THE GENUS POLYGONUM (POLYGONACEAE): AN ETHNOPHARMACOLOGICAL AND PHYTOCHEMICAL PERSPECTIVES—REVIEW

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ABSTRACT

The genus Polygonum (Polygonaceae), comprising about 300 species, is distributed worldwide, mostly in north temperate climates, is interesting from both biological and phytochemical perspectives. In this review, a contemporary summary of biological and pharmacological investigate on Polygonum species will be presented and critically evaluated. Significant findings in the treatment various diseases such as snake-bites, inflammatory, antitumor, antibacterial, antivirus, antiseptic, antifungal, diabetics, hypertensions, hyperlipemia, jaundice, hemorrhage, cough, fever, ulcers, skin infections, anemia, diarrhea and various urological disorders, have been presented in ethnobotanical reports and recent studies were performed on ethanol extracts for certain Polygonum species. Polygonum, the most important constituent isolated is known to possess antitumor activity. Very few additional data are available on the biological activities and cytotoxicity of pure compounds from Polygonum. Twenty-nine distinguished species of Polygonum have been reported in scientific literature as ethnomedically used or phytochemically investigated. However, information about a chemical outline is available only for few species. The following review gives a critical assessment of the literature to date and aims to show that the pharmaceutical potential of this genus has been underestimated and deserves closer attention.

Keywords: Polygonum, Traditional medicine, Pharmacology, Phytochemistry.

INTRODUCTION

The plant kingdom continues to be a foremost source of novel natural products with potential for use as drugs or pharmaceutical mediators. According to The World Health Organization, more than 80% of the world population in developing countries depends primarily on plants based medicines for basic healthcare needs[1]. Polygonum is a member of Polygonaceae family that contains, according to respective taxonomic treatments; ca. 300 species is distributed worldwide in temperate climates[2]. They vary widely from prostrate herbaceous annual plants under 5 cm high, others erect herbaceous perennial plants growing to 3 - 4 m, and yet others perennial woody vines growing up to 20-30 m high in trees. Several are aquatic, growing as floating plants in ponds.

The leaves are 1-30 cm long, and vary in shape between species from narrow lanceolate to oval, broad triangular, heart-shaped, or arrowhead forms. The stems are often red-speckled or reddish. Flowers are small, white, pink or greenish, appearance in summer in arrowhead forms. The stems are often red from narrow lanceolate to oval, broad triangular, heart shaped, or speckled or reddish. From the leaf joints or stem apices. A number of Polygonum species are used as food and for traditional folk medicines such as cardiovascular protection [3], antinflammation [4], neuroprotection [5] and mitigation of biochemical processes involved in age-related neurodegenerative disorders such as Alzheimer’s [6] and Parkinson’s disease [7].

Chemical constituents recognized in the Polygonum species are flavonoids [8], triterpenoids [9], anthraquinones [10], coumarins [11], phenylpropanoids [12, 13], lignans [14], sesquiterpenoids [15, 16], stilbenoids [17], and tannins [2]. Amongst them, flavonoids are the most common components found in Polygonum and have previously been used as chemotaxonomic markers of the genus, playing an important role in the systematics of Polygonaceae species [18].

Present study is an attempt to compile an up-to-date and comprehensive review of the genus Polygonum that covers its traditional medicinal uses, chemistry and pharmacology. Many plants of this genus are pharmacologically known but chemically unknown and vice-versa, therefore, the scope of future research in this aspect.

Ethnobotanical studies

Polygonum acuminatum

Aerial parts of P. acuminatum, are used to heal infected wounds and for other disorders related to fungal infections [19]. Recently Derita et al., [16] reported that evaluate the antifungal properties of aerial parts of P. acuminatum.

Polygonum amplexicaule

Emodin-8-O-β-D-glucoside of P. amplexicaule significantly stimulated cell proliferation at 0.1-100 µg/mL and the proportion of cells in S-phase amplified from 16.33 to 27.29% in osteoblastic MC3T3-E1 cells. Moreover, ethanol extracts of P. amplexicaule improved alkaline phosphatase (ALP) expression in MC3T3-E1 cells at the concentration from 0.1 to 100 µg/mL and inhibited PGE2 production induced by TNF-α in osteoblasts at the concentrations ranging from 10 to 100 µg/mL in MC3T3-E1 osteoblasts [20].

Polygonum aviculare

The supplementation of P. aviculare ethanol extract to high-fat diet-induced obese mice significantly decreased body weight gain, adipose tissue weight, adipocyte size, and lipogenic gene expression as well as serum triglyceride, leptin, and malondialdehyde (MDA) levels [21].

Polygonum bistorta

Ethnolic extract of P. bistorta showed strong antioxidant effect [22]. Nikawa et al.,[23] reported that the aqueous extract strongly inhibits the mutagenicity of Trp-P1. The hexane and chloroform fractions and their sub-fractions were evaluated for their cytotoxic activity against P388 (Marine lymphocytic leukemia), HepG2 (Hepatocellular carcinoma), J82 (Bladder transitional carcinoma), HL60 (Human leukemia), MC7 (Human breast cancer) and LL2 (Lewis lung carcinoma) cancer cell lines in culture [24].

Polygonum capitatum

Ethnolic extracts of P. capitatum possessed antibacterial, analgesic, antiinflammatory, hypothermic, diuretic and antioxidative activities [25].

Polygonum chinense

The chloroform and ethanol extract of whole plant of P. chinense demonstrated a strong activity against Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa, Aspergillus niger [26].

Polygonum Cillinerve

The administration of P. Cillinerve with gavage was able to overcome the cyclophosphamide-induced immunosuppression and...
significantly to raise the total oxidant capacity (TOC), catalase (CAT), superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) level. It also raised the liver, spleen, thymus indices and decreased the malondialdehyde (MDA) level in mice [27].

**Polygonum cuspidatum**

Extract of *P. cuspidatum* has antiinflammatory activities such as inhibition of NF-kB have been reported [4, 28]. Polydatin of *P. cuspidatum* has favorable potency to develop a hypolipemic and hepatoprotective agent in clinic [29]. Ethanol and ethyl acetate extracts of *P. cuspidatum root* exhibit an antiproliferative effect on human lung cancer cells [30]. Piceid of *P. cuspidatum* represents a safe and new candidate for a skin-lightening agent [31]. 2-methoxy-6-acetyl-7-methyljuglone may act as a potent anti-oxidant, which significantly interferes with the Mitogen-activated protein kinases apoptotic cascades, probably rescuing cells by inhibiting the death pathways [32]. Han et al., [33] reported that ethyl acetate extract of *P. cuspidatum* can be a potent candidate for rheumatoid arthritis treatment. Extract of *P. cuspidatum* shown that possesses wound-healing activity [34]. Resveratrol and emodin have shown anticancer potential in various cancer cells, including hepatocarcinoma cells [35, 36].

**Polygonum ferrugineum**

Lopez et al., [37] reported that *P. ferrugineum* extracts as used to heal infected wounds and as antiseptic, antibiotic antifungal agent in traditional medicine.

**Polygonum flaccidum**

Mazid et al., [38] reported that alpha-santalone, of *P. flaccidum* could be a potent candidate for analgesic and the diuretic.

**Polygonum glabrum**

*P. glabrum* extract is clinically effective as antiinflammatory drug and works by the mechanism of action similar to that of nonsteroidal antiinflammatory drugs (NSAIDs), also has been researched for antimelitic activity [39]. Which showed activity against Hymenolepis nana var. fraternal. Kiron et al., [40] reported that analgesic activity of aqueous extract of *P. glabrum* has performed by formalin-induced paw licking in rats.

**Polygonum hypoleucum**

*P. hypoleucum* *Obwi* is a Chinese herbs that has been used for the treatment of arthritis, rheumatitis, cough, influenza, anemia, hemorrhoids and kidney stones [41]. The previous studies found that *P. hypoleucum* is a growth modulator for tumor cells and human mesangial cells [42].

**Polygonum hynocanum**

Aerial parts of the *Polygonum hynocanum* are used for the treatment of liver problems, anemia, hemorrhoids and kidney stones [43]. Methanolic extract from aerial parts of *P. hynocanum* showed high activity against Trypanosoma brucei rhodesiense (IC50 = 3.7 microg/mL) [44].

**Polygonum lanatum**

Oral administration of either hexane, and ethyl acetate extracts at a dose of 300 mg/kg body weight showed statistically significant (p < 0.001) inhibition of rat paw edema by 41.09% and 30.15%, respectively, which was comparable to that of standard drug phenylbutazone (42.15%). Compared to the inhibition of acetic acid-induced writhing by acetylsalicylic acid (69.94%, p < 0.001), treatment with either hexane, or ethyl acetate extracts or methanol extracts elicited significant inhibition of acetic acid-induced writhing reflex by 44.80% (p < 0.001), 33.87% (p < 0.01) and 62.29% (p < 0.001), respectively. In addition, mild to potent diuretic activity was observed after oral administration of these extracts in Swiss albino mice [45].

**Polygonum lapathifolium**

Phenylpropanoid esters of sucrose, vanicoside B and lapathoside A, of *P. lapathifolium* exhibited significant antitumor-promoting effects on mouse two-stage skin carcinogenesis induced by 7,12-dimethylbenz[a]anthracene and tetradecanoyl phorbol acetate (TPA) as a promoter [13]. Methanolic extract of *P. lapathifolium* stems have potential anthelmintic and anti-emetic properties [46].

**Polygonum limbatum**

Methanol extract and compounds of *P. limbatum* have showed cytotoxicity and antimicrobial activity [47].

**Polygonum minus**

Various researchers reported the different biological and pharmacological activities of *Polygonum minus* in both in vitro and in vivo experimental models. It has been found to exhibit antitumor [48], antimicrobial [49], antioxidant, anticytotoxicity and argentoxoticity activities [50].

**Polygonum multiflorum**

This herb possesses many effects, such as lipid lowering, antioxidant, toxin detoxification, anti-tumor, and lubricating intestine, to treat cardiovascular disorders, neurological disorders, and other diseases commonly associated with aging [51, 52]. Modern chromatographic separation studies have demonstrated that many bioactive compounds in *P. multiflorum*, eg. stilbene glycosides, are responsible for its medicinal activities [53-55]. 2,3,5,4'-Tetrahydroxystilbene-2-O-beta-d-glucosid, a major active stilbene glycoside in *P. multiflorum*, has been reported to possess antioxidative, anti-inflammator, endothelial protective, and oncogenic enzyme inhibitory activities [56]. Hexane extract of *P. multiflorum* neuroprotective effect against glutamate-induced neurotoxicity via inhibition of apoptosis [57].

**Polygonum odoratum**

The n-Butanol fraction from the methanol extract of this herb exhibited dramatic hypoglycemic effects in STZ-induced diabetic mice [58]. Chia et al., [59] reported that the water extract of rhizomes of *P. odoratum* decreased the blood glucose level in starch-loaded mice.

**Polygonum orientale**

Water extract of *P. orientale* comprising flavonoids as its principles was of potential use in the treatment of cardiovascular and cerebrovascular diseases and an injection prepared from the flavonoid-enriched water extract had demonstrated protective effects on myocardial ischamia [60]. Leaves and flowers of *P. orientale* showed a protective effect on H9c2 myocardial cells oxidative injury [61]. A flavonoid-enriched extract of *P. orientale* was reported to show cardioprotective effect [62].

**Polygonum paleaceum**

Recently, a few pharmacological studies showed that extract of *P. paleaceum* has antiinflammatory effect on inflammatory rates and antitumor activity to K562, HL-60 (Human promyelocytic leukemia cells) in vitro and 51B0, Hep A in vivo, which are related to oxygen free radical scavenging and antilipid pereoxidation activity of *P. paleaceum* [63].

**Polygonum perfoliatum**

Recently, contemporary studies have shown that *P. perfoliatum* has a variety of pharmacological functions including antiinflammatory [64], antibacteirum [65] and antitumor effects. Pharmacological studies indicated that the flavonoids in *P. perfoliatum* have antiviral, anti-oxidative and antitumor activities [66].

**Polygonum punctatum**

Previous pharmacological reports with the ethanol/water extract of the entire *P. punctatum* disclosed antifungal, antihistaminic, anti-inflammator, antipyeretic and hypotensive activities [67].

**Polygonum sachelanensis**

Previous work showed that leaves extracts of *P. sachelanensis* can be used as a plant fungicide against powdery mildew that flavonones and anthraquinones of flower extracts are good antioxidant compounds and that phenylpropanoid glycosides from the rhizomes exhibit β-glucosidase inhibitory activity [68].
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Polygonum spectabile

Geraldo et al., [69] reports on the investigation of the antimicrobial and antiviral activity of different extracts and compounds isolated from the aerial parts of *P. spectabile*.

Polygonum stagninum

The n-hexane, ethyl acetate and methanol extracts of the aerial parts of *P. stagninum* were assessed for analgesic and antiinflammatory properties in experimental mice and/or rat models [70].

Polygonum tinctorium

Antifungal, cancer chemopreventive and antibacterial activities [71, 72]. Yu et al., [73] reported that the potent anti-HIV-1 and HSV-1 activity of an aqueous extract from the fermented leaves of *P. tinctorium* while seeds and leaves of *P. tinctorium* have an antioxidant and anticancer properties.

Polygonum viscosum

Ethanolic extract of young shoots of *P. viscosum* was found to possess antibacterial activity [74].

Polygonum viviparum

It is used as a folk remedy to treat inflammation related diseases. On the antiinflammatory response of *P. viviparum* against lipopolysaccharide (LPS)-induced inflammation in RAW264.7 macrophages [75].

Chemical constituents

The reported data showed that flavonoids, terpenoids coumarins, fatty acid, cinnamic acid derivatives, steroids and alkaloids are the main and common phytochemicals of the genus Polygonum. The reported phytochemicals from different plants of the genus are given as following.

Polygonum acuminatum

Polygodia (1), isopolygodial (2), drimenol (3), confertifolin (4)[16].

Polygonum amplexicaule

Friedelin (1), β–sitosterol (2), simiarenone (3), angelin (4), psoralen (5), palmitic acid (6), (-)epicatechin (7), quercetin (8)[76], Emodin-8-O-β-D-glucoside (9) [20], flavan-3-ol (10), khellactone (11)[77], 5, 6-dihydropyranobenzopyrone (12), amplexicine (13), catechin (14), rutin (15), quercetin-3-O-β-D-galactopyranoside (16), chlorogenic acid (17), galloyl glucose (18), caffeic acid (19), gallic acid (20), scopletin (21) [77].
Polygonum aviculare

Avicularin (1), kaempferol (2), quercetin (3), myricetin (4), cafferic acid (5), chlorogenic acid (6), coumaric acid (7), oxalic acid (8), D-catechin (9), gallic acid (10) \[78\], naphthoquinone (11), 6-methoxyplumbagin (12), β-sitosterol (13), oleanolic acid (14), 5,6,7,4’-tetramethoxyflavone (15) \[79\].

Polygonum bistorta

3-O-methyl-gallic acid (1), quercetin-3-O-β-D-glucopyranoside (2) \[80\], 5-glutten-3-one (3), friedelanol (4) \[9\], 24(E)-ethylidenecycloartanone (5), 24(E)-ethylidenecycloartan-3a-ol (6), cycloartane-3, 24-dione (7), 24-methylenecycloartane (8), c-sitosterol (9), β-sitosterol (10), β-sitosterone (11), friedelin (12), 3-β-friedelinol (13) \[24, 81\].
(7) \( R=O \), (8) \( R=\alpha - OH \), (9) \( R_1=O \), (6) \( R=\alpha - OH \), (7) \( R_1=O \), (8) \( R_1=\text{CH}_2 \).
Polygonum capitatum

Gallic acid (1), quercitrin (2), vanillic acid (3), protocatechuic acid (4), flavones (5), chromone glycoside (7-O(6'-Galloyl)-β-D-glucopyranosyl-5-hydroxychromone) (6), progallin A (7), nimbecitin (8), quercetin (9), quercitrosid (10), tetracosyferrulate (11), quercetin-3-O-β-D-glucoside (12), β-deucosterol (13), β-sitosterol (14), Schizandriside (15), (-)-isolariciresinol-2a-O-β-D-xylopyranoside (16), (+)-5'-methoxy isolariciresinol-2a-O-β-D-xylopyranoside (17), nutiposide (18), [84] 5,7-dihydroxy-4H-

chromen-4-one (19), ellagic acid (20), myricetin (21), hirsutine (22), rutin (23), quercetin-3-O-(2′-O-galloyl)-β-D-glucopyranoside (24) quercitin (25), kaempferol-3-O-α-L-rhamnopyranoside (26), quercetin-3-O-(2′-O-galloyl)-α-L-rhamnopyranoside (27), kaempferol (28) [85].

**Polygonum chinense**

Squalene (1), 1,2-benzenedicarboxylic acid (2), 1,2-benzenedicarboxylic acid, mono [2-ethylhexyl] ester (3), 4-hexene-1-ol, 5-methyl-2-(methylthyl)acetate-8-4 [86].

![Chemical structures of Polygonum chinense](image1)

**Polygonum Cillinerve**

Emodin-8-β-D-[2′-O-coumarate] glucoside (1), emodin-8-β-D-(6′-O-acetyl) glucoside (2), physcion-8-β-D-(6′-O-acetyl) glucoside (3) [10].

![Chemical structures of Polygonum Cillinerve](image2)

**Polygonum cuspidatum**

Piceid (5,4′-dihydroxystilbene-3-O-β-D-glucopyranoside) (1) [87], 2-methoxy-6-acetyl-7-methyljuglone (2) [88], 2-methoxystypantrone (3), emodin (4), resveratrol (5), polydatin (6), emodin-8-β-D-glucopyranoside (7), (E)-3, 5, 12-trihydroxystilbene-3-O-β-D-glucopyranoside-2′ (3′, 4′, 5′-trihydroxybenzoate) (8), (+)-catechin-3-O-gallate (9) [89], resveratroloside (10), 3,5,5-trihydroxystilbene-3-O-(6′-galloyl) glucoside (11), emodin-1-O-glucoside (12), torachrysone-8-O-glucoside (13), emodin-8-O-glucoside (14), emodin-8-O-(6′-malonyl)-glucoside (15), torachrysone-8-O-(6′-acetyl)-glucoside (16), physcion-8-O-glucoside (17), physcion-8-O-(6′-acetyl)-glucoside (18) [90].

![Chemical structures of Polygonum cuspidatum](image3)
**Polygonum ferrugineum**

5,7-dihydroxy-6-methoxy-3-chroman-4-one (1), 2'-4'-6'- 9-hydroxy-pheyllethyl)-trihydroxy-30-methoxy-a-hydroxymethyl-b-hydroxy-dihydrochalcone (2), pashanone (3), flavokawin B (4), cardamonin or alpinetin chalcone (5), pinostrobin (6) 5,8-dimethoxy-7-hydroxychroman-4-one (7)[8], chalcone (8)[37].
**Polygonum hypoleucum**

Emodin (1), physcion (62A) (2), emodin 1-O-β-D-glucoside (49A) (3), physcion 1-O-β-D-glucoside (50A) (4), emodin-8-O-β-D-glucopyranoside (5), (+)-catechin (6), (-)-epicatechin (7) [91, 92].

\[(1). R_1=R_2=H, (2). R_1=H, R_2=CH_3 (3). \beta -D-glucoside, R_2=H, (4). \beta -D-glucoside, R_2=CH_3, (5) \]

**Polygonum hyrcanicum**

Quercetin (1), myricetin (2) [93, 17], N-trans-caffeoyltyramine (3) [94], quercetin 3-O-α-L-(3',5'-diacetyl-arabinofuranoside) (4) [95], quercetin 3-O-α-L-(3'-acetyl-arabinofuranoside) (5), myricetin 3-O-α-L-arabinofuranoside (6) [96], myricetin 3-O-α-L-(3',5'-diacetyl-arabinofuranoside) (7) [97], (+) catechin (8), (+) gallicatechin (9) [98], myricetin 3-O-β-D-galactopyranoside (10), myricetin 3-O-α-L-rhamnopyranoside (myricitrin) (11) [99], quercetin 3-O-β-D-galactopyranoside (12) [100], quercetin 3-O-α-L-arabinofuranoside (avicularin) (13) [101], tyrosol (14), p-coumaric acid (15), ferulic acid (16), N-cis-feruloyltyramine (16), N-trans-p-coumaroyltyramine (17), N-trans-3,4-dimethoxycinnamoyldopamine (18) [44].

\[(1). R_1=R_2=H, (2). R_1=H, R_2=OH, (3). R_1=\beta -D-galactopyranoside, R_2=OH, (4). R_1=\beta -D-galactopyranoside, R_2=OH, (5). R_1=H, R_2=H, (6). R_1=H, R_2=H, (7). R_1=COOH, R_2=COOH, (8). R=H, (9). R=OH (10) \]
**Polygonum lapathifolium**

Vanicoside B (1), lapathoside A (2) [13], 5-hydroxy-7-methoxy flavanone (pinostrobin) (3) [102].

**Polygonum limbatum**

Cardamomin (1), (+)-polygohomoisoflavanone (2), (±)-(-)-pinostrobin (3), 2',4'-dihydroxy-3',6'-dimethoxychalcone (4), (25)-(−)-5-hydroxy-6,7-dimethoxyflavanone (5), (25)-(−)-5,7-dimethoxyflavanone (6) [47].

**Polygonum minus**

Decanal (1), dodecanal (2), decanol (3), 1-dodecanol (4), undecanal (5), tetradecanal (6), 1-undecanol (7), nonanal (8), 1-nonanol (9), β-Caryophyllene (10) [103], rutin (11), catechin (12), quercetin (13), isorhamnetin (14), hexanal (15) [104], 1-hexanol (16), α-Pinene (17), kaempferol (18), undecane (19), nonanal (20), 1-nonanol (21), isobornyl acetate (22), n-decanic acid (23), α-cubebone (24), xanthorrhizol (25), β-caryophyllene (26), trans-α-bergamotene (27), α-bisabolol (28), farnesene (29), β-himachalene (30), α-selinene (31), valencene (32), 8-cadinine (33), alloaromadendrene (34), α-cumulene (35), (-)-α-pauninsene (36), cis-lanceol (37), farnesol (38), humulene (39), nerolidol (40), dodecanoic acid (41), β-caryophyllene oxide (42), trans-α-(2)-Bergamotol (43), tetradecanal (44), alloaromadendrene oxide (1) (45), trans-longipinocarveol (46), neisolongifolene, β-bromo- (47) isocaryophyllene (48), drimenol (49), drimenin (50), phytol (51) [105], 6,7-methylenedioxy-5,3',4',5'-tetramethoxyflavone (52), 7,4',5'-dimethylenedioxy-3,5,3'-trimethoxyflavone (53) [106].
**Polygonum multiflorum**

Tetrahydroxystilbene-glucoside (2,3,5,4'-tetrahydroxystilbene-2-O-β-D-glucoside) (1)[107], Chrysophanol (2), physcion (3), emodin (4), aloemodin (5), rhein (6), physcion-8-O-β-D-glucoside (7), emodin-8-O-β-D-glucoside (8), noreugenin (9), apigenin (10), daucosterol (11), β-sitosterol (12), stearic acid (13)[108], 5-methyl-2-(1-methylethyl)phenyl-β-D-glucopyranoside(14) [109], hyperoside (15), rutin (16), vitexin (17), β -amyrin (18) [110], gallic acid (19), hypaphorine (20), catechin (21), proanthocyanidin B1(22), proanthocyanidin B2 (23), epicatechin (24) [111].
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**Polygonum odoratum**

(13)-3-hexenal (1), (14)-3-hexenol (2) decanal (3), undecanal (4), dodecanal (5), aldehydes (6), 3-sulfanyl-hexanal (7), 3-sulfanyl-hexan-1-ol (8) [112], eucalyptol (9), undecane (10), 1-nonanol (11) decanol (12), n-decanoic acid (13), 1-nonenone (14), β-elemene (15), β-caryophyllene (16), allo-aromadendren (17), α-caryophyllene (18), eremophilene (19), 7-epi-alpha-selinene (20), ledol (21), nerolidol (22), globulol (23), caryophyllene oxide (24), cubenol (25), eupatoriocromene (26), drimenol (27), hexahydro farnesylacetone (28), isophytol (29), n-hexadecanoic acid (30)[113], saponin (31), flavonoid (32) [114].
Polygonum orientale

alpha-tolin (1), methyl 3, 4-dihydroxybenzoate (2), apocynin (3), kaempferol-3-O-β-D-glucoside (4), 1,3,5-trihydroxybenzene (5), 3,3’-dimethoxyellagic acid-4-O-β-D-glucoside (6), kaempferol-3-O-α-L-rhamnoside (7), quercetin-3-O-α-L-rhamnoside (8), kaempferol (9) [115], 3,5,7-trihydroxyflavone (10), 5,7,4’-trihydroxydihydroflavonol (11), dihydroquercetin (12), quercetin (13), p-hydroxyphenylethanol ferulate (14), p-hydroxyphenylethanol-p-coumaric (15) catechin (16), isoorientin (17), orientin (18), quercetin-3-O-(2’-O-α-L-rhamnopyranosyl)-β-D-gluarano-pyranoside (19), taxifolin (20), luteolin (21) [116], ombuine-3-O-β-D-galactopyranoside (22), ombuine-3-O-rutinoside (23) [117], tryptophan (24), quercetin-3-O-methyl ether (25), kaempferol-3-O-(2’-O-α-L-rhamnopyranosyl)-β-D-glucuronopyranoside (26), quercetin-3-O-β-D-glucuronide (27) [118], gallic acid (28), alpha-tolin (29), taxifolin (30), kaempferol-3-O-β-D-glucoside (31) [119].
**Polygonum paleaceum**

Paleaceolactoside (1), 6-O-galloyl-glucose (2), (+)-catechin (3), (-)-epicatechin (4), procyanidin B1 (5), procyanidin B2 (6), procyanidin C1 (7), chlorogenic acid (8), methyl 5-O-cafeoylquinic (9), 3-O-cafeoyl quinic acid (10), quercetin-3-O-β-D-glucuronide (12), caffeic acid (13), gallic acid (14) [2].

![Image of chemical structures of Polygonum paleaceum](image)

**Polygonum perfoliatum**

4-dihydro-4-(4'-hydroxyphenyl)-5,7-dihydroxy coumarin (1), 3,4-dihydro-5-hydroxy-7-methoxy-4-(4'-methoxyphenyl) coumarin (2), 3,4-dihydro-5-hydroxy-4-(4'-hydroxyphenyl)-7-methoxy coumarin (3), 3,4-dihydro-5,7-dihydroxy-4-(4'-methoxyphenyl) coumarin (4)[11], 6'-acetyl-3,6-diferuloylsucrose (helonioside B) (5), 2'4'6'-triacetyl-3,6-diferuloylsucrose (6), 1'2'4'6'-tetraacetyl-3,6-diferuloylsucrose (7), 1'2'6'-triacyt-3,6-diferuloylsucrose (8), 2'6'-diacetyl-3,6-diferuloylsucrose (9), 1,3,6-tri-p-coumaryl-6'-feruloyl sucrose (10), vanicoside A (11), vanicoside B (12)[120], quercetin-3-O-β-D-glucuronide (13)[65], 5-hydroxy methyl-2-furaldehyde (14), methyl caffeate (15), protocatechuic aldehyde (16), quercetin (17), pinocembrin (18), catechin (19), taxifolin (20), taxifolin-3-0-β-D-xlyopyranoside (21), 13-epiturulosal (22), coumarin-7-O-β-D-glucosidic (23)[121], 8-oxo-pinoresinol (24), 3',5'-dihydroxy-3,4',5',7-tetramethoxy-flavone (25), rutin (26)[122].

![Image of chemical structures of Polygonum perfoliatum](image)
(4) R₁ R₂ R₃ R₄ R₅ R₆
(5) H H H H H COCH₃
(6) H H COCH₃ H COCH₃ COCH₃
(7) COCH₃ H COCH₃ H COCH₃ COCH₃
(8) COCH₃ H COCH₃ H H COCH₃
(9) H H COCH₃ H H COCH₃

(10)

(11) R = -COCH₃

(12) R = H

(13)

(14)

(15)

(16)

(17)

(18)

(19)

(20)

(21)

(22)

(23)

(24)
Polygonum punctatum

Polygodial (1)[123].

Polygonum sachalinensis

Quercetin-3-O-β-D-galactopyranoside (1), quercetin-3-O-
arabinopyranoside (2), lapathoside D (3), N-trans-
teruloyltyramine (4), lapathoside C (5), hydropersoside (6),
vanicoside B (7)[124], phenylacetonitrile (8), (E)-β-ocimene (9),
linakol (10), (E)-4,8-dimethyl-1,3,7-nonatriene (11), (E,E)-α-
farnesene (10)[125].
Polygonum viscosum

3',5'-dihydroxy-3,4', 7-tet-ramethoxyfavone (1), quercetin 3-O-(6-feruloyl)-β-D-galactopyranoside (2), 4-isobutyl-6-methyl-5-oxo-3a,4,5,7a-tetrahydro-1H-inden-13-oic acid (3) [15].

CONCLUSION

Although, an extensive amount of research work has been done on some plants of this genus to date, the isolated compounds from this genus are belong to terpenoids, flavonoids, coumarins, fatty acid, cinnamic acid derivatives, steroids and alkaloids but some of species are still chemically and/or pharmacologically unknown such as P. flaccidum, P. glabrum P. lanatum, P. spectabile, P. stagninum P. tinctorium, and P. viviparum. Consequently, a broad field of future research remains possible in which the isolation of new active principles from these species would be of great scientific merit. However, the mechanism of their action is still unknown.

Hence, a detailed study is required to understand the structure–activity relationship of these constituents. As literature showed, many plant extracts having cytotoxic activity, antitumor, antimicrobial, antibacterial, analgesic, anti-inflammatory, hypothermia, diuretic, and anti-oxidative activities, hence, the particular constituent responsible for the activity may be isolated for further process. In addition, some plant extracts were only screened for their preliminary in vitro activities; so, the advance clinical trial of them deserves to be further investigated. Herein, we described the possible applications in clinical research but further investigations on phytochemical discovery and subsequent screenings are needed for opening new opportunities to develop pharmaceuticals based on Polygonum constituents.

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