Medicinal properties of genus *Chenopodium* Linn.

Neerja Yadav, Neeru Vasudeva, Sumitra Singh and Surendra K Sharma*

Pharmacognosy Division, Faculty of Pharmaceutical Sciences
Guru Jambheshwar University, Hisar-125 001, Haryana, India
*Correspondent author, E-mail: drsks_gjuhsr@yahoo.co.in

Received 22 August 2005; Accepted 6 October 2006

Abstract

In Ayurveda ***Chenopodium* Linn.** is well-known for its applications in the treatment of various ailments like pectoral complaints, cough, abdominal pain, pulmonary obstruction and in nervous affections. On the basis of recent pharmacological studies some additional medicinal properties of various species of the genus have been established. In the present paper an attempt has been made to summarize the traditional uses and reported biological activities of the genus for further studies.

Keywords: *Chenopodium*, Traditional uses, Pharmacological properties.

IPC code; Int. cl.[8]—A61K 36/00, A61P 17/04, A61P 33/10, A61P 37/00

Introduction

The genus ***Chenopodium* Linn**. (Family–Chenopodiaceae) is native plant of western Asia. In India it is represented by about 21 species, of which some are cultivated for vegetable and a few for grain. ***C. album* Linn.** (Lamb's Quarter) is commonly used for food and medicinal values; it is known by various vernacular names, viz. *Bathu sag* (Hindi), *Chandan betu* (Bengali), *Parupukkirai* (Tamil), *Pappukura* (Telgu) and *Katu ayamoddakam* (Malyalam) and grows in waste places and as weed in wheat or other crops in almost all parts of the world[1]. In India the plant is being used since ancient times. In *Rig Veda,* it is reported to cure all diseases. In *Atharva Veda* (Vaidyakakalpa), it is reported to be beneficial in piles, clearing worms and act as a laxative. *Charaka Samhita* has mentioned that it enhances digestive power. *Sushruta Samhita* reports that it is pungent, enhances memory, appetite, digestive power, strength of the body and destroys all worms. *Rajanighantu* has mentioned that it is sweet, cooling, increases appetite, antipyretic and useful in piles. In Ayurveda it is reported to be useful in curing anorexia, cough, dysentery, diarrhoea, oedema, piles and kills small worms[2].

Traditional uses

Many species of Chenopodium are being used traditionally in indigenous systems of medicine for the treatment of numerous ailments. ***C. album*** improves the appetite, acts as anthelmintic, laxative, diuretic and tonic. It is also useful in biliousness, *vata* and *kapha*, abdominal pain and eye diseases. It is used in the form of pot herb in piles. The finely powdered leaves are used as a dusting powder about the external genitalia in children[3].

In South America, ***C. ambrosioides* Linn.** (Mexican Tea, Indian worm seed) infusions made from the leaves and seeds have been a household remedy against intestinal parasites from time immemorial. In Europe, plant is used in pectoral complaints and in nervous affections. In Brazil an infusion of the herb is considered carminative, diaphoretic and emmenagogue. It is given in compression cough, pulmonary obstruction and amenorrhea. It is recommended for the expulsion of the dead foetus. In Madagascar and La Reunion, the juice of the plant is taken as a vermifuge. In France and Southern Europe, ***C. botrys* Linn.** (Feather Geranium) is used in catarrh and humoral asthma and said to be a good substitute for ***C. ambrosioides***[3].

Chenopodium album

Biological activities

Chenopodium spp. possess immense traditional applications but a few species have been screened for their biological activity. The experimental results have shown a wide spectrum of such effects; some of them have been discussed and summarized (Table 1) below.

Antipruritic and antinociceptive activity

The ethanolic extract of the fruits of ***C. album*** has shown to inhibit scratching behaviour induced by 5-HT (5-hydroxytryptamine) at the dose of 100, 200 and 400 mg/kg. It is well known that 5-HT not only facilitates the inflammatory pain by itself, but also potentiates pain introduced by other inflammatory mediators, such as noradrenaline and prostaglandin E. Therefore, the antinociceptive effect of the extract may be mediated by inhibition of 5-HT. The extract significantly attenuated the writhing responses induced by acetic acid (i.p.) and the inflammatory pain response induced by an intraplanetary injection of formalin in mice. At a dose of 400 mg/kg, it also inhibited the neurogenic pain response of formalin test. The species has been clinically used for the treatment of cutaneous pruritus[4]. The methanolic extract of the leaves of ***C. ambrosioides*** administered at 100 and 200 mg/kg (i.p.) produced an inhibition of the carrageenan-induced rat paw oedema and a reduction in writhings induced by acetic acid in mice. It also exhibited antipyretic effect[5].

Table 1 : Biological activities of *Chenopodium* spp.

S. No	Species	Part/extract	Activity
1	***C. album***	Fruit (ethanol extract)	Antipruritic, Antinociceptive
2	***C. ambrosioides***	Leaf (methanol extract)	Antipruritic, Antinociceptive
		Aerial part (Acetone and aqueous extract), Whole plant (aqueous extract)	Antimicrobial Anthelmintic
		Aerial part (essential oil)	Induces tumour, Vermifuge
3	***C. amaranticolor***	Leaf	Antiviral, Haemagglutination
4	***C. quinoa***	Seed (saponin fraction)	Antifungal, Immunomodulatory
5.	***C. botrys***	Aerial part (essential oil)	Antibacterial
6	***C. multifidum***	Aerial part (aqueous extract)	Cytogenitic
7	***C. anthelmenticum***	Essential oil	Cytotoxic
8	***C. murale***	Leaf (ethanol extract)	Cytotoxic, Hypotensive
		Aerial part (flavonoid)	
9	***C. chilense***	Aerial part (methanol extract)	Spasmolytic

Antimicrobial activity

The acetone and water extracts of aerial parts of ***C. ambrosioides*** have shown activity against the drug resistant strain of *Mycobacterium tuberculosis* (CCK028469V) at concentration of 0.1mg/ml[6]. Leaf extract of ***C. amaranticolor*** **Coste & Reyn.** has two protein like substances which manifest the antiviral activity against *Tobacco mosaic* virus (TMV)[7]. The total saponin fraction of seeds of ***C. quinoa*** **Willd.** (Quinoa) was found to inhibit the growth of *Candida albicans* (ATCC 10231) at 50µg/ml. Individual saponins did not exhibit any comparable effect[8]. The essential oil (0.43% w/w) isolated from aerial parts of ***C. botrys*** exhibited significant bactericidal and fungicidal activity (Table 2) against selected strains of microorganisms, viz. *Staphylococcus aureus* ATCC 25923, *Bacillus subtilis* ATCC 6633, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Aspergillus niger* ATCC 16404, *Candida albicans* ATCC 10259,

Table 2 : Antimicrobial activity of the essential oil of *Chenopodium botrys*

Microorganism	MBC[a] (%)	1:25[b]	1:50[b]
Staphylococcus aureus ATCC 25923	0.025	26	30
Bacillus subtilis ATCC 6633	0.012	25	26
Escherichia coli ATCC 25922	0.4	22	24
Pseudomonas aeruginosa ATCC 27853	0.4	15	16
Pseudomonas aeruginosa ATCC 9027	0.4	22	22
Sarcina lutea ATCC 9431	0.05	23	25
Klebsiella pneumoniae ATCC 29665	0.4	25	25
Salmonella enteridis ATCC 13076	0.4	25	25
Shigella flexneri 119x	0.2	19	19
Aspergillus niger ATCC 16404	0.1	13	15
Candida albicans ATCC 10259	0.2	20	20

[a]MBC= Minimal Bactericide Concentration

[b]Dilution of essential oil in absolute ethanol, V/V

Pseudomonas aeruginosa ATCC 9027, *Sarcina lutea* ATCC 9341, *Klebsiella pneumoniae* ATCC 29665, *Salmonella enteridis* ATCC 13076 and *Shigella flexneri* 119x (Ref. 9).

Cytogenetic activity

Aqueous extract of aerial part of the ***C. multifidum*** **Linn.** has shown cytogenetic effect. This effect was due to ascaridole which is a terpene peroxide with a high oxidation capacity that reduces locomotion activity. This activity was enhanced by methanephrine. Administration of 300mg/kg of ascaridole in mice produced convulsions and lethal toxicity. Hence, it could be inferred that ascaridole has possible sedative and analgesic effects and oxidized related forms could be the pharmacological active principles of the aqueous extracts of the species[10].

Anthelmintic activity

Oil of Chenopodium obtained from flowering and fruiting shoot of ***C. ambrosioides*** is an anthelmintic drug, used against tapeworms, hookworms and roundworms[11]. Infusions and decoctions of the leaves, roots and inflorescences of this herb are used for killing of intestinal worms. The decoctions containing up to 300mg dry plant material per kg body weight has shown positive response against ascariasis[12].

Cytotoxic activity

Ascaridol isolated from the oil of ***C. anthelminticum*** **Linn.** (American wormseed) has shown activity against different tumour cell line *in vitro*, viz. HL60, MDA-MB-231, CCRF-CEM[13]. The oil of ***C. ambrosioides*** have been found to induce tumour in the liver of the Egyptian toad *Bufo regularis*. The average latent period of tumour induction was 3.6 ± 0.4 months[14]. The ethanolic extract of leaves of ***C. murale*** **Linn.** (Swinebane) has shown cytotoxic activity on human amniotic epithelia cell line (FL cells). The IC_{50} of ethanolic extract of the species was 28µg/ml[15].

Immunomodulatory activity

Saponins isolated from the seeds of ***C. quinoa***, when co-administered with cholera toxin (CTX) or ovalbumin (OVA), have shown to potentiate specific IgG and IgA antibody responses to the antigen in serum, intestinal and lung secretions. The saponins co-administered with the antigens evoked enhanced antibody responses to CTX and OVA, when compared to responses elicited with the administration of antigens alone. The antigen specific IgG antibodies were characterized by increase of the IgG_1 subclass, but not IgG_{2a}. The IgG_1 subclass is associated with the stimulation of $CD4^+$ T cells of the Th_2 subset, which prime for the production of secretory IgA responses at mucosal sites[16]. The production of systemic and mucosal immune responses by oral or intranasal immunization requires the repeated administration of large amounts of antigen[17]. The potentiating effect of the saponin appeared, to some extent, mediated by an increase permeability of the mucosa, allowing an increase uptake of the antigen. Hence, they acted as immunological adjuvants[18].

Hypotensive activity

Kaempferitrin (Kaempferol-3, 7-dirhamnoside) and the total flavonoid mixture isolated from the aerial parts of ***C. murale*** have induced dose related hypotension and bradycardia in rabbits. Kaempferitrin did not block α-1 or β-1-adrenoreceptors when tested using isolated guinea pig aortic strip and atria[19].

Haemagglutination activity

Haemagglutinin (CLH) isolated from the leaves of ***C. amaranticolor***, agglutinated rabbit erythrocyte but did not agglutinate any of the groups A, B or O of human blood. CLH also inhibited protein synthesis in rat thymocytes at a high concentration (50µl)[20, 21].

Trypanocidal activity

Aerial parts of ***C. ambrosioides*** contain four monoterpene hydroperoxides, viz. (–)-(2*S*,4*S*)-*p*-mentha-1(7), 8-dien-2-hydroperoxide, (–)-(2*R*,4*S*)-*p*-mentha-1(7),8-dien-2-hydroperoxide, (–)-(1*R*,4*S*)-*p*-mentha-2,8-dien-1-hydroperoxide, (–)-(1*S*,4*S*)-*p*-mentha-2,8-dien-1-hydroperoxide along with ascaridole. The compounds have shown anti-trypanosomal activity. *In vitro* trypanocidal activities of ascaridole and monoterpene hydroperoxides against epimastigotes of *Trypanosoma cruzi* were 23, 1.2, 1.6, 3.1 and 0.8 µm, respectively[22].

Spasmolytic activity

The methanolic extract of the aerial portion of ***C. chilense*** **Schrad.**, has shown spasmolytic activity in acetylcholine contracted rat ileum. The extract was found to be non-toxic both for rat and brine shrimp *Artemia salina* in acute toxicity test[23].

Miscellaneous

Ascaridole less infusion of the ***C. ambrosioides*** contained a nematocide(s) that was not toxic to the mammalian smooth muscle, thereby authenticating the traditional use of its infusion as a safe vermifuge[24]. Cryptomeridiol isolated from the seeds of ***C. album*** has shown significant growth promoting activity[25]. Phenolic amide, N-*trans*-feruloyl-4-*O*-methyldopamine isolated from the roots of this species has shown attracting activity towards zoospores of *Aphanomyces cochlioides* at concentration of 0.01µm[26].

Conclusion

The medicinal properties of *Chenopodium* spp., discussed in this paper highlighted significant traditional and pharmacological activities of these herbs. The active constituents can be isolated and further evaluated for the development of useful drugs from these commonly available weeds or cultivated leafy vegetables.

References

1. Bhattacharjee SK, Handbook of Medicinal Plant, Pointer Publishers, Jaipur, 3rd Edn, 2001, pp. 1-2.
2. Bakshi DNG, Sensarma P and Pal DC, A Lexicon of Medicinal plants in India, Naya Prakash, Calcutta, 1999, pp. 424-425.
3. Kirtikar KR and Basu BD, Indian Medicinal Plants, International Book Distributor, Dehra Dun, Reprint, 1987, Vol. 3, pp. 2070-2076.
4. Dai Y, Ye WC, Wang ZT, Matsuda H, Kubo M and But PPH, Antipruritic and antinociceptive effects of *Chenopodium album* L. in Mice, *J Ethnopharmacol,* 2002, **81**, 245-250.
5. Olajide OA, Awe SO and Makinde JM, Pharmacological screening of the methanolic extract of *Chenopodium ambrosioides, Fitoterapia*, 1997, **68**, 529-532.
6. Lall N and Meyer JJM, *In vitro* Inhibition of drug-resistant and drug-sensitive strains of *Mycobacterium tuberculosis* by ethnobotanically selected South African plants, *J Ethnopharmacol,* 1999, **66**, 347-354.
7. Oliveira MM, Sampaio MR, Noronha AB, Vicente M and Vianna S, Detection of antiviral and antitumoral fractions of *Chenopodium amaranticolor* leaf extract, *Microbios,* 1993, **76**, 213-221.
8. Woldemichael GM and Wink M, Identification and biological activities of triterpenoid saponins from *Chenopodium quinoa*, *J Agric Food Chem*, 2001, **49**, 2327-2332.
9. Maksimovic ZA, Dordevic S and Mraovic M, Antimicrobial activity of *Chenopodium botrys* essential oil, *Fitoterapia,* 2005, **76**, 112-114.
10. Gadano A, Gurni A, Lopez MN, Lopez P, Gratti A, Baren CV, Ferraro G and Carballo M, Cytogenetic effects of aqueous extracts of the medicinal plant paico (*Chenopodium multifidium* L.), *Pharm Biol,* 2000, **38**, 7-12.
11. Chandler AC and Read CP, Introduction to Parasitology with special Reference to the Parasites of Man, Wiley, 2nd Edn, 1961, pp. 450-457.
12. Kliks MM, Studies on the traditional herbal anthelmintic *Chenopodium ambrosioides* L.: ethnopharmacological evaluation and clinical field trials, *Soc Sci Med,* 1985, **21**, 879-886.
13. Efferth T, Olbrich A, Sauerbrey A, Ross DD, Gebhart E and Neugebau M, Activity of ascaridol from the anthelmintic herb *Chenopodium anthelminticum* L. against sensitive and multidrug resistant tumor cells, *Anticancer Res,* 2002, **22**, 4221-4224.
14. El-Mofty MM, Khudoley VV, Sakr SA and Ganem NF, Induction of neoplasms in Egyptian toads *Bufo regularis* by oil of *Chenopodium*, *Oncology,* 1992, **49**, 253-255.
15. Awadh Ali NA, Julich WD, Kusnick C and Lindequist U, Screening of Yemeni medicinal plants for antibacterial and cytotoxic activities, *J Ethnopharmacol,* 2001, **74**, 173-179.
16. Kramer DR, Sutherland RM, Bao S and Husband AJ, Cytokine mediated effects in mucosal immunity, *Immunol Cell Biol*, 1995, **73**, 389-396.
17. Aizpurua HJ and Russell-Jones GJ, Oral vaccination identification of classes of proteins that proke an immune response upon oral feeding, *J Exp Med*, 1988, **167**, 440-451.
18. Estrada A, Li B and Laarveld B, Adjuvant action of *Chenopodium quinoa* saponins on the induction of antibody responses to intragastric and intranasal administered antigens in mice, *Comp Immunol Microbiol Infect Dis,* 1998, **21**, 225-236.
19. Gohar AA and Elmazar MMA, Isolation of hypotensive flavonoids from *Chenopodium* species growing in Egypt, *Phytother Res,* 1997, **11**, 564-567.
20. Suseelan KN, Sainis KB and Mitra R, Characterization and biological activities of *Chenopodium* leaf hemagglutinin (CLH), *Indian J Biochem Biophys,* 2001, **38**, 193-198.
21. Suseelan KN and Mitra R, Purification and characterization of a hemagglutinin isolated from the leaves of *Chenopodium* (*Chenopodium amaranticolor*), *Indian J Biochem Biophys,* 2001, **38**,186-192.
22. Kiuchi F, Itano Y, Uchiyama N, Honda G, Tsubouchi A, Nakajima-Shimada J and Aoki T, Monoterpene hydroperoxides with trypanocidal activity from *Chenopodium ambrosioides, J Nat Prod,* 2002, **65**, 509-512.
23. Garcia R, Lemus I, Rivera P and Erazo S, Biological and chemical study of paico (*Chenopodium chilense*, Chenopodiaceae), *J Ethnopharmacol,* 1997, **57**, 85-88.
24. MacDonald D, Vancrey K, Harrison P, Rangachari PK, Rosen feld J, Warren C and Sorger G, Ascaridole-less infusions of *Chenopodium ambrosioides* contain a nematocide(s) that is (are) not toxic to mammalian smooth muscle, *J Ethnopharmacol,* 2004, **92**, 215-221.
25. Bera B, Mukherjee KK and Ganguly SN, Chemical investigation of the seeds of diploid cytotypes of *Chenopodium album, Fitoterapia,* 1991, **62**, 178.
26. Horio T, Yoshida K, Kikuchi H, Kawabata J and Mizutani J, A phenolic amide from roots of *Chenopodium album*, *Phytochemistry,* 1993, **33**, 807-808.