Ethnobotany, Phytochemistry, Pharmacological Activity of Genus *Malachra* L.

Subjects: Others

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The genus *Malachra* L. belongs to the family Malvaceae. It includes herbs or subshrubs of nine accepted species with approximately thirty synonyms, and it has been widely used in community folk medicine to treat health problems including inflammation, nasal obstruction, leishmaniasis, malaria, childbirth, kidney disorders, fever, respiratory tract diseases, among others.

Keywords: Malachra ; ethnobotany ; pharmacological activity

1. Botanical Description of the Species of the Genus *Malachra* L.

The genus *Malachra* L. is represented by herbs or suffrutes, sometimes puberulent, generally hispid, or with stinging trichomes. Leaves are simple or palmately lobed; acute, acuminate, or obtuse at the apex; truncated or subcordate at the base; serrated or crenated; and generally pubescent. They also present: bracteate inflorescences; axillary or terminal heads; broadly cordate-ovate bracts at the base, with prominent nerves often alternating with whitish areas, although it can be in other parts green and sessile. Absent calliculus (except in *M. radiata*); small calyx, five-lobed; white, yellow, or lilac corolla; and five-lobed leaves can also be observed. Additionally, schizocarpal fruits have the shape of a wheel similar to a cheese that can be split into five ripe wing types; flowers are in heads, surrounded by bracts larger than them [1][2][3][4].

***Malachra alceifolia* Jacq.** is a herb or shrub, 1. 6 m tall. The aerial parts and petioles are hispid, simple or split, flavescent, tuberculate base, scattered hairs, short, star-shaped, and long forming knots, with stem pubescence and a green to reddish color. The leaves are simple, opposite, and lobed, with up to five lobes, with pubescence, and their margins are serrated or toothed. There are inflorescences in axillary heads with the presence of acuminate bracts and flowers with five petals, 2 to 3 cm in diameter, with a yellow coloration. The fruits have bracts and persistent calyx, with numerous seeds, up to 2 mm in diameter, dark colored, and flattened (**Figure 1**) [5].

Figure 1. *Malachra alceifolia* Jacq.

***Malachra capitata* Linn.** is a herb or subshrub, up to 2 m tall, with stem pubescence and green to orange coloration. The leaves are simple, opposite, palmate or lobed, with up to five lobes; the texture of the leaves is velvety and their margins are crenulate or serrated. Inflorescences are peduncular and axillary, with the presence of lanceolate bracts; flowers have five petals, 1 cm in diameter, with a white coloration. Schizocarpic fruits have single seeds up to 3 mm in diameter, and are dark colored (**Figure 2**) [6].

Figure 2. *Malachra capitata* Linn.

***Malachra fasciata* Jacq.** is a herb or subshrub, up to 2 m tall, with stem pubescence, simple or stellate trichomes up to 7 mm, and green to orange coloration. The leaves are simple, opposite, ovate, truncated at the base, acute at the apex, lobed or deeply parted, otherwise crenate-serrate, pubescent above with appressed trichomes. The heads are short-stalked bracts, 2–6 per head, lance/ovate, subcordate at the base, acute at the apex, often ciliate, prominently hispid. Calyx 4 to 5 mm, hispid; petals white 6–8 mm, mericarps light brown to grayish green, reticulate veined (**Figure 3**) [1].

Figure 3. *Malachra fasciata* Jacq.

***Malachra radiata* (L.) L.** is a herb or suffrutex, 1.5 m tall, with stem pubescence and green and purple coloration. The leaves are simple, opposite, palmate or lobed, with up to seven lobes; the texture of the leaves is velvety, and their margins are crenulate or serrated, and most apical leaves may have a triangular shape. Inflorescences are pedicular and

terminal, with the presence of ovate or acute bracts; flowers have five petals, 2.5 cm in diameter, with a lilac coloration and purple at the base. Schizocarpic fruits have numerous seeds, up to 2 mm in diameter, and are dark colored (**Figure 4**) [7].

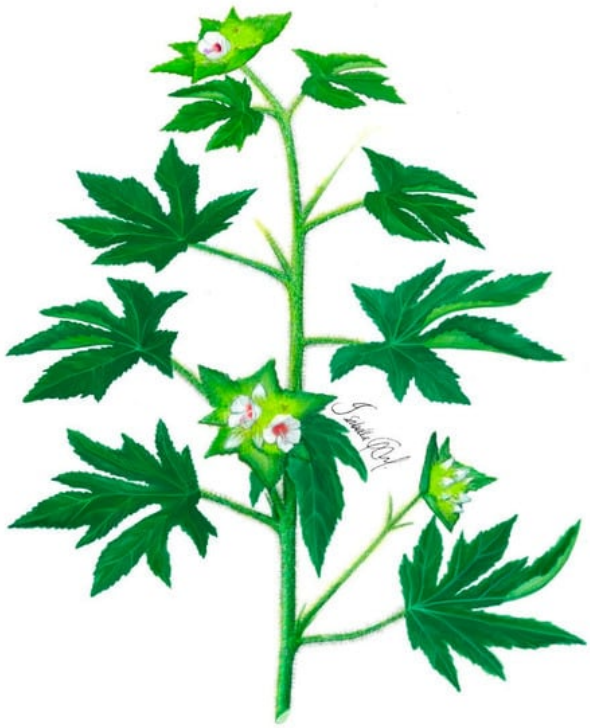

Figure 4. *Malachra radiata* (L.) L.

***Malachra ruderalis* Gürke.** is an annual herb, up to 3 m high, with stem pubescence and green coloration. The leaves are simple, opposite, palmate or lobed, with up to five lobes; the texture of the leaves is velvety, and their margins are crenulate; the most apical leaves have a triangular shape. It shows pedicular inflorescence with terminal or acute axillary bracts, five petals, 3 cm long, with yellow schizocarpic fruit with numerous dark-colored seeds up to 2 mm in diameter (**Figure 5**) [4][8].

Figure 5. *Malachra ruderalis* Gürke.

***Malachra rudis* Benth**. is a perennial herb, up to 0.7 m high, with a stem that has very short pubescence, and its coloration is light green. The leaves are simple, opposite, lobed, with up to three lobes; velvety texture; crenulated margins with pedicular, axillary, or terminal inflorescence; ovate bracts with five petals; 1.5 cm in long. Schizocarpic fruits are yellow to white with numerous seeds up to 1 mm in diameter, one per carpel (**Figure 6**) [4][8].

Figure 6. *Malachra rudis* Benth.

***Malachra urens* Poit. ex Ledeb. & Alderstam** is an annual herb, up to 1 m high, with pubescent stems of different sizes and green to orange coloration. The leaves are simple, opposite and lobed, with up to three lobes relatively marked, with pubescence; the margins of the leaves are toothed, about 3–12 cm long. Inflorescences are peduncular racemes with acuminate, boat-shaped, pubescent bracts. Flowers have five petals, 2 to 3 cm in long, with a yellow color. Schizocarpic fruits have mericarps and pubescent bracts, with numerous seeds, up to 2 mm in long, dark colored, and flat (**Figure 7**) [4][8].

Figure 7. *Malachra urens* Poit.

***Malachra helodes* Mart.** is an annual herb, up to 1 m high. The stem is slightly pubescent with dark to light green coloration. The leaves are simple, opposite, and lobed, with up to five lobes that are well marked, with slightly marked pubescence on the underside; the margins of the leaves are serrated, about 3–10 cm long. Inflorescences are terminal and axillary racemes with the presence of acuminate bracts in the form of pubescent. The flowers have five petals, 2 to 3 cm in length, with a pink color. Schizocarpic fruits with mericarps and bracts with stem indumentum hispid; terminal inflorescence; pinkish flower; epicalyx absent; fruit, up to 4 mm in length; glabrous indumentum (**Figure 8**) [4][8].

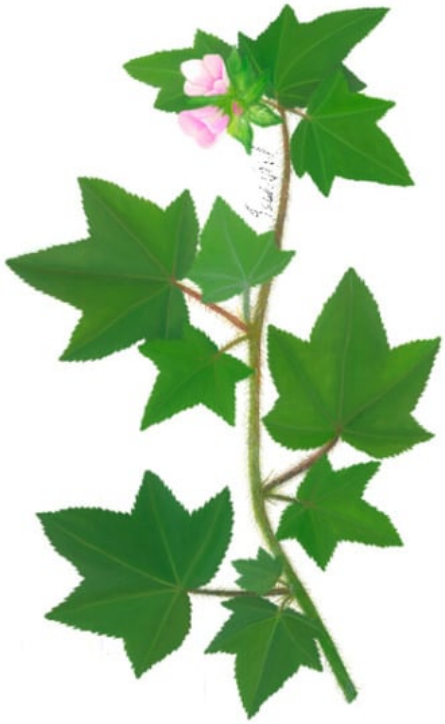

Figure 8. *Malachra helodes* Mart. ex Ledeb. & Alderstam.

2. Phytochemistry Species of the Genus *Malachra* L.

Phytoconstituents are chemical compounds that plants synthesize as a defense mechanism against biotic and abiotic environmental conditions; they play key roles in biological processes [5][6]. Many phytoconstituents isolated from the genus *Malachra* L., such as flavonoids, coumarins, carbohydrates, glycosides, triterpenes, alkaloids, tannins, and saponins, exhibit pharmacologic activity. **Table 1** lists the phytoconstituents reported only in *Malachra* species: *M. alceifolia* Jacq., *M. capitata* (L.) L., and *M. fasciata* Jacq, see **Figure 9** molecular structure of some compounds isolated from species of the genus *Malachra* L.

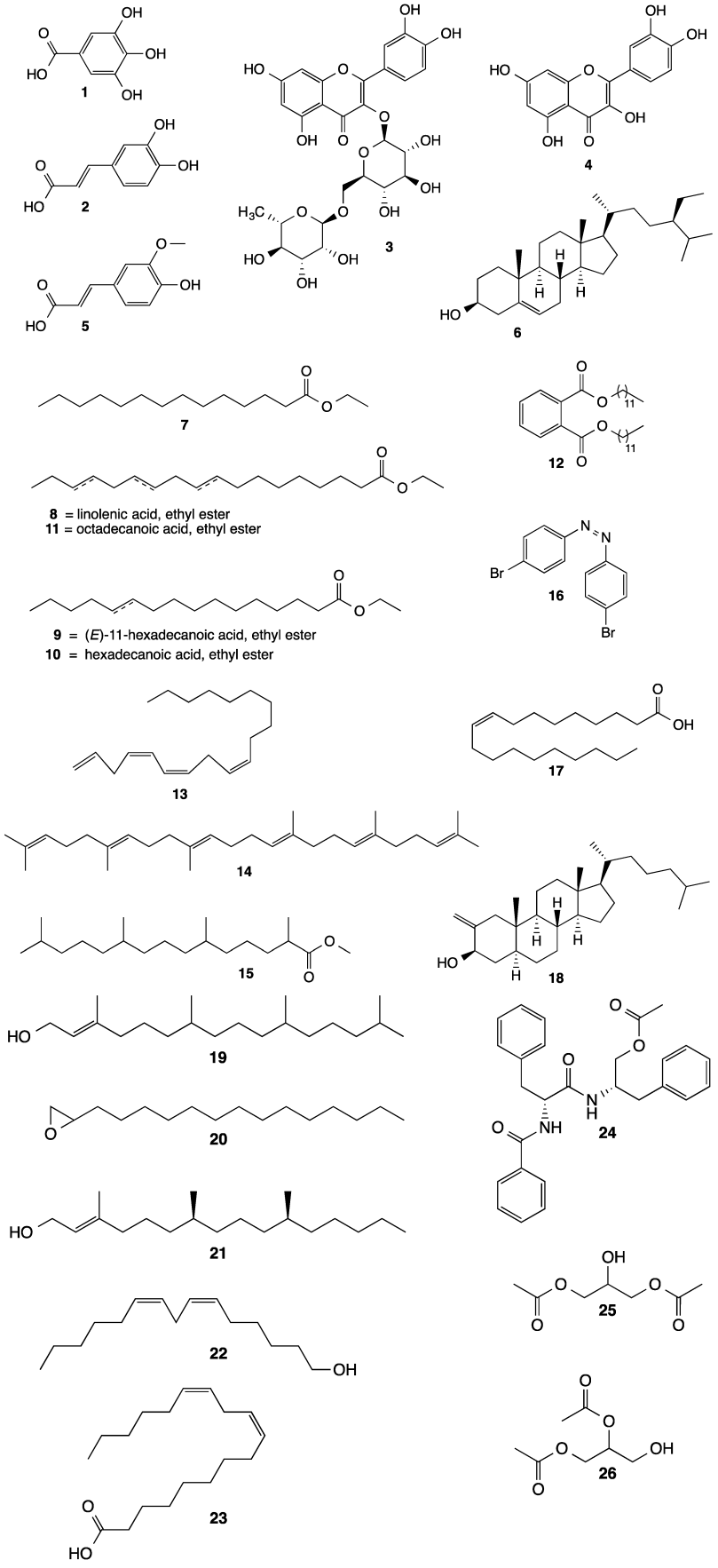

Figure 9. Molecular structure of some compounds isolated from species of the genus *Malachra* L.

Table 1. Major phytoconstituents identified in species of the genus *Malachra* L.

***Malachra* species**	**Plant Part Used**	**Phytoconstituents**	**Reference**
***Malachra alceifolia* Jacq.**	**Leaf**	**Flavonoids, steroids, triterpenes anthocyanins, leucoanthocyanins, saponins**	[9]
	Flowers	**Flavonoids, steroids, triterpenes anthocyanins, leucoanthocyanins**	

Malachra species	Plant Part Used	Phytoconstituents	Reference
Malachra capitata (L.) L.	Root	Gallic acid (1), caffeic acid (2), rutin (3), quercetin (4), ferulic acid (5)	[10][11]
	Leaf	Rutin, ferulic acid	
	Stem	Gallic acid	
	Whole plant	*β*-Sitosterol (6)	[12]
	Root	Carbohydrates, phenols, flavonoids, glycosides, triterpenes, alkaloids, tannins, saponins	[10][11]
	Root	Tetradecanoic acid, ethyl ester (7); linolenic acid, ethyl ester (8); (*E*)-11-hexadecenoic acid, ethyl ester (9); hexadecanoic acid, ethyl ester (10); octadecanoic acid, ethyl ester (11); didecyl phthalate (12); (*Z,Z,Z*)-1,4,6,9-nonadecatetraene (13); squalene (14)	[10][11]
	Stem	Tetradecanoic acid, ethyl ester; pentadecanoic acid, 2,6,10,14-tetramethyl methyl ester (15); linolenic acid, methyl ester; (*E*)-11-hexadecenoic acid, ethyl ester; octadecanoic acid, ethyl ester; (*Z,Z,Z*)-1,4,6,9-nonadecatetraene azobenzene, 4,4′-dibromo- (16); squalene	[13][14]
	Leaf	oleic acid (17) Cholestan-3-ol, 2-methylene-(3β,5α)- (18); Tetradecanoic acid, ethyl ester 3,7,11,15-tetramethyl-2-hexadecen-1-ol (19); Oxirane, tetradecyl- (20); (*E*)-11-hexadecenoic acid, ethyl ester Hexadecanoic acid, ethyl ester Phytol (21); (*Z,Z*) 6,9 pentadecadien-1-ol (22); (*Z,Z*) 9,12-octadecadienoic acid (23); octadecanoic acid, ethyl ester; squalene	[13][14]
Malachra fasciata Jacq.	Leaf	Flavonoids, glycosides, triterpenes, alkaloids, tannins, saponins, phlobatannins	[13][14]
	Leaf	Aurantiamide acetate (24)	[15]
	Leaf	1,3-Diacylglycerol (25) 1,2-Diacylglycerol (26)	[16]

Generally, organic compounds obtained from extracts, fractions, and isolated compounds of plant species possess unique structural characteristics among which the geometrical and energetic interactions of the atoms stand out; chirality and stereoisomers of molecular structures, intermolecular interactions, hydrogen bond acceptors and donors, molecular mass, diversity of ring systems, among others, become tools of interest for medicinal chemistry in drug development, to improve the potency, for pharmacokinetic properties, and to reduce the toxicity of new drugs [17]. However, the secondary

metabolites isolated from plant species constitute a group of chemical molecules with a great diversity of biological activities applied to the pharmaceutical, cosmetic, and food sectors [18].

Gallic acid (GA) is a phenolic compound with anti-inflammatory, antimicrobial, hepatoprotective, neuroprotective, and carcinogenic properties that prevent gastrointestinal, cardiovascular, metabolic, and neuropsychological diseases [19]. The livers of Wistar rats exposed to carbon tetrachloride in doses of 50 mg/kg and 100 mg/kg GA, were evaluated by decreasing serum liver enzymes, regulating the expression of proinflammatory genes, and regulating the expression of antioxidant genes [20]; mercuric chloride induced at 200 mg/kg, increased glutathione peroxidase, superoxide dismutase, and catalase activity, and decreased the level of glutathione in liver tissue [21]. Caffeic acid has antimicrobial potential against *Staphylococcus aureus* strains with MICs from 256 µg/mL to 1024 µg/mL [22]. The compound quercetin isolated from extracts and organic fractions of *Allium cepa* L., *Morus alba*, *Camellia sinensis*, *Moringa oleifera*, and *Centella asiatica,* at doses between 50 and 100 mg/kg, and evaluated in in vivo models, showed antiulcer activity [23]. Beta-sitosterol isolated chloroform extract of *Corchorus capsularis L.* leaves has been shown to exhibit a significant effect against trypanothione reductase *Leishmania donovani* promastigotes at IC_{50} = 17.7 ± 0.43 µg/mL [24], and the dipeptide aurantiamide acetate patent has an effect of resisting influenza virus and an inhibition effect on a cytopathic effect mediated by the influenza A virus CN106431960B, filing date: 11 November 2018, legal status: active [25].

3. Species of the Genus *Malachra* L. with Pharmacological Activity

Applications of plant remedies in traditional medicine are still central in the health systems in some countries of world [26]. The biogenesis and biosynthesis of phytoconstituents in plant species provide an opportunity for medicinal chemistry to advance pharmacological studies for treating pathologies that have been little studied [27]. **Table 2** summarizes the most important pharmacological activities reported for the genus *Malachra* L., such as antidiarrheal, anti-epileptic, antiulcerogenic, antioxidant, anticonvulsant, hepatoprotective, antiviral, anticancer, antibacterial, and anthelmintic properties. The bibliographic search describes only the pharmacological activities of *M. alceifolia* Jacq., *M. capitata* (L.) L., and *M. fasciata* Jacq.

Table 2. Summary of the species of the genus *Malachra* L. with reported pharmacological activity.

Malachra Species	Plant Part Used	Extract/Compounds	Pharmacological Activity	Concentration	Method	Major Findings	Reference
M. alceifolia Jacq.	Leaf	Ethanolic	Antiplasmodial	10 µg/mL	*In vitro Plasmodium falciparum* 152.2 ± 28.6 nM Chloroquine control	Inhibitory activity on *P. falciparum* ferriprotoporphyrin biomineralization inhibition	[28][29]
	Shoot	Ethanolic	Antiplasmodial	77 µg/mL	*In vitro Plasmodium falciparum* (3D7) chloroquine (concentration no report)	Inhibitory activity on *P. falciparum*	[30]

Malachra Species	Plant Part Used	Extract/Compounds	Pharmacological Activity	Concentration	Method	Major Findings	Reference
	Leaf	Ethanolic	Antibacterial	62.5 ppm	*In vitro* MIC	Inhibition of the growth of *Propionibacterium acnes* (ATCC 6919)	[31]
		Aqueous	Antidiarrhoeal	200 and 400 mg/kg	*In vivo* oral administration to Wistar rats; castor oil-induced diarrhoea, enteropooling, and small intestinal transit; 5 mL/kg, p.o diphenoxlate control	Decreases intestinal transit	[32]
		Aqueous	Anti-epileptic	250 and 500 mg/kg	*In vivo* maximal electroshock (MES) and pentylenetetrazole (PTZ)-induced seizuresmodels in albino Wistar rats, pentylenetetrazol control	Anticonvulsant activity against MES and PTZ animal models	[32]
M. capitata (L.) L.	Shoot	Aqueous	Anti-ulcerogenic	200 mg/kg y 400 mg/kg	*In vivo* oral administration to Wistar rats pylorus ligated model, 50mg/kg, p.o ranitidine control	Reduce the gastric acid secretion of pylorus	[33]
		Aqueous	Antioxidant	200 y 400 mg/kg	*In vivo* oral administration to Wistar rats	*In vivo* oral administration to Wistar rats pylorus ligated model, 50mg/kg, p.o ranitidine control	[34]
		Aqueous	Hepatoprotective	100, 200 y 400 mg/kg	*In vivo* oral administration to Wistar rats, carbon tetrachloride CCl_4 induced hepatotoxicity	Reduced levels of the hepatic enzymes SGOT, SGPT, alkaline phosphatase (ALP), and acid phosphatase (ACP)	[35]
	Leaf silver nanoparticles (AgNPs)	Methanol	Antibacterial	1 ppm	*In vitro* MIC	Nanoparticles bactericidal *Bacillus subtillis*, *Micrococcus luteus*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*	[36]
	Leaf	Methanolic Chloroform Benzene	Antibacterial	50 mg/mL	*In vitro* MIC	Inhibition of the growth of *Escherichia coli*, *Listeria monocytogenes*	[37]

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Malachra Species	Plant Part Used	Extract/Compounds	Pharmacological Activity	Concentration	Method	Major Findings	Reference
Malachra fasciata	Leaf	Chloroform/ Aurigtamide acetate	Antimicrobial	30 µg	*In vitro* MIC	Inhibition of the growth of *P. aeruginosa*, *B. subtilis*, *C. albicans*	[21]
	Leaf	Unknown	Phototoxic (photosensitization)	Unknown	*In vivo* sheep females and male	Cause of primary photodermatitis in sheep ingestion leaf	[35]
	Leaf	Chloroform	Antifungal	30 µg	*In vitro* MIC	Inhibition of the growth of *Aspergillus niger*	[21]
	Leaf	Flavonoids	Antimutagenic	8 mg/kg	*In vitro* micronucleus test induced using mitomycin (MC, 32%	Reduce the number of micronucleated polychromatic erythrocytes (MPCE)	[22]

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