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
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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 (Malayalam) and grows in waste places and as weed in wheat or other crops in almost all parts of the world1. In India the plant is being used since ancient times. In Rig Veda, it is reported to cure all diseases. In Atharva Veda (Vaidyakalpa), 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 worms3.

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 an 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 children3.

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. ambrosioides3.

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 intraplantar 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. 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.

Table 1: Biological activities of *Chenopodium* spp.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Species</th>
<th>Part/extract</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>C. album</em></td>
<td>Fruit (ethanol extract)</td>
<td>Antipruritic, Antinociceptive</td>
</tr>
<tr>
<td>2</td>
<td><em>C. ambrosioides</em></td>
<td>Leaf (methanol extract)</td>
<td>Antipruritic, Antinociceptive</td>
</tr>
<tr>
<td>3</td>
<td><em>C.amaranticolor</em></td>
<td>Aerial part (Acetone and aqueous extract), Whole plant (aqueous extract)</td>
<td>Anthelmintic</td>
</tr>
<tr>
<td>4</td>
<td><em>C. quinoa</em></td>
<td>Seed (saponin fraction)</td>
<td>Antiviral</td>
</tr>
<tr>
<td>5</td>
<td><em>C. botrys</em></td>
<td>Aerial part (essential oil)</td>
<td>Antimicrobial</td>
</tr>
<tr>
<td>6</td>
<td><em>C. multiformis</em></td>
<td>Aerial part (aqueous extract)</td>
<td>Anthelmintic</td>
</tr>
<tr>
<td>7</td>
<td><em>C. anhelmenticum</em></td>
<td>Essential oil</td>
<td>Anthelmintic</td>
</tr>
<tr>
<td>8</td>
<td><em>C. murale</em></td>
<td>Leaf (ethanol extract)</td>
<td>Antiviral, Haemagglutination</td>
</tr>
<tr>
<td>9</td>
<td><em>C. chilense</em></td>
<td>Aerial part (methanol extract)</td>
<td>Antiviral, Haemagglutination</td>
</tr>
</tbody>
</table>

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. Leaf extract of *C. amaranticolor* Coste & Reyn. has two protein like substances which manifest the antiviral activity against *Tobacco mosaic virus* (TMV). 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. 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, *Salmonella enteridis* ATCC 13076, *Shigella flexneri* 119s, and *Candida albicans* ATCC 10259.

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

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>MBC (%)</th>
<th>1:25</th>
<th>1:50</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em> ATCC 25923</td>
<td>0.025</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td><em>Bacillus subtilis</em> ATCC 6633</td>
<td>0.012</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td><em>Escherichia coli</em> ATCC 25922</td>
<td>0.4</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em> ATCC 27853</td>
<td>0.4</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em> ATCC 9027</td>
<td>0.4</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td><em>Sarcina lutea</em> ATCC 9431</td>
<td>0.05</td>
<td>23</td>
<td>25</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em> ATCC 29665</td>
<td>0.4</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td><em>Salmonella enteridis</em> ATCC 13076</td>
<td>0.4</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td><em>Shigella flexneri</em> 119s</td>
<td>0.2</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td><em>Aspergillus niger</em> ATCC 16404</td>
<td>0.1</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td><em>Candida albicans</em> ATCC 10259</td>
<td>0.2</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

*MBC*: Minimal Bactericide Concentration

* Dilution of essential oil in absolute ethanol, V/V
Pseudomonas aeruginosa ATCC 9027, Sarcina lutea ATCC 9341, Klebsiella pneumoniae ATCC 29665, Salmonella enteriditis 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 species10.

Anthelmintic activity

Oil of Chenopodium obtained from flowering and fruiting shoot of C. ambrosioides is an anthelmintic drug, used against tapeworms, hookworms and roundworms11. 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 ascariasis12.

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-CEM13. 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 months14. The ethanolic extract of leaves of C. murale Linn. (Swinebane) has shown cytotoxic activity on human amniotic epithelia cell line (FL cells). The IC50 of ethanolic extract of the species was 28µg/ml15.

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 IgG1 subclass, but not IgG2a. The IgG1 subclass is associated with the stimulation of CD4+ T cells of the Th2 subset, which prime for the production of secretory IgA responses at mucosal sites16. The production of systemic and mucosal immune responses by oral or intranasal immunization requires the repeated administration of large amounts of antigen17. 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 adjuvants18.

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 atria19.

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. (–)-(2S,4S)-p-mentha-1(7), 8-dien-2-hydroperoxide, (–)-(2R,4S)-p-mentha-1(7), 8-dien-2-hydroperoxide, (–)-(1R,4S)-p-mentha-2,8-dien-1-hydroperoxide, (–)-(1S,4S)-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, respectively22.

Spasmolytic activity

The methanolic extract of the aerial portion of C. chilenense 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 test23.
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. Cryptomeridol isolated from the seeds of *C. album* has shown significant growth promoting activity. Phenolic amide, N-trans-feruloyl-4-O-methylxanthine isolated from the roots of this species has shown attracting activity towards zoospores of *Aphanomyces cochlioides* at concentration of 0.01μM.

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

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