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A Comprehensive Pharmacognostic, Phytochemical Description, and Clinical Implementation of *Amaranthus viridis*

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Abstract

The pigweed family, Amaranthaceae, includes *Amaranthus viridis*, popularly known as green amaranth. This herb grows quickly and has an annual lifespan. Traditionally, it has been used to treat anemia, eczema, bronchitis, inflammation, and leprosy, as well as for respiratory issues, ocular conditions, and asthma. The phytochemical analysis of *Amaranthus viridis* L extracts identifies the presence of several categories of biologically active substances (phytochemicals): phenolics, which include flavonoids, tannins, and phenolic acids. Alkaloids, cardiac glycosides, various classes of triterpenoids, and steroids were also found. Numerous investigations on *A. viridis* have been conducted to explore its pharmacological range. Most research identified laxative, hepatoprotective, analgesic, anti-inflammatory, antitumor, antimicrobial, anti-diabetic, wound healing, and antioxidant properties. The goal of the current review of the literature is to give extensive information on the morphological traits, folk usage, phytochemicals, and pharmacological properties of *Amaranthus viridis.*

Keywords: Alkaloids, *Amaranthus viridis*, Flavonoids, Gallic acid, Quercetin

Introduction

Nature is considered an important source of medicinal curative plants. For numerous years, these plants have served as crude moieties to cure various diseases. These medicinal plants implement curative properties, anti-cancer, anti-inflammatory, anti-microbial, and antidiabetic activities, besides their action against ROS, and traditionally, the medicinal actions of these plants were investigated in various diseases [1]. The Amaranthus genus is recognized as one of the earliest classes of plants and belongs to the Amaranthaceae family, which includes sixty-five genera and 850 species. About fifty to sixty species are cultivated for their leaf (greens) and grains. In addition, a few wild species are also included in this genus [2]. Amaranthus is an annual plant with a short lifespan, whereas it is perennial. A few Amaranthus species have been grown for their grains, as ornamentals, and as green vegetables [3]. Also, there is a weed, Amaranthus [4].

This genus of plants is promising since their leaves, seeds, and roots are excellent providers of plant-based proteins, superior nutrients, unsaturated fatty acids, and other crucial organic minerals. The Amaranthus genus has a multitude of well-documented bioactive compounds.

Iraq is among the countries in which this species is naturally grown [12]. Green amaranth, slender amaranth, and Chinese spinach are common vernacular names for Amaranthus viridis [13, 14]. They can scavenge free radicals that could disrupt biological processes, and these include phenolic moieties, anthocyanins, flavonoids, lectins, and antioxidant minerals [5]. Amaranthus leaves are a powerful alternative to betalains because of their betacyanin pigments; betacyanin also shows anticancer activity [6]. These plants exhibit a significant morphological variation within species and even among individuals of the same species in response to environmental factors. They are found growing alongside roadsides, in gardens, and in habitats [7].

Amaranthus viridis

Amaranthus viridis is a member of Amaranthaceae (pigweed family) [8]. *Amaranthus viridis* is a wild type of amaranthus in addition to *A. retroflexus, A. hybridus, A. gracilis, A. gangeticus, A. paniculatus, and A. graecizans* [9]. Amaranthus or Amaranth is defined as a "never-fading flower" in Greek [10]. It is known as Spiny amaranth [11]. This species is native or naturally grown in the Caribbean and disseminated in tropical and subtropical areas of the world. More than 50 crops are infested by this species.

Taxonomical Classification "

Kingdom: Plantae

Unranked: Angiosperms

Unranked: Eudicots

Order: Caryophyllales
Family: Amaranthaceae
Genus: Amaranthus
Species: Viridis
Binomial name: *Amaranthus viridis* L [15].

Description

Amaranthus viridis is an annual terrestrial, fast-growing herbaceous plant, with stems usually erect, might be hairy, with sparse short pubescence at the top, bare at the bottom. Leaves ovate, elongate rhombic ovate, 2-6 cm long, base broadly curved, rounded, apex blunt or slightly emarginated, dark green; petioles 1-5 cm long. Flowers frequently had paniculate spikes, 2.5 to 10cm in length and 25mm in width. They also hold bracts and bracteoles that are white, pale, or reddish. Brakets are deltoid-to lanceolate-ovate in shape [16, 17]. Trichomes were absent [8]. The flower is pale white to green [18], which mostly blooms in summer and fall [19]. The inflorescences are brownish to green in color, and according to the age of the plant, the terminal panicle varies [20]. Fruit of a subglobose capsule, c.1.5 mm in diameter, not or slightly exceeding the perianth, often strongly wrinkled, indehiscent, one-seeded. Seed subglobose, slightly compressed, c.1mm in diameter, glossy black, margin acute, verrucose, or with inconspicuous structure [16]. Seeds of A. viridis are predominantly black [21]. This plant stands out for its adaptability to the environment and prolific seed production [22].

Figure 1. Iraqi *A. viridis* whole plant

Traditional use of A. viridis

In Nepal and India, this herb is grown for pain reduction due to intense activity, while in Pakistan, it is used to cure respiratory ailments, for bleeding regulation, excessive menstrual cycle, and diarrhea, in Côte d'Ivoire this plant is adapted for maintenance of the pregnancy [23] In India, it was used for labor pain and as an antipyretic formulation [24]. The crushed leaves were utilized topically by the Negritos of the Philippines to treat rashes, psoriasis, and eczema. Other traditional uses are anthelmintic, for venereal diseases, diuretic, antirheumatic, antiemetic, laxative, and antileprotic. It can also recover appetite and manage respiratory problems, eye illness, and asthma [25]. As a whole plant, it was used conventionally for menorrhagia, amenorrhea, hemoptysis, and bleeding ulcers [26].

Phytochemistry

Lots of studies were done to investigate the phytochemical constituents. Examination of the various extracts (hexane, chloroform, methanol, and distilled water) of *A. viridis* revealed the presence of major phytochemical compounds, including phenolics, flavonoids, and tannins. In addition to alkaloids, terpenoids, steroids, saponins, and cardiac glycosides [27]. In aqueous root extract alkaloids, flavonoids, triterpenoids, unsaturated steroids, saponins, and polyoses were detected; while anthracene glycosides, anthraquinones, emodines, simple phenolics, tannins, leucoanthocyanins, cardenolides, and polyurenoids were found to be absent [28].

Coumarin presence was demonstrated in the methanolic leaf extract [29]. In another study, coumarin and quinone are absent in *A. viridis*[23]. Concerning phytosterols, the following compounds were isolated: trilinolein, 24-ethyl-22-dehydrocholesterol, 24-methyllathosterol, and 24-ethyllathosterol in leaves extract, spinasterol from the stems and roots, and amasterol (an ecdysone precursor and a growth inhibitor) from the roots [12]. Cycloeucalenol, Oleanolic acid, and 3,4-seco-olean-

12-en-4-ol-3,28-dicarboxylic acid were also identified [3]. Squalene was isolated from the stems and leaves, polyprenol (isoprenoid alcohol), and phytol (diterpene alcohol) from the leaves of *A. viridis* [30]. β-Carotene [25] and lutein had been isolated from *A. viridis* L [31].

A carotenoid content (86 - 92.87mg 100 g−1) was measured in a study by Sarker et al. Betalains, β-Cyanins, and β-xanthine were also identified in fresh leaves of *A.viridis* [15]. Both types of phenolic acids were identified: hydroxybenzoic acids (vanillic acid, 4-OH benzoic acid, protocatechuic acid, and syringic acid), and hydroxycinnamic acids (cinnamic acid, ferulic acid, sinapic acid, p-coumaric acid, and caffeic acid) were identified in methanolic seed extract by HPLC. Autoclaving and germination increased the flavonoid and hydroxycinnamic acid content of the seed extracts [32]. In HPLC of hydroalcoholic leaf extract, salicylic acids are the most prominent benzoic acids. The rest of the benzoic acids, arranged in decreasing order, are gallic acid, vanillic acid, protocatechuic acid, 4-hydroxybenzoic acid, gentisic acid, β-resorcylic acid, syringic acid, and finally ellagic acid. Trans-cinnamic acid was the major and the most predominant among cinnamic acids, followed by chlorogenic acid. Concerning flavonoids (polyphenolic compounds), the most abundant flavonoids are: isoquercitrin, rutin, quercetin, naringenin, kaempferol, myricetin, catechin, apigenin, and hyperoside. It was found that the drought increased *A.viridis* phenolic acid and flavonoid contents [33, 34]. Another study shows the presence of quercetin, rutin, and gallic acid in the *A.viridis* methanolic leaves extract using HPTLC [35]. LC/MS of *Amaranthus viridis* hydroalcoholic leaves extract revealed quercetin as a main flavonoid [36].

In seed extract, the identified flavonoids were rutin, kaempferol diglycoside, quercetin diglycoside, and, in addition to vitexin [32, 37]. The chemical structures of some phytochemicals are demonstrated in Figure 2 Quercetin -3 glycoside, quercetin-3-O-neohesperidoside, myricetin-3-O-rutinoside, Kaempferol-3-O-neohesperidoside, hydroxy kaempferol, Isorhamnetin-3-O-neohesperidoside, rutin, and 4-hydroxycinnamic acid and ferulic acid, feruloylquinic acid, qoumaroylquinic acid, and caffeoylglucaric acid were identified in the methanolic aerial part extract using LC\MS [36, 43]. A recent study found that the leaves and inflorescence of A. viridis had higher phenol and flavonoid content, whereas the seeds displayed lower phenol and flavonoid content compared to the leaves and inflorescence [44]. Gulonic acid (a strong antioxidant) has also been identified [45].

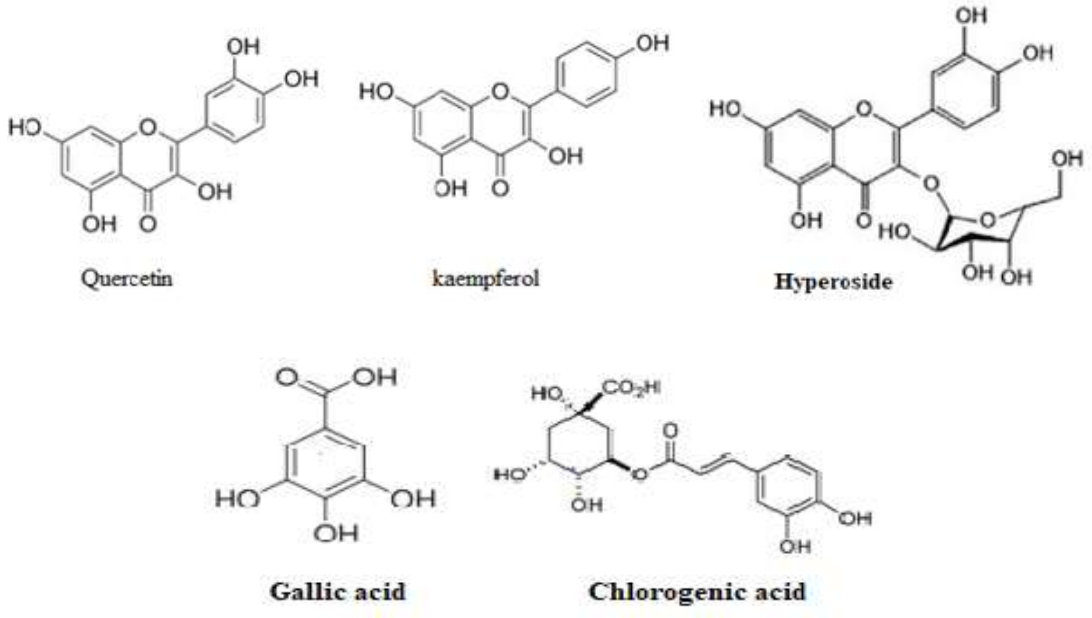

Figure 2. Chemical structures of main flavonoids and phenolic acids in *Amaranthus viridis* [38-42]

Concerning alkaloids, these compounds were identified in the leaves and seeds of the plant, but till now have not been isolated, and nothing is known about their type. The percentage of alkaloids is shown by *A. tricolor, A. viridis, and A. caudatus* (8-8.8%) when compared to other Amaranthus species (46). Another study reported the alkaloid percentage in leaves to be 26.7% [18] and 10.34 to 13.14% [47].

A. viridis contains the amino acids lysine, arginine, histidine, cystine, phenylalanine, leucine, isoleucine, valine, threonine, methionine, tyrosine, and tryptophan. In addition to a high level of minerals [48]. The main minerals were calcium, potassium, iron, and zinc [49].

Table 1. Quantitative estimation of phytochemicals in *A. viridis*

Extract	Alkaloids	Flavonoids	Tannins	Cardiac glycosides	
Aqueous leaves extract	14.25 ± 0.92 gm/100gm		8.80 ± 0.69 gm/100gm	63.20 ± 0.92 gm/100gm	(50)
80% MeOH leaves extract	% 13.14% ± 0.68		% 6.07% ± 0.93		(10)
60% Ethanolic leaves extract	93mg/gm	8mg/gm	4.4 mg/gm		(51)
Ethanolic leaves extract	51mg/100gm dry weight	33mg/100gm	4.75mg/100gm		(52)

Pharmacological effects of A. viridis

Antioxidant effect

Reactive oxygen species damage contributes to the etiology of numerous chronic and degenerative health problems, such as inflammation, cardiovascular disease, cataracts, and cancer. Antioxidants protect against free radical-induced tissue damage by avoiding the formation of radical species, scavenging them, or supporting their decomposition [53]. Amaranthus is one of the plants that was thoroughly screened for its antioxidant action and classified as one of the top five antioxidant capacities across vegetable crops.

The plant leaves and inflorescence possess the greatest antioxidant potential [49]. Sunday EA study proved the antioxidant activity of Amaranthus leaves aqueous extract that exhibited better antioxidant potential against the ascorbic acid used as the control in his study [54, 55]. Using a DPPH assay, JIN YS assessed the antioxidant capacity of ethyl acetate, n-butanol, and ethyl ether. n-butanol has the highest antioxidant effect, followed by ethyl acetate, and finally, the ethyl ether fraction showed the minimum activity. Amaranthus is a rich source of flavonoids, phenolic acids, protein, carotenoids, and vitamin C [56]. Sadia S utilized four tests to establish the antioxidant potential of *A. viridis:* (2,2-diphenyl-1-picrylhydrazyl) DPPH radical scavenging activity assay, ABTS radical cation assay, hydrogen peroxide scavenging activity assay, and phosphomolybdenum assay. Every assay employed to assess the radical scavenging activity demonstrated *A. viridis's* strong antioxidant capacity. IC50 values were found to be: 27.97 µg/ml (DPPH assay), 13.22 µg/ml (ABTS assay), 52.77 µg/ml (Hydrogen peroxide assay), and 12.60µg/ml (Phosphomolybdenum assay). A small IC50 value indicates a strong scavenging capability and, thus, a higher antioxidant effect in the samples [10].

Antihypercholesterolemic effect

Salvamani et al conducted a study on various parts of *A. viridis* (leaf, stem, and seed) to estimate the anti-HMG-CoA reductase, anti-inflammatory, and antioxidant activities. In Lineweaver-Burk plot analysis, the leaf extract revealed noncompetitive inhibition for HMG-CoA reductase, with the highest HMG-CoA reductase inhibitory effect at about 71%. The putative HMG-CoA reductase inhibitory action of different concentrations of *A. viridis* extracts was estimated spectrophotometrically by NADPH oxidation, and HMG-CoA was used as substrate. The leaf extract showed good inhibition of hydroperoxides, 2,2-diphenyl-1-picrylhydrazyl (DPPH), nitric oxide (NO), and ferric ion radicals in various concentrations. Lipoxygenase, hyaluronidase, and xanthine oxidase enzymes are effectively inhibited by *A. viridis* leaf extract. The experimental data suggest that *A. viridis* leaf extract is a source of effective antioxidant and anti-inflammatory mediators and may modify cholesterol metabolism by hindering HMG-CoA reductase [57].

Antibacterial effect

The Amaranthaceae family demonstrates the antimicrobial effect. Rose J et al evaluated the antibacterial effect of *Amaranthus viridis* leaf and stem extract in different solvents, ethanol, petroleum ether, and aqueous extract, against *E. coli, Staphylococcus aureus, Proteus mirabilis, Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* bacteria. According to the study, the stem and leaf ethanol and petroleum ether extracts had higher levels of antibacterial activity than the aqueous extract. This experiment demonstrated the plant extracts' possible ability to combat harmful germs by acting as antibacterial agents [58].

Zahir S et al evaluated the antimicrobial effect of the whole plant ethanolic extract of *Amaranthus viridis, Aerva sanguinolenta*, and *Cynodon dactylon* against *Streptococcus mutants* and *Lactobacillus acidophilus*. The qualitative and quantitative antibacterial assay revealed that the antibacterial activity of *Aerva sanguinolenta is* more than that of *Amaranthus viridis* and *Cynodon dactylon* [59]. Javid Iqbal MJ, in a previous study, proved the antibacterial and antifungal effects of ethanolic and 80% ethanolic seed and leaves extracts; the maximum inhibitory effect was against *E. coli*. The least activity is inhibited by 80% methanol seed extract against *R. oligosporus* [60]. Funde SG's study showed that Amaranthus has an antibacterial effect on positive and gram-negative bacteria. Inhibition of strains like *Staphylococcus epidermidis* and *Micrococcus luteus* was higher compared to E. coli. In general, older leaves of *Amaranthus viridis* methanol extracts exhibited very high antimicrobial activities against *Micrococcus luteus* compared to the younger leaves of *Amaranthus viridis* [61].

Antifungal effect

Various Amaranth species display antifungal effects. Akbar M et al study evaluates the antifungal effect of different fractions of methanolic leaf extract of *A. viridis* (n-hexane, chloroform, and ethyl acetate).

Fungal biomass reduction is proportional to fraction concentration; however, the ethyl acetate leaf fraction showed clear activity and reduced fungal growth in *A. alternata, A. flavus, D. australiensis, F. oxysporum*, and *M. phaseolina* by up to 44%, 39%, 48%, and 45%, respectively. The antifungal activity was attributed to 1,2-benzenedicarboxylic acid, mono(2-ethylexyl) ester [62].

Anticancer effect

The anticancer effect of *A. viridis* was demonstrated in previous studies. The anti-cancer effect of the ethyl ether fraction of *A. viridis* L against human colon cancer HT-29 cells and HepG2 cancer cells was proved. Reactive oxygen species generation, caspase-3 gene regulation, cytoplasmic protein activation (Bax and Bcl-2), and cell cycle arrest all lower cell viability and have an antiproliferative effect [63]. House et al, through MTT assay, proved the in vitro moderate anticancer activity of the methanolic extract of *A. viridis* on MCF-7 and MDAMB231 triple-negative breast cancer cells [43]. Malicdem et al showed the same effect using ethyl acetate leaf extract, with IC_{50} being less than 30 µg/ml on MCF-7 [64]. Funde SG study showed that the anti-cancer effect of younger green and red methanolic leaf extract was less than on Human colon carcinoma cells (HT20) as compared to older leaf extract [61]. Another study showed the antiproliferative potential of methanolic leaf extracts of *Amaranthus viridis* and *Swertia chirata* on the B16F10 melanoma cell line. MTT assay was used to evaluate the antiproliferative effect, at a concentration of 50µl/ml, the percentage of viable cells was assigned to be 73.59% and 62.87% for *A. viridis* and *S. chirata*, respectively. Cell viability was decreased with increasing concentrations of the extract [65].

Antidiabetic effect

Traditionally, *A. viridis* exhibited an antidiabetic effect. Previous studies conducted by Ashok BS and Mareshvaran UR proved the antidiabetic effect of *A. viridis* methanolic extract in alloxan-induced diabetic rats. Inhibition of α-amylase activity was one of the proposed mechanisms by which *A. viridis* reduces glucose concentration. Inhibition of amylase was attributed to the high phenolic content [66, 67]. Wakchaure R uses the aqueous extract of *A. viridis* in the form of powder and prepares tablets using the dry granulation method. One of the prepared formulas could be effective for the treatment of diabetes [68]. *A. viridis* may exhibit an anti-diabetic effect by enhancing insulin from pancreatic β-cells, increasing glucose uptake by the diaphragm, and glycogenesis stimulation by the liver [69]. Petal J proved the hypoglycemic and hypolipidemic effects of an aqueous extract of *A. viridis* in streptozotocin-induced diabetic rats. A significant decrease in the blood glucose level occurred in a dose-dependent manner during the 30 days of the treatment period. *A.viridis* modulated lipid profile changes in STZ-diabetic rats in a dose-dependent manner. The hypolipidemic effect may be directly attributed to improvement in glycemic control upon *A.viridis* therapy [70]. Sarvida F proved the antidiabetic effect of aqueous stem extract of *A. viridis*. Data analysis revealed that the decoction has a significant effect in reducing the blood sugar level of Mus musculus using 3 different concentrations-50%, 75%, and 100%. the reduction in glucose concentration was33 %, 42%, 47%, respectively, while 2.3%. was the reduction percentage in the control group [71].

Cardioprotective effect

The cardioprotective properties of *A. viridis* ethanolic extract in ISO-induced oxidative damage generated by (isoproterenol) were confirmed by Saravanan G. A cardioprotective effect was obtained when male Wistar rats were orally treated with *Amaranthus viridis* methanolic extract (100, 200, and 300 mg/kg body weight) for 45 days. Decreases in serum marker enzymes, cardiac troponin, oxidized glutathione (GSSG), and lipid peroxidation were accompanied by increases in GSH and antioxidant enzymes, indicating the cardioprotective impact. A more pronounced effect was elicited at a dose of 300 mg/kg of *A. viridis* than that of 100 mg/kg and 200 mg/kg, and recovered all the parameters close to normal. The effect produced by *A. viridis* was compared with that of α-tocopherol. It has been suggested that the cardioprotective effect results from an increase in endogenous antioxidant indicators and the suppression of membrane lipid peroxidation [72].

Effect on fertility

In conventional medicine, *Amaranthus viridis* is widely used as an infertility therapy [73]. In Devi S et al.'s study, four groups of methotrexate-exposed male albino mice (Gr I: received MTX (methotrexate), Gr-II: received MTX and folic acid, Gr III: received MTX and hydroalcoholic extract of the plant, and Gr IV: control group received distilled water. Methotrexate causes a decrease in sperm count and motility due to abnormal morphological features of the head and tail in mice. Plant extract contains about 82 mg of folic acid/100 g. Folic acid mitigates methotrexate's toxic effects, such as abnormal sperm morphology and limited sperm motility. Sperm fertilizing capacity is evaluated by markers such as motility and morphology. According to the result of their study, Devi S et al emphasize that *A. viridis* extract and folate prominently contributed to the perfection of sperm morphology in male mice, and it is highly advantageous to sub-fertile men not subjected to

MTX therapy [45].Kanerkar UR evaluates the antifertility effect of aqueous Amaranthus root extract. For five days from day 11 to 15 of gestation, female albino rats (four groups, each with six) received three different doses of the extract orally: 50 mg/kg, 100 mg/kg, and 150 mg/kg body weight for Gr II, III, and IV, respectively, while group I received distilled water. The results of the study revealed the antifertility activity that is expressed as a dose-dependent abortifacient action that increases with a higher dose [28].

Emmanuel AM evaluated the effect of methanolic leaf extract on female rat uterine and reproductive hormones. The study showed that the methanolic extract of *Amaranthus viridis* stimulates follicle maturation and ovulation. *A. viridis* contains estrogenic or a substance that mimics estrogen in its action, clarifying the fertilizing tendency of *A.viridis* in a dose-dependent manner. Tested doses of 200 and 400mg/kg of body weight show no substantial increase in the progesterone level, while 600mg/kg produces a significant increase in the progesterone level [73]. Additionally, the study's findings for a twenty-eight-day therapy at various doses showed that there was no toxicity observed during this treatment period for the parameters examined when *Amaranthus viridis's* methanolic extract was administered at doses of 200 and 400 mg/kg. Reproductive toxicity induced by cyclophosphamide is evidenced by remarkably dropped levels of testosterone, FSH, and LH, disarrangement of sperm characterization, and antioxidant system disturbances as evidenced by reduced levels of glutathione as well as elevation of thiobarbituric acid reactive substance activity. Also, histopathological specimen examination revealed hemorrhagic lesions with scant and hypertrophied parenchymal cells in the pituitary gland, whereas the testis had distended seminiferous tubules with disorganized connective tissues in addition to vacuolated testicular interstitium. Subjects with cyclophosphamide-induced reproductive toxicity can be managed by *A. viridis* aqueous extract. Both its antioxidant and membrane-stabilizing properties are responsible for its therapeutic potential [50].

Wound healing effect

Sahoo HB study demonstrates that *A. viridis* extract, when applied topically in the form of a simple ointment, encourages wound healing in diabetic rats.

In diabetic-induced rats, the rate of collagen turnover, wound contraction, and hydroxyproline content is decreased. Different concentrations of the leaf extracts were used (2%, 5%, and 10% w/w). All the tested concentrations showed improved wound closure proportion. These preliminary results moreover suggest that *A. viridis* induces wound healing by increasing or promoting wound closure rate and extent, the content of hydroxyproline of granulation tissue in delayed healing wounds [74].

Anti-epileptic effect

Bharadwaj A. et al. used chloroform extract of Amaranthus leaves (doses of 200mg/kg and 400mg/kg orally) to demonstrate the antiepileptic effect. Strychnine was used to induce epilepsy in rats. The dose of 400mg/kg established an antiepileptic effect in a strychnine-induced animal model of epilepsy. Moreover, this dose lessens strychnine-induced mitochondrial injury in the rat brain's prefrontal cortex. Amaranthus is regarded as a glycine receptor agonist in the brain.

Amaranthus could be considered as an additional preventative approach for epilepsy management. Malnutrition-induced epilepsy can be avoided in lower-income people by Amaranthus administration [75].

Antiurolithiatic effect

The Amaranthus diuretic effect is one of the activities that was reported traditionally. Asha S et al demonstrate the antiurolithiatic activity *of Amaranthus viridis* aqueous extract on ethylene glycol-induced male rats. Four groups of Wistar rats, each containing six, were kept in metabolic cages separately for the whole period of the experiment. All animals had unlimited access to standard rat food and drinking water ad libitum. Group I served as a control group. Group II was given ethylene glycol for thirty days. On the sixteenth day of administration of ethylene glycol, group III was treated with cystone, while group IV received an aqueous extract of *Amaranthus viridis*.

On the 30th day of the experimentation, Wistar rats were kept in metabolic cages. Serum samples and 24-hour urine samples were collected. Then all the animals were sacrificed. The collected samples (urine and serum) were used for the assessment of biochemical markers such as phosphorus, calcium, and creatinine; at the same time, uric acid concentration was determined. The decreased urinary levels and increased blood levels of biochemical markers such as uric acid, with a decline in the blood calcium level and increased urinary calcium level, reflect crystal deposition. Aqueous extract administration enhanced the urinary excretion of calcium, phosphorus, and creatinine, causing a reduction in their serum concentration [76]. Thakur R et al verified the nephroprotective effect of whole plant methanolic extract in aspirin-induced renal damage through a reduction in serum uric acid and creatinine in mice that were treated with aspirin and whole plant methanolic extract [77].

Hepatoprotective effect

Sundarrajan T et al. study manifested the hepatoprotective effect of the ethanolic fraction of ethanolic leaves extract in Aflatoxin B1 (AFB1) triggered hepatocellular carcinoma in rats. AFB1 gives rise to cellular damage as a result of oxidative stress. It stimulates the formation of reactive oxygen species (ROS), which is linked with rises in

biochemical markers such as serum glutamate pyruvate transaminase (SGPT), serum alkaline phosphatase (SALP), serum glutamate oxalacetic acid (SGOT), ã-glutamate transpeptidase (GGT), bilirubin, lipid levels, besides a decrease in the total protein and uric acid level. Amaranthus extract was administered orally at a dose of (100 & 200 mg/kg) for fourteen days to hepatocarcinoma-bearing rats.

liver homogenates were used for the determination of the lipid peroxide level and the activity of the enzymatic antioxidants. In carcinoma-induced rats, there were pronounced rises in lipid peroxide levels and accompanying decreases in enzymatic antioxidant levels, while in *A.viridis*-treated groups, the conditions reversed to near-normal levels. Liver histopathology revealed that *A.viridis* minimizes the occurrence of liver lesions, lymphocytic infiltrations, and hepatic necrosis triggered by AFB1 in rats [78].

Another study also proved the hepatoprotective effect of Amaranthus against paracetamol-induced hepatotoxicity in rats. The methanolic extract of the whole plant of *A. viridis* exhibited a remarkable reduction in the SGOT, SGPT, ALP, and bilirubin in comparison to the paracetamol group due to a considerable level of antioxidant constituents present in the examined fraction [77].

Laxative effect

Omodamiro OD evaluates the laxative (bowel and antimicrobial actions of ethanolic leaf and root extracts of the *Amaranthus viridis* L. The laxative activity of the ethanolic leaf extract of *A. viridis* was studied using six groups of Wistar albino rats; the negative control (Group I) received 0.5ml/kg of normal saline, 10mg/kg of Dulcolax was given to Group II. Groups (III-VI) received 400, 200, 100, and 50mg/kg of the ethanolic extract, respectively. The laxative activity of the leaf extract was denoted by the mean of the total weight of fecal material output in each group. Fecal output significantly increased in 200 and 400mg/kg groups; meanwhile, in 50 and 100 mg/kg groups, the extract produced no significant modification in fecal output [19].

Toxicity of A. viridis

Emmanuel et al. evaluate the toxic effect of the methanolic extract of *A. viridis* in Wistar rats. The findings of the study show that a single dosage of *Amaranthus viridis* methanolic extract is safe. Additionally, the study's findings for a twenty-eight-day therapy at various doses showed that there was no toxicity observed during this treatment period for the parameters examined when *Amaranthus viridis's* methanolic extract was administered at doses of 200 and 400 mg/kg., while a higher dose of 600 mg/kg, the methanolic extract triggers biochemical, histological and relative hepatic weight variations. This justifies that frequent administration of the *Amaranthus viridis* methanolic extract is not safe at 600 mg/kg. It is possibly toxic at this dose [23].

Conclusion

There has been a lot of interest in medicinal plants worldwide in recent years. According to the thorough literature assessment, *Amaranthus viridis* Linn. is an important herbal remedy with a wide range of pharmacological effects. The extract of the various plant parts has been used in numerous pharmacological studies. The plant is widely used in traditional medicine and has been shown to have antidiuretic, antibacterial, antimicrobial, antioxidant, hepatoprotective, and anti-inflammatory properties.

Given its therapeutic potential, *Amaranthus viridis* L. should be further studied in terms of its phytochemicals, pharmacological properties, and clinical applications to unlock its untapped potential for the development of safer medications.

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Conflicts of Interest

The authors declare no conflict of interest.

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وصف دوائي شامل، ووصف كيميائي نباتي، والتنفيذ السريري لـنبات عرف الديك البري

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الخلاصة

عائلة الخنازير، Amaranthaceae، تشمل*Amaranthus viridis* ، المعروف شعبيا باسم عرف الديك البري. تنمو هذه العشبة بسرعة ولها عمر سنوي. تقليديا، تم استخدامها لعلاج فقر الدم والأكزيما والتهاب الشعب الهوائية والالتهاب والجذام. بالإضافة إلى ذلك يتم معالجة مشاكل الجهاز التنفسي، وحالات العين، والربو. يحدد التحليل الكيميائي النباتي لمستخلصات L *Amaranthus viridis* وجود عدة فئات من المواد النشطة بيولوجيًا (المواد الكيميائية النباتية): كما تم العثور على الفينولات، والتي تشمل الفلافونويدات والأحماض الفينولية. القلويدات والجليكوسيدات القلبية وفئات مختلفة من ترايتيربينويدات والمنشطات تم تشخيصها في النبات. تم إجراء العديد من البحوث على *A. viridis* لاستكشاف تاثيرها الدوائي. حددت غالبية الأبحاث خصائص ملينة، وواقية للكبد، ومسكنة، ومضادة للالتهابات، ومضادة للأورام، ومضادة للميكروبات، ومضادة للسكري، ومضادة للأورام، وشفاء الجروح، ومضادة للأكسدة. الهدف من المراجعة الحالية للأدبيات هو تقديم معلومات مستفيضة عن السمات المورفولوجية، والاستخدام الشعبي، والمواد الكيميائية النباتية، والخصائص الدوائية لعرف الديك البري.

الكلمات المفتاحية :القلويدات ، *Amaranthus viridi*الفلافونويدات، حامض الكالك، كويرسيتين