activity in animal models of osteoporosis. Planta Med. 2019;85(9-10):766-73. doi: 10.1055/a-0942-1960.
44. Baba K, Taniguti M, Yoneda Y, Kozawa M. Coumarin glycosides from *Edgeworthia chrysantha*. Phytochemistry. 1990;29(1):247-9. doi: 10.1016/0031-9422(90)89043-9.
45. Han S. Coumarins and Biflavonoids from *Edgeworthia chrysantha* and Their Glucose Uptake Activity [dissertation]. Seoul, Korea: Seoul National University; 2020.
46. Chakrabarti R, Das B, Banerji J. Bis-coumarins from *Edgeworthia gardneri*. Phytochemistry. 1986;25(2):557-8. doi: 10.1016/s0031-9422(00)85530-2.
47. Hashimoto T, Tori M, Asakawa Y. Piscicidal sterol acylglucosides from *Edgeworthia chrysantha*. Phytochemistry. 1991;30(9):2927-31. doi: 10.1016/s0031-9422(00)98226-8.
48. Haijun Z, Yuying Z, Li O, Xiulan L. Studies on the chemical constituents from the flowers of *Edgeworthia chrysantha*. Nat Prod Res Dev. 1997;9(1):24-7.
49. Li M. A new coumarin from flowers of *Edgeworthia gardneri*. Chin Tradit Herb Drugs. 2020;24:4109-12.
50. Gao D, Zhang YL, Yang FQ, Li F, Zhang QH, Xia ZN. The flower of *Edgeworthia gardneri* (Wall.) Meisn. suppresses adipogenesis through modulation of the AMPK pathway in 3T3-L1 adipocytes. J Ethnopharmacol. 2016;191:379-86. doi: 10.1016/j.jep.2016.06.059.
51. Li SS, Gao Z, Feng X, Hecht SM. Biscoumarin derivatives from *Edgeworthia gardneri* that inhibit the lyase activity of DNA polymerase beta. J Nat Prod. 2004;67(9):1608-10. doi: 10.1021/np040127s.
52. Yan J, Tong S, Chu J, Sheng L, Chen G. Preparative isolation and purification of syringin and edgeworoside C from *Edgeworthia chrysantha* Lindl by high-speed counter-current chromatography. J Chromatogr A. 2004;1043(2):329-32. doi: 10.1016/j.chroma.2004.05.087.
53. Wang JX, Tao G, Yang F, Yang M, Feng QQ, Ma MF, et al. Chemical composition and hypoglycemic activity of *Edgeworthia gardneri*. Acta Pharm Sin. 2021;56(5):1434-8. doi: 10.16438/j.0513-4870.2020-1970.
54. Hu XJ, Jin HZ, Zhang WD, Zhang W, Yan SK, Liu RH, et al. Two new coumarins from *Edgeworthia chrysantha*. Nat Prod Res. 2009;23(13):1259-64. doi: 10.1080/14786410903098319.
55. Gao D, Zhang YL, Xu P, Lin YX, Yang FQ, Liu JH, et al. In vitro evaluation of dual agonists for PPARγ/β from the flower of *Edgeworthia gardneri* (Wall.) Meisn. J Ethnopharmacol. 2015;162:14-9. doi: 10.1016/j.jep.2014.12.034.
56. Zhang Z, Xu H, Zhao H, Geng Y, Ren Y, Guo L, et al. *Edgeworthia gardneri* (Wall.) Meisn. water extract improves diabetes and modulates gut microbiota. J Ethnopharmacol. 2019;239:111854. doi: 10.1016/j.jep.2019.111854.
57. Kim P. Investigation of the Anti-Osteoporotic Activity of *Edgeworthia papyrifera* and Edgeworoside A and Anti-Melanogenic Activity of *Rhizoma arisaematis* [dissertation]. Seoul, Korea: Seoul National University; 2018.
58. Zhang Y, Ma Y, Zhao D, Zhou A, Du Z. Preparation and α-amylase inhibition activity of tiliroside. Nat Prod Res Dev. 2016;28(Suppl 1):26-9.
59. Cai F, Li D, Zhou K, Zhang W, Yang Y. Tiliroside attenuates acute kidney injury by inhibiting ferroptosis through the disruption of NRF2-KEAP1 interaction. Phytomedicine. 2024;126:155407. doi: 10.1016/j.phymed.2024.155407.
60. Zhuang M, Qiu H, Li P, Hu L, Wang Y, Rao L. Islet protection and amelioration of type 2 diabetes mellitus by treatment with quercetin from the flowers of *Edgeworthia gardneri*. Drug Des Devel Ther. 2018;12:955-66. doi: 10.2147/dddt.S153898.
61. Zhang Y, Yan LS, Ding Y, Cheng BC, Luo G, Kong J, et al. *Edgeworthia gardneri* (Wall.) Meisn. water extract ameliorates palmitate induced insulin resistance by regulating IRS1/GSK3β/FoxO1 signaling pathway in human HepG2 hepatocytes. Front Pharmacol. 2019;10:1666. doi: 10.3389/fphar.2019.01666.
62. Ono M, Iwashina T. Quantitative flavonoid variation accompanied by change of flower colors in *Edgeworthia chrysantha*, *Pittosporum tobira* and *Wisteria floribunda*. Nat Prod Commun. 2015;10(3):413-6.
63. Cao JX, Chen YL, Fu CX, Wu P. GC-MS analysis of essential oil components from flowers of *Edgeworthia chrysantha* Lindl. Chin J Pharm Anal. 2005;25(10):1211-4.