



## ***Amaranthus spinosus*- A review**

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### **ABSTRACT**

*Amaranthus spinosus*, belongs to *Amaranthaceae* family, is an annual or perennial herb grows annually as an erect, monoecious herb with greenish or purplish stem color widely distribution throughout the United States of America, and all tropical and subtropical regions of Africa, Southeast Asia and India. Traditionally, the plant is widely used to cure many diseases all over the world. Pharmacologically, *Amaranthus spinosus* contains medicinal properties like antioxidant, hepatoprotective, anti-inflammatory, anti-malarial, anti-tumour, anti-pepticulcer, anti-nociceptive, anti-bacterial, anti-helminthic, anti-diabetic and other activities. The plant also contains some of the biologically active constituents which provide medicinal values to the plant and hence can be further investigated and utilized in folklore system of medicine as drug.

**KEY WORDS:** *Amaranthus spinosus*, Pharmacological, Medicinal uses.

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### **INTRODUCTION**

#### **Scientific classification / Taxonomy**

<b>Kingdom</b>	: Plantae
<b>Subkingdom</b>	: Viridiaeplantae
<b>Phylum</b>	: Magnoliophyta
<b>Subphylum</b>	: Euphyllophytina
<b>Class</b>	: Magnoliopsida
<b>Subclass</b>	: Caryophyllidae
<b>Order</b>	: Caryophyllales
<b>Suborder</b>	: Chenopodiineae
<b>Family</b>	: Amaranthaceae
<b>Genus</b>	: Amaranthus
<b>Species</b>	: spinosus L.
<b>Botanical name</b>	: <i>Amaranthus spinosus</i> L

#### **Vernacular Names**

**English:** Spiny amaranth, Pig weed, Thorny amaranth, Prickly Amaranth, Needle burr.

<b>Sanskrit</b>	: Meghanada, Alpamarisha, Tandula, Tanduliuyah.
<b>Kannada</b>	: Mulla-dantu, Mulla harave soppu.
<b>Hindi</b>	: Kantamiris, Kantabhaji, Kataili-chaulai, Kantanatia.
<b>Gujarati</b>	: Kantalo dhimdo, Kantanu dant, Tandaljo.
<b>Telugu</b>	: Mundla kura, Nalladoggali, Mullatotakura.
<b>Tamil</b>	: Mud-kerrai, Mullukeerai.
<b>Malayalam</b>	: Kattumullenkeera, Mullan-cheera.

#### **General description**

*Amaranthus spinosus*, Amaranthaceae, is an annual or perennial herb, believed to originate from low and tropical south and Central America and was introduced into warmer parts of the world. This weed has a wide distribution including the United States of America, and all tropical and subtropical regions of Africa,

Southeast Asia and India. *Amaranthus spinosus* grows annually as an erect, monoecious herb, up to 100-300cm tall, much branched. Stems are hard, obtusely angular, glabrous, often greenish to purple in colour with a simple and alternate leaves without stipules. The leaf blade is 3.5 – 11cm x 1-4.5 cm long. The leaves have a characteristic odour with bitter taste. The flowering season is throughout the year. The flowers are numerous, sessile, axillary. Male flowers are perianth, 2.5 – 3 mm long, 5 sepals, ovate, acute, bristle - pointed. Female flowers are perianth, 1.5 mm long, 5 sepals. The ripe fruit is ovoid with a compressed, shiny, tiny, dark red to black coloured seeds. The plant has a long history usage in traditional medicine against various ailments in the world [1]. The plant is also used as green vegetables and cultivated in all over the India [2, 3].

#### **Chemical constituents**

*Amaranthus spinosus* contains 7-p-coumaroyl apigenin 4-o-beta-D-glucopyranoside, a new coumaroyl flavone glycoside called spinoside, xylofuranosyl uracil, beta – D-ribofuranosyl adenine, beta-sitosterol glucoside, hydroxycinnamates, quercetin and kemferol glycoside [4], betalins, betaxanthin, betacyanin, amaranthine and isomaranthine, gomphrenin, betanin, stigmasterol, linoleic acid, 0.15% rutin and beta-carotene [5-7].

#### **TRADITIONAL USES**

Juice of *Amaranthus spinosus* is used by tribals of Kerala, to prevent swelling around stomach. The leaves are boiled without salt and consumed for 2-3 days to cure jaundice and also employed to cure some kind of rheumatic pain and stomach ache. The leaves and roots are applied as poultice to relief bruises, abscesses, burns, wound, inflammation, monorrhagia, gonorrhoea and eczema. It is also used as a sudorific and febrifuge. In Napalese, *Amaranthus spinosus* is used to induce abortion. In many parts of Africa, it is in nutritional deficiency disorders and various other diseases. In Ayurvedic, plants regarded as emmenagogue and galactagogue used for refrigerant, diuretic, and purgative, as an enema for stomach problem, piles, against cholera. A decoction of plant increases digestion, and also used for kidney complaints and mouth wash for toothache. The leaves are boiled and root is given to the children for laxative. The whole plant is used for the treatment of snake-bit, and thus acts as an antidote to snake-venom. The root paste in equal volume of honey is used to control vomiting [8,9].

#### **PHARMACOLOGICAL ACTIVITY**

##### **Antioxidant and Hepatoprotective activity**

Hussain Zeashen *et al.*, [10] studied hepatoprotective and antioxidant activity of ethanolic extract of whole plant of *Amaranthus spinosus* against carbon tetrachloride (CCl<sub>4</sub>) induced hepatic damage in rats. The results of this study strongly indicate that whole plants of *Amaranthus spinosus* have potent hepatoprotective activity. This might be due to the presence of antioxidant defense factors such as flavonoids and phenolics compound present in the ASE. They also reported that 50% ethanolic extract of ASE showed antioxidant and hepatoprotective activity in invitro.

Hussain Zeashen *et al.*, [11] had reported the hepatoprotective activity of *Amaranthus spinosus* Linn. against d-galactosamine/lipopolysaccharide (d-GalN/LPS) – induced liver injury in rats. Results of this study revealed that *Amaranthus spinosus* extract shows a significant protection against (d-GalN/LPS) – induced hepatocellular injury.

Srinivasa *et al.*, [12] has reported the methanolic extract of whole plant of *Amaranthus spinosus* for hepatoprotective activity against paracetamol (PCM) (3gm/kg o.p) induced liver damage in wistar rats. Presence of compounds such as aminoacids, flavonoids and phenolic compounds in the methanolic extract was responsible for its chemoprotective and antioxidant activities against paracetamol induced liver damage in wistar rats.

They also reported the antioxidant activity of *Amaranthus spinosus* by non-enzymatic haemoglycosylation [13]. They investigated the activity of different extracts by estimating the degree of haemoglycosylation at 520nm, measured colorimetrically. The result showed that rutin and quercetin showed the inhibition of haemoglycosylation as maximum as 42% and 52% respectively at two different concentrations; 0.5 and 1 mg/ml. The  $\alpha$ -tocopherol (Vitamin E) acts as a standard.

Ashok Kumar *et al.*, [14] also reported that methanolic extract of *Amaranthus spinosus* leaves exhibited a antioxidant and antipyretic property. 1,1-diphenyl-2-picryl-hydrazole (DPPH) free radical scavenging, superoxide anion radical scavenging, hydroxyl free radical scavenging, nitric oxide radical scavenging and ABTS radical scavenging assay was measured to determine the antioxidant activity. Total phenolic content was also measured. Antipyretic activity was measured by yeast induced pyrexia method. 200 and 400 mg/kg of methanolic extract of *Amaranthus spinosus* serves as a treatment doses. Paracetamol used as a standard drug.

**Anti-diabetic activity**

Ashok Kumar *et al.*, [15] proved, *invitro* study of an alpha amylase and antioxidant potential of methanol extract of *Amaranthus spinosus* that exhibits alpha amylase enzyme inhibition by CNPG<sub>3</sub> (2-chloro - 4-nitrophenol  $\alpha$ -D- maltotrioxide). The extract also had an *in vivo* antioxidant potential on malondialdehyde (MDA), glutathione (GSH), catalase (CAT) and total thiols (TT) in alloxan induced in diabetic rats. From the report, the methanolic extract of *Amaranthus spinosus* has been found to have a potent inhibition on alpha amylase, anti-diabetic and antioxidant activities.

Anti-diabetic, anti-hyperlipidemic and spermatogenic effects in streptomycin (STZ) induced diabetic rats were proved by Sangameswaran *et al.*, [16]. Both standard drug (Gilbenclamide) and methanolic extract of *A. spinosus* significantly reduced blood glucose level on a 15 day treatment. Moreover, in streptomycin (STZ)-induced diabetic rats, the methanolic extract evidenced a significant anti-hyperlipidemic and spermatogenic effects. The spermatogenic effect was accelerated by increasing the sperm count and accessory sex organ weight.

According to Sangameswaran and Jayakar, [17] the *Amaranthus spinosus* described to have anti-diabetic, anti-hyperglycemic, anti-hyperlipidaemic, spermatogenic effects on alloxan induced diabetic rats. Thus, the investigation supports the folklore claim to utilize the plant as an anti-diabetic agent.

**Anti-inflammatory activity**

Olumayokun *et al.*, [18] reported that *Amaranthus spinosus* methanol extract exhibited anti-inflammatory activity in different animal models. The effect of the plant extract was also studied on castor oil-induced diarrhoea and gastric mucosal integrity. These results demonstrate that anti-inflammatory activity of the leaf extract of *Amaranthus spinosus*. This activity of the plant extract probably acts by the inhibition of prostaglandin biosynthesis.

Senthil Kumar *et al.*, [19] studied the analgesic activity of *Amaranthus spinosus* Linn. leaves in mice. The methanol extract showed significant, dose dependent peripheral analgesic activity on tested animals. The extract significantly reduced the acetic acid induced abdominal contractions.

**Anti-helmintic activity**

Baral *et al.*, [20] done experiment using water extract of *Amaranthus spinosus* Linn. Adult Indian earthworms (*Pheritima posthuma*) and *Tubifex tubifex* was used for study. Piperazine citrate acts as a reference standard. At 50 mg/ml dose, aqueous extract produced a shortest time of paralysis (P) and death (D) to both worms *Tubifex tubifex* and *Pheritima posthuma*. The aqueous extract showed more potent activity at a concentration of 15mg/ml against *Tubifex tubifex* compared to *Pheritima posthuma*.

**Anti-malarial activity**

According to Hilou *et al.*, [21] spiny amaranth, *Amaranthus spinosus* L. and *Boerhaavia erecta* L. plant extracts showed anti-malarial activity in mice. The screened extract showed significant anti-malarial activities in mice inoculated with parasitized red blood cells (*Plasmodium berghei berghei*) in a 4-day suppressive anti-malarial assay. The ED<sub>50</sub> values obtained for *Amaranthus spinosus* and *Boerhaavia erecta* L. extracts are 789 and 564 mg/kg, respectively.

**Anti-nociceptive activity**

Hussain Zeashana *et al.*, [22] evaluated the antinociceptive and anti-inflammatory activities of ethanol extract of *Amaranthus spinosus* whole plant. 50% of ethanolic extract of *Amaranthus spinosus*, whole plant shows a significant dose dependent antinociceptive and anti-inflammatory activity.

**Haematological activity**

Haematological effects of ethanol extract of *Amaranthus spinosus* (EEAL) leaf was reported by Olufemi *et al.*, [23]. The ethanolic extract was administered orally to growing pigs to determine its effects on various haematological parameters like packed cell volume (PCV), red blood cell (RBC) and white blood cell (WBC) counts, and haemoglobin (HB) concentration. The EEAL significantly reduced the PCV, RBC, and Hb of pigs after seven days of post treatment. Further, the administration of ethanol extract of *Amaranthus* significantly improved their final weight and average weight gains in pigs.

Srivastava *et al.*, [24] observed the alteration in hematocellular components of albino rats due to the administration of methanolic extract of *Amaranthus spinosus*. For this study, the extract was administered in a dose of single and daily for 5, 7 and 14 days. The values confirmed that the RBC count and WBC count and Hb% were significantly altered due to administration of methanol extract. Moreover, the Hb % was also restored significantly by the administration of methanolic extract of *Amaranthus spinosus*.

The aqueous extract of *Amaranthus spinosus* leaf does not produced any significant changes in the value of haematological parameters such as RBC, WBC, packed cell volume (PCV), haemoglobin concentration (Hb) and blood coagulation time in rats. There was a significant reduction in serum biochemical parameters such as glucose and cholesterol was observed in rats. Although, the level of alkaline phosphatase (ALP), serum glutamate pyruvate transaminase (SGPT) and serum glutamate oxaloacetate transaminase (SGOT) showed no significant changes [25].

**Anti-pepticulcer activity**

*Amaranthus spinosus* L. anti peptic ulcer activity was studied in peptic ulcer models in rats. Ethanol and cysteamine serves as an inducer of gastric and duodenal ulcers, respectively. A standard drug, omeprazole serves as a positive control. On comparison with standard drug, the leaves of *Amaranthus spinosus* Linn exerted anti peptic ulcer activity against ethanol and cysteamine induced peptic ulcer. The activity of extract was found to be less when compared with that of omeprazole [26].

Root, stems and leaves extract of *Amaranthus spinosus* was evaluated against gastric ulcer induction. Ethanol, hydrochloric acid, indomethacin and pyloric ligation induced gastric ulcer in albino rats. A standard anti gastric ulcer drug omeprazole was used. A significant anti gastric ulcer activity was noticed among the various plant parts, root, stem and leaves of *Amaranthus spinosus* Linn. However, among the plant parts, root extract showed a highest activity when compared to that of standard drug, omeprazole [27].

**Immunomodulatory activity**

Lina *et al.*, [28] investigated the immune-stimulatory effect of water extract of *Amaranthus spinosus* in spleen cells from female mice. The results indicate that the immune-stimulatory effects of ethanolic extract might be due to stimulatory proliferation action on B lymphocyte activation and subsequent T-cell proliferation *in vitro*.

Jin-yuarn Li *et al.*, [29] also studied the immune-modulatory effects of *Amaranthus spinosus* water extract on spontaneous and Dexamethasone (DEX)-induced apoptosis in murine primary splenocytes. The data showed that the ethanolic extract inhibited the spontaneous and DEX-induced apoptosis of splenocytes.

Tatiya *et al.*, [30] studied phytochemical investigation and immunodilator activity of *Amaranthus spinosus* Linn. The immunomodulatory activity was studied by cell-mediated immune response (CMIR) measured by delayed type of hypersensitivity reaction to SRBC and humoral immune response (HIR) measured by hemagglutination antibody titre. Among the various extracts, the ethanolic and alcoholic extracts showed a significant elevation in cell mediated immune response and humoral immune response whereas, the petroleum ether extract significantly reduced humoral as well as cell-mediated response.

**Gastrointestinal activity**

Ashok Kumar *et al.*, [31] investigated ethanolic extract of *Amaranthus spinosus* for its gastrointestinal activity in mice by using a charcoal meal method. Three different doses of *Amaranthus spinosus* ethanolic extract at 100, 200 and 400 mg/kg was compared to control. Inhibition results showed a significant gastrointestinal motility at 100 mg/kg dosage.

**Antigenic and allergenic activity**

Singh *et al.*, [32] reported that *Amaranthus spinosus* five pollen samples act as an important aeroallergen in India and other different parts of the country. These observations will be helpful in standardizing pollen antigens for diagnosis and immunotherapy in India.

**Antimicrobial activity**

Maiyo *et al.*, [33] utilized different solvents like hexane, ethyl acetate, dichloromethane and methanol leave extracts of three plant species *Amaranthus hybridus*, *Amaranthus spinosus* and *Amaranthus Caudatus* for antimicrobial activity. The leaves extract of plant species, extraction fraction and various concentrations showed antimicrobial activity.

The *Amaranthus spinosus* whole plant extract was evaluated for preliminary qualitative analysis and antimicrobial activity against some bacterial and fungal strains (*Escherichia coli*, *Staphylococcus*, *Klebsiella*, *Paracoccus*, *Fusarium*, *Aspergillus* and *Alternaria*). The plant extracts (stem and flower) showed the maximum zone of inhibition on *E. Coli* (14mm), *Pseudomonas* (13mm), *Staphylococcus* (10mm), *Paracoccus* (9mm), and *Klebsiella* (15mm) in 4.7mg/disc (distilled water) and 3.8 mg/disc (methanol), respectively [34].

**Antitumor activity**

The antitumor activity of *Amaranthus spinosus* leaves against EAC bearing Swiss albino mice was studied by Samuel Joshua *et al.*, [35]. The ethanol extract of *Amaranthus spinosus* leaves exhibited a significant antitumor effect in EAC bearing mice with a LC50 value of 7.55 µg/ml (Vincristine sulphate), 18.15 µg/ml (chloroform extract), 29.51µg/ml (n-hexane extract) and 18.15µg/ml (ethyl acetate) respectively. For Brine shrimp lethality bioassay method, vincristine sulphate used as positive control.

**Antibacterial activity**

Both ethanol and aqueous extract of *Amaranthus spinosus* of root exhibits antibacterial activity against ten bacterial strains including Gram-positive and Gram-negative bacteria using agar-well diffusion method was developed [36]. The ethanol extract showed better results than the methanol extract of *Amaranthus spinosus*.

**Diuretic activity:**

The *Amaranthus spinosus* extract showed a strong saluretic effect and carbonic anhydrase inhibition activity. The extract increased the Na<sup>+</sup>, K<sup>+</sup>, Cl<sup>-</sup> excretion in urine. The extract also caused alkalinisation of urine as like thiazide, a standard drug. The extract exerted these effects predominantly at 500 mg/kg dose. The effect showed no dose response relationship. Thus, this study strongly recommends that *Amaranthus spinosus* acts as a diuretic, which restates the assert as a diuretic herb in Siddha medicine [37].

**Bronchodilator and spasmolytic activity**

In vivo bronchodilator and laxative activities was studied using aqueous – methanol extract of whole plant of *Amaranthus spinosus* Linn. The spasmolytic effect was assessed in-vitro using isolated tissue preparations mounted on a tissue bath assembly embedded in a physiological salt solutions, maintained at 37°C and carbogen aerated condition to find the mechanism underlying behind it. The result indicated that *Amaranthus spinosus* laxative activity and spasmolytic effect mediated through cholinergic action and calcium channel blockage. Whereas, the bronchodilator activity was mediated through a combination of  $\beta$ -adrenergic and CCB pathways [2].

**CONCLUSION**

In recent years, medicinal plants have attracted considerable global interest in the investigation of traditional medicine. For the treatment of rural and tribal communities with conventional illness, the traditional medicine plays a very important role. The extensive survey literature on *Amaranthus spinosus* Linn. validated its efficacy as an important medicinal plant in traditional usage with diverse pharmacological spectrum. In Indian traditional medicine system, the plant has been proved to possess some pharmacological properties like antidiabetic, antipyretic, anti-inflammatory, antioxidant, hepatoprotective, antimalarial, antibacterial, antimicrobial, antidiuretic, antiviral and in hepatic disorders. These properties are mainly due to the presence of medicinally active constituents in whole plant parts of *Amaranthus spinosus* Linn. Due to the presence of enormous traditional usages in various treatments, it is recommended to investigate this plant for the discovery of safe drugs.

**CONFLICT OF INTEREST STATEMENT**

Authors declare no conflict of interest.

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