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REVIEW

A REVIEW OF CHEMISTRY AND BIOLOGICAL ACTIVITIES OF THE GENUS *AERVA* – A DESERT PLANT

PAYAL CHAWLA[1]*, AMIT CHAWLA[1], NEERU VASUDEVA[2] and SURENDRA KUMAR SHARMA[2]

[1]Global College of Pharmacy, Kahnpur Khui, Anandpur Sahib-140117 (Punjab), India
[2]Department of Pharmaceutical Sciences, Guru Jambheshwar University of Science and Technology, Hisar-125001, India

Abstract: There are approximately 28 species of *Aerva* genus, but only a few species are medicinal of which *A. persica, A. lanata* and *A. javanica* are of great value. A number of flavonol glycosides (e.g., aervanone, kaempferol-3-galactoside, isorhamnetin-3-O-β-D-glucoside) have been reported from *Aerva persica* as major phytoconstituents and the minor constituents are β-cyanins (glycine betaine and trigonelline), sterols and carbohydrates. This plant is used as medicinal herb in several traditional systems of medicine all over the world, like diuretic, demulcent, purgative, emetic and tinder. *Aerva* plants are used to cure ulcer, lithiasis, dropsical affections, eye affection, toothache, headache, in disorders of abdomen and inflammation of internal organs. Roots and flowers are reported to possess hypoglycemic, antioxidant, anthelmintic, analgesic, antimalarial, antivenin activities and medicinal properties against rheumatism and kidney troubles.

Keywords: *Aerva persica*, aervanone, kaempferol-3-galactoside, diuretic, anti-inflammatory

Herbal drugs have great growth potential in the global market. Natural product research continues to explore Indian traditional medicines to develop novel drugs. There is a great demand for herbal medicines in the developed as well as developing countries because of their wide biological activities, higher safety margin than the synthetic drugs and lower costs. Current estimates indicate that about 80% of people in developing countries still rely on traditional medicines based largely on various species of plants and animals – for their primary healthcare. About 30% of the worldwide sales of drugs is based on natural products (1). Commercially, these plant-derived medicines are worth worldwide about 40 billion US dollars. In India, the herbal drug market is about 1 billion US dollars and the export of plant based crude drugs is around 80 million US dollars (2). Advances in biotechnology, particularly methods for culturing plant cells and tissues, provide new means for chemicals that they produce.

Aerva species

They are hoary-tomentose herbs, up to 1 m in height, widely distributed in Srilanka, Myanamar, Rajasthan, Peninsular India, Gujarat. There are approximately 28 species in this genus: *A. 'Desert Yearning', A. ambigua, A. artemisioides, A. brachiata, A. cochinchinensis, A. congesta, A. coriacea, A. desertorum, A. glabrata, A. hainanensis, A. incana, A. japonica, A. javanica (Java Aerva), A. lanata (Aerva), A. leucura, A. madagassica, A. microphylla, A. monsonia, A. persica, A. revoluta, A. sanguinolenta, A. sanguinolenta sanguinea, A. sansibarica, A. scandens, A. sericea, A. timorensi, A. triangularifolia, A. wightii*.

Vernacular names

Gujrati-Bur; Kannad-Dodda; Hindi-Gidda; Tamil-Perumpoolai; Telagu-Magavira; Delhi-Dholimundi, kamheda; Punjabi-Boi kalan; Rajastani-Buida.

Scientific classification

Domain – Eukaryota, Kingdom – Plantae, Subkingdom – Viridaeplantae, Phylum – Magnoliophyta, Subphylum – Spermatophytina, Infraphylum – Angiospermae, Class – Magnoliopsida, Subclass – Caryophyllidae, Superorder – Caryophyllanae, Order – Caryophyllales, Suborder – Chenopodi-

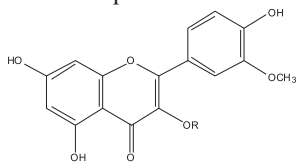
* Corresponding author: e-mail: palamitchawla@gmail.com; phone: +919357702237, +919592021088

ineae, Family – Amaranthaceae, Subfamily – Amaranthoideae, Tribe – Amaranthceae.

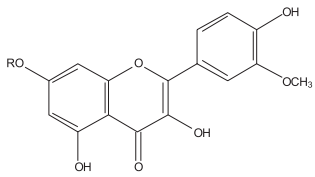
Phytoconstituents

A number of flavonol glycosides have been reported from different *Aerva* species as major phytoconstituents and the minor constituents are β-cyanins, sterols and carbohydrates.

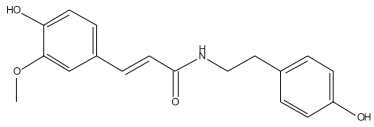
Flavonol glycosides: The aerial parts of *A. lanata* have been reported to contain *O*-acylglycosides: isorhamnetin-3-O-β-D-glucoside (**Ia**), narcissin (isorhamnetin-7-O-rutinoside) (**Ib**), feruloyltyramine (**Ic**), feruloylhomovanillylamine (**Id**), aervitrine, syringic acid (**Ie**), vanillic acid (**If**), ferulic acid (**Ig**) (3). Flavonone glycosides like chrysin-7-O-galactoside (**Ih**) and aervanone (8-C-β-D-galactosyl-7,4'-dihydroxyflavonone) have been isolated from the roots of *A. persica*. Kaempferol-3-galactoside (**Ii**), 3-rhamnogalactoside (**Ij**), quercetin-3-galactoside (**Ik**), isorhamnetin-3-galactoside (**Il**), 3-rhamnosyl-(1→6)-galactoside and 3-(*p*-coumaroyl)-rhamnogalactoside have been isolated from the fresh aerial parts of *A. javanica* (4). From the perianth lobes of *A. tomentosa*, a rare acylated flavonol glycoside kaempferide-3-O-(6"-O-acetyl-4"'-O-α-methylsinapyl)-neohesperidoside (**Im**) has been isolated (5). Persinol (flavonone) (**In**), persinosides A (**Io**) and B (**Ip**) and flavonoids (**Iq-r**) have been reported in the ethyl acetate fraction of the whole plants of *A. persica* (6). The flavonoid constituents isolated from aqueous and ethanolic extracts of *A. javanica* were identified as chrysoeriol (**Is**) (7). Kaempferol-3-rhamnogalactoside (**It**) has been reported in roots of *A. persica* (8).



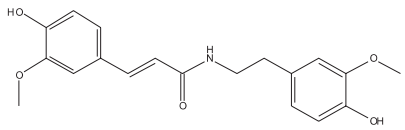
(Ia) R = *β*-D-glucoside, **(Il)** R = Galactoside



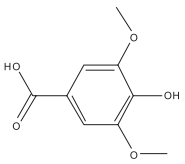
(Ib) R = Rutinoside



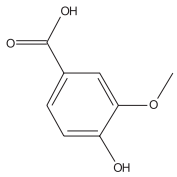
(Ic)



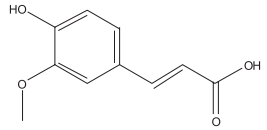
(Id)



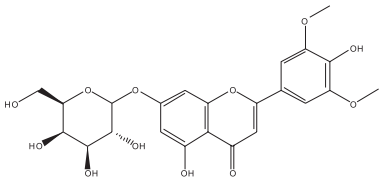
(Ie)



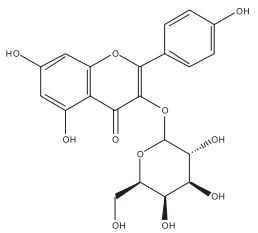
(If)



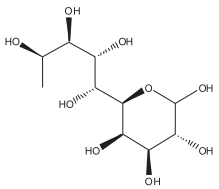
(Ig)



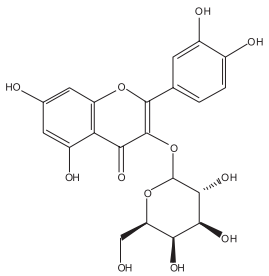
(Ih)



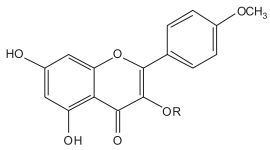
(Ii)



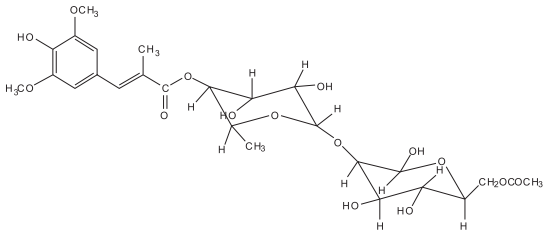
(Ij)

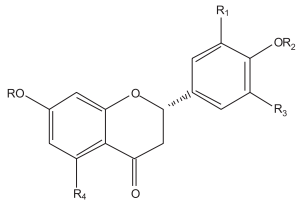


(Ik)

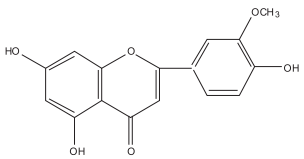


(Im) R =

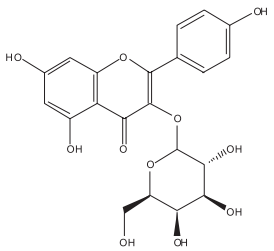




	R	R_1	R_2	R_3	R_4
(In)	-Me	-OH	-H	-OH	-OH
(Io)	-Me	-OH	-β-D-glu	-H	-OH
(Ip)	-β-D-glu	-OH	-H	-OH	-OH
(Iq)	-H	-H	-H	-H	-H
(Ir)	-H	-H	-H	-H	-β-D-glu

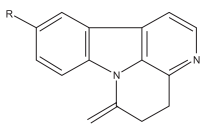


(Is)

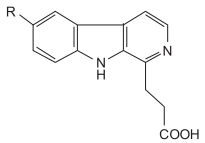


(It)

Alkaloids: canthin-6-one (**IIa**), 10-methoxy-canthin-6-one (methylaervin) (**IIb**), 10-hydroxycanthin-6-one (aervin) (**IIc**), 10-β-D-glucopyraosyloxy-canthin-6-one (aervoside) (**IId**), β-carboline-1-propionic acid (**IIe**), 6-methoxy- β-carboline-1-propionic acid (aervolanin) (**IIf**) were isolated from the roots and aerial parts of *A. lanata* (9).

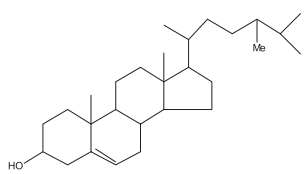


(IIa) R = H
(IIb) R = OCH_3
(IIc) R = OH
(IId) R = OAc

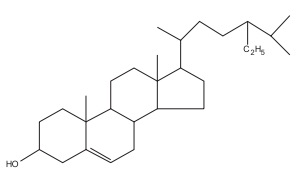


(IIe) R = H
(IIf) R = OCH_3

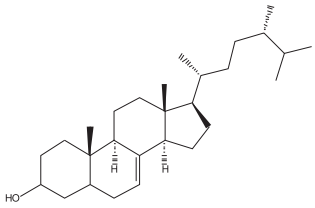
Sterols: campesterol (**IIIa**), sitosterol (**IIIb**), 7-ergostenol **(IIIc),** spinasterol, 7-stigmastenol **(IIId),** campestanol **(IIIe)** and 22-stigmastenol **(IIIf)** have been reported in *A. persica* and *A. javanica* (10)**.** β-Sitosterol **(IIIg),** triterpenoid α- and β-amyrin **(IIIh–i)** and pentadecanoic acid have been reported in GLC analysis of unsaponifiable fraction of *A. javanica* (7).



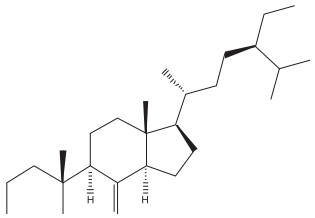
(IIIa)



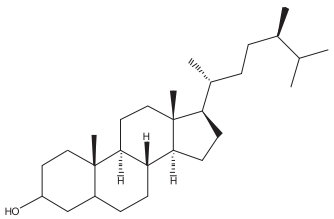
(IIIb)



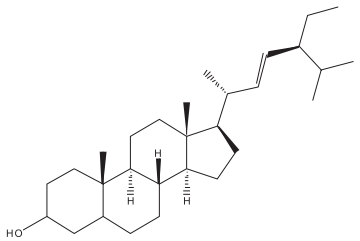
(IIIc)



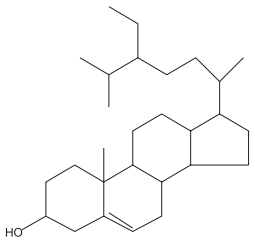
(IIId)



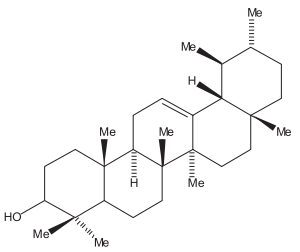
(IIIc)



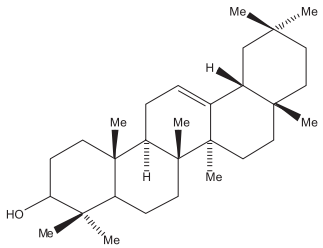
(IIId)



(IIIg)



(IIIh)



(IIIi)

Others: In *A. lanata* and *A. javanica* arabinose**,** rhamnose**,** xylose**,** galactose**,** glucose**,** mannose and mannitol (2.2% in *A. javanica* and 4.2% in *A. lanata*) were isolated (12, 13). Glycine betaine (0.59%) and trigonelline (0.005%) has been isolated from the aerial parts of *A. japonica* (14). Amarantine, isoamaranthine, celosianin I and celosianin II were extracted out from the infloresence of the *A. sanguinolenta* (15).

Traditional uses

The herb is diuretic and demulcent (9). Its decoction is used to remove swellings (16). It is used as purgative and emetic for horses and camels. The powdered plant is applied externally to ulcers in domestic animals. It is also used as tinder. The wooly seeds are said to relieve headache. *Aerva* plants are used to cure lithiasis, dropsical affections, eye affection, toothache, headache, in disorders of abdomen and inflammation of internal organs (7). Roots and flowers are reported to possess medicinal properties against rheumatism and kidney troubles (4, 17). *A. lanata* is officially recognized as anthelmintic and analgesic (12). Infusion of *A. lanata* is used as herbal drink (18). *A. lanata* possesses antimalarial, antivenin, analgesic and sedative activities (19). Refrigerant, sudorific, stimulant, vermifuge and positive inotropic effects are possessed by *A. lanata* (20).

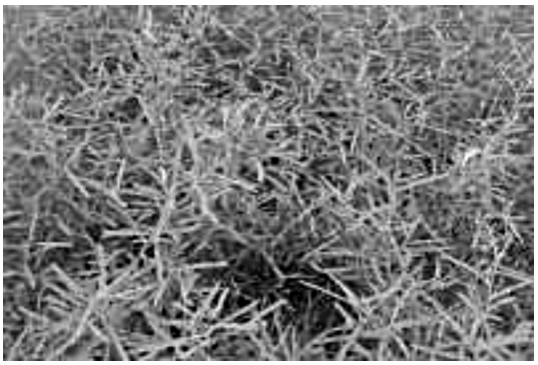



Figure 1. Entire plant of *A. persica*

Biological activities

Antimicrobial activity: The whole plant of *A. lanata* (ethyl acetate and methanol extracts) showed antimicrobial activity against Gram positive (*Bacillus subtilis*, *Bacillus cereus*, *Staphylococcus aureus*) and Gram negative bacteria (*Escherichia coli, Shigella dysenteriae, Shigella shiga, Shigella sonnnei, Shigella flexneriae, Shigella boydii* and *Klebsiella species*) and fungi (*Aspergillus fumigatus, Aspergillus niger, Candida albicans, Hensinela californica* and *Rhizopus oligosporum*) (21). Aqueous leaf extract of *A. persica* showed antibacterial activity against *Salmonella typhi*. Alcoholic extracts of flowers and aqueous extracts of leaf and stem of *A. persica* were found to have antibacterial activity against *Staphylococcus aureus*. The root, stem and leaf of *A. persica* (aqueous and alcoholic extracts) totally inhibited the growth of plant pathogenic fungal species *Macrophomina phaseolina* (22). The ethyl acetate fraction of *A. bovei* showed significant antimicrobial activity against *E. coli*, fungi *Aspergillus niger* and yeast *Saccharomyces*; while the butanol fraction showed marked activity against fungi *Aspergillus niger* and yeast *Saccharomyces* (7). The perianth lobes of *A. tomentosa* showed antimicrobial activity against *E. coli* and *Staphylococcus aureus* (5). The flavonoidal constituents isolated from ethyl acetate fraction of aqueous and alcoholic extracts of *A. javanica* showed significant antimicrobial activity against Gram negative bacteria, yeast and fungi (7).

Diuretic activity: The aqueous and alcoholic extracts of *A. lanata* root, stem and leaf have shown significant diuretic activity at the dose of 1600 mg/kg body weight (23). Flowers of *A. lanata* were found to be the most effective in inducing diuresis at the dose of 50 g/L (18, 24). Alcoholic extract of *A. lanata* (800 mg/kg) acts as diuretic (25).

Immunomodulatory effect: petroleum ether extract of *A. lanata* have shown significant cytotoxicity against Daltons lymphoma ascites tumor cell lines *in vitro* and stimulated lymphocyte proliferation *in vitro* and *in vivo* conditions (26).

Hepatoprotective activity: petroleum ether extract of whole plant of *A. lanata* reversed the histopathological changes and restored the elevated activites of liver marker enzymes and also enhanced the antioxidant enzyme activities at a dose level of 1600 mg/kg body weight (26). Dried alcoholic extract of root and leaf extract of *A. lanata* at the dose of 600 mg/kg body weight showed significant hepatoprotective activity (23).

Antidiarrhoeal activity: **e**thanolic and aqueous extracts of *A. lanata* and *A. javanica* have significant antidiarroheal activity at dose level of 800mg/kg in Inbred wistar rats (27).

Antiplasmodic activity: the aqueous extracts of *A. javanica* and *A. lanata* exhibited smooth muscle relaxant effect in a dose dependent manner, *A. javanica* being more potent than *A. lanata*. When the same doses of ethyl acetate and *n*-butanol fractions were used, significant smooth muscle relaxant activity was noticed (28). Stem, leaf and mature fruit (3, 2.70, 4 mg dry extract/80 mg dry plant material) of *A. javanica* showed antiplasmodic activity (29).

Hypoglicemic activity: treatment with alcoholic extract of *A. lanata* at 375 and 500 mg/kg exhibited reduction in blood glucose levels (30).

Cytotoxic activity: petroleum ether, ethyl acetate and methanol extracts of *A. lanata* showed significant cytotoxicity properties (21). Petroleum ether extract of *A. lanata* (in 0.1 mL 10% DMSO) was proved to be cytotoxic to Dalton's lymphoma ascites, Ehrlich ascites and B16F10 cell lines *in vitro* (31).

Nephroprotective activity: The ethanolic extract of the entire plant of *A. lanata* at the dose

levels of 75, 150 and 300 mg/kg showed dose dependent reduction in the elevated blood urea and serum creatinine (32).

Antioxidant activity: flavonoids present in ethyl acetate fraction of the whole plant of *A. persica* have shown antioxidant activity (6).

Antiinflammatory activity: benzene and alcoholic extracts of *A. lanata* have shown anti-inflammatory activity in carageenan-induced rat paw edema model at dose level of 800 mg/kg (25).

Miscellaneous activities: *A. lanata* acts as an antilithic agent at the dose of 3 mg/kg body weight. Increased urinary excretion of calcium, oxalate, uric acid, phosphorus and protein in hyperoxaluric rats has been decreased significantly by the administration of *A. lanata* (33). Administration of *A. lanata* aqueous suspension (2 g/kg b.w./dose/day for 28 days) to calcium oxalate urolithic rats had reduced the oxalate synthesizing enzymes, diminished the markers of crystal deposition in the kidney (34).

DISCUSSION AND CONCLUSION

Requirements for herbal medicines have been established within last few years, and the trend is to define the dosage form with a uniform amount of extract (35). On the contrary, most of the herbal drugs reduce the offensive factors and are proved to be safe, clinically effective, have better patient tolerance, relatively less expensive and globally competitive. Treatment with natural products presents promise of a cure. *Aerva* plants have been a raw material for the synthesis of many drugs and they remain an important source of new therapeutic agents. Plants from genus *Aerva* and their extracts are some of the most attractive sources of new drugs and have been shown to produce promising results in the treatment of gastric ulcers (36). In traditional medicine several plants and herbs have been used to treat gastrointestinal disorders, including gastric ulcers. This is an important reason to investigate anti ulcer effect of *Aerva* species medicinal plants with traditional use in gastric disease. The genus *Aerva* though is known for its very significant medicinal properties. This review will help in the future to explore the medicinal potential of the phytoconstituents of these plants.

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