

AMARANTHUS SPP. IN UTTARAKHAND: A NARRATIVE REVIEW OF ETHNOMEDICINAL, PHYTOCHEMICAL AND NUTRITIONAL ASPECTS

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ABSTRACT

Amaranthus is one of the millets with rich source of vitamins, micronutrients, fatty acids, proteins and squalene. It is used as forages, medicinal plants, cereals, vegetables, dye plants and as ornamentals. It has a higher protein content which making it a beneficial choice for people who do not consume or cannot afford animal protein sources. The genus displays a huge ecological plasticity, with species occurring from river banks, wet areas, shady places, roadsides and wastelands. The present study deals on ethnomedicinal, phytochemical and nutritional values of eight species of genus *Amaranthus* in Uttarakhand. Information on traditional practices, preparation, scientific names and available vernacular names has been provided.

Keywords: *Amaranthus*, Ethnomedicinal uses, Nutritional values, Phytochemicals.

INTRODUCTION

Uttarakhand, a Himalayan state in India, is renowned for its rich biodiversity due to its distinct geographical location and different climatic conditions. Plant resources are extensively consumed by rural people of Uttarakhand and are also utilized in traditional folk medicines (Prasad and Sharma 2018). Millets are widely seeded food grain crops suitable for tropical and subtropical climates, requiring minimum inputs for cultivation. Millets are utilized for food and beverages and fodder (Bhat *et al.* 2019). In India, millets are traditionally consumed as staple foods (Apetrei 2012). Uttarakhand traditionally grows various millets including Barnyard millet (Maadira/Jhangora/Sawa), Proso millet (Cheena), Finger millet (Madua/Koda/Mandua/Ragi), Buckwheat (Ugul/Phaper/Kutu), Foxtail millet (Kauni) and Amaranth (Chua/Marsu) (Raiger *et al.* 2023).

Genus *Amaranthus* L. belongs to the family Amaranthaceae. According to Joshi and Verma 2020, there are approximately 70 species found globally. Singh *et al.* 2019, reported 11 *Amaranthus* species in Himalayan region of India, with only 8 species (*A. blitum*, *A. caudatus*, *A. cruentus*, *A. hybridus*, *A. viridis*, *A. spinosus*, *A. tricolor* and *A. graecizans*) are from Uttarakhand. The *Amaranthus*

plant, sometimes referred to as kiwicha, which is a native of Central America (Iftikhar and Khan 2019) and is cosmopolitan in distribution. Moreover, it is referred to as "Ramdana" in India, which means "God's own grain" (NIFTEM 2024). In India, *Amaranthus* has been grown in hills as well as in plains mainly in Arunachal Pradesh, Assam, Chhattisgarh, Gujarat, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Maharashtra, Meghalaya, Nagaland, Orissa, Sikkim, Tripura, Tamil Nadu and Uttarakhand (Bisht *et al.* 2021). Genus having an annual or rarely perennial herbs. Stem is erect, ascending, decumbent, or prostrate, usually branched; leaves are alternate, ovate to linear, opposite or alternate, apex acute or obtuse, margins entire, base rounded to narrowly cuneate, slightly undulate, or crispate; flowers are unisexual; fruits are in form of utricles and seeds are lenticular, smooth and shiny (Assad *et al.* 2017, Bisht *et al.* 2021). They are fast-growing herbs with significant nutritional qualities, drought tolerance, and the ability to grow in nutrient-poor soil (NIFTEM 2024). This genus provides high-quality proteins, minerals, vitamins, and bioactive compounds, making it an excellent food source of nutrition (Joshi and Verma 2020). Many species in the genus are frequently considered as weed, while other

species are consumed as leafy vegetables in many parts of the world (Stallknecht and Schulz-Schaeffer 1993).

Since ancient times, *Amaranthus* spp. have been used medicinally. Even in the present era, several studies have been done time to time, and the results have shown that *Amaranthus* spp. contains several biological activities such as anti-carcinogenic, anti-diabetes, anti-inflammatory, anti-malaria, anti-microbial, anti-oxidant, cardioprotective, gastroprotective hepatoprotective, hypolipidemic, immunomodulatory activities etc. (Adegbola *et al.* 2020; Gandhi *et al.* 2020). Moreover, patients with celiac disease, an autoimmune disorder of small intestinal linked to a lifelong intolerance to gluten proteins, currently have no therapeutic option except to follow a gluten-free diet. *Amaranthus* can be a good option for such patients due to its excellent nutritional profile and absence of gluten (Martínez-Villaluenga *et al.* 2020).

By 2025, the amaranth market is expected to reach USD 13.89 billion, growing at a compound annual growth rate of 11.3 percent. The occurrence of rare elements such as oleic acid, stearic acid, squalene and tocopherols, which maintain bone strength, tissue repair, inflammation, and a variation of other health benefits, is anticipated to drive amaranth demand in the upcoming years (NIFTEM 2024).

This study is based on the secondary data. The aim of this study is to provide medicinal details of the *Amaranthus* species found in Uttarakhand. This type of data has not been compiled before for the *Amaranthus* species in Uttarakhand. All the data is found scattered.

Amaranthus in Uttarakhand

1. *Amaranthus blitum* L.: (*Chaulai*)

Fl. & Fr.: May to November

Ecology: It is commonly found in open areas (India Biodiversity Portal).

Characters: Glabrous herb; stem ascending to prostrate or erect, simple or branched; leaves petiolate, blade ovate or obovate, 1-6×0.5-4 cm, apex distinctly emarginate to almost bilobate, mucronate, margins entire, plane, base tapering or cuneate; inflorescences slender terminal spikes or panicles and axillary clusters; flower tepals 3, stamens 3; fruit utricle, compressed, subglobose to obovate (Efloras).

Uses: In Uttarakhand, whole plant is used to treat ulcers, pharyngitis, and tumors (Bano *et al.* 2017).

2. *Amaranthus caudatus* L.: (*Marshu, Ramdana*)

Fl. & Fr.: August-September & September-November.

Ecology: It is mostly found in roadsides and wastelands areas. This plant is occasionally cultivated (Gaur 1999).

Characters: Herb, 1.5 m tall; stem striate, glabrescent; leaves petiolate, ovate, lanceolate, 10-20×5.5-11 cm, apex obtuse or acuminate, margin subentire, base cuneate or decurrent; inflorescence clusters of terminal or axillary paniculate spikes; flower tepals 5, stamens 5, ovary 1-celled, stigma 3; fruit utricle (Gaur 1999).

Uses: In Tungnath-Chopta region of Garhwal Himalaya, used the whole plant ethnomedicinally to treat haemorrhoids and sores (Ratha *et al.* 2018). Grinded seeds are used to prepare breads and husk is used for manuring (Gaur 1999).

3. *Amaranthus cruentus* L.: (*Marchu*)

Fl. & Fr.: July-September & September-November (Gaur 1999).

Ecology: The plant is commonly cultivated along the borders of fields, growing in wet areas and shady places (India Biodiversity Portal; Gaur 1999).

Characters: Herb, 0.3-2.5 m tall; leaves petiolate, ovate, lanceolate to rhomboid, 10-25×6-14 cm, apex acuminate or obtuse margin subentire to crenulate, glabrous, base narrowed and decurrent; inflorescence terminal and axillary, erect; flower tepals 5, red or pale yellow; stamens 5, ovary 1-celled, 1-ovuled (Gaur 1999).

Uses: The indigenous groups of Uttarakhand, used fried seeds to killing of liver worm in children (Zakir 2020). Moreover, roasted *Amaranthus* with ghee and then jaggery is added to it, then it is taken to cure throat infections and fever (Kala and Nautiyal 2023). Grinded seeds are used to prepare breads and husk, which is used as manure (Gaur 1999).

4. *Amaranthus graecizans* L.

Fl. & Fr.: July-November

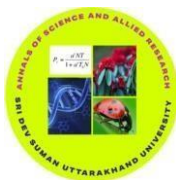
Ecology: The plant is rarely found, nearly by crop fields, grown along drains and gravelly soil (Gaur 1999; India Biodiversity Portal).

Characters: Prostrate ascending herb; leaves petiolate, elliptic-ovate to obovate, 1-3×0.6-2.2 cm, apex often notched or apiculate, base attenuate; inflorescence axillary cluster; flowers tepals 3, almost equal, stamens 3, ovary oblong-globose; fruit utricle, globose (Gaur 1999).

Uses: Not Known in Uttarakhand.

5. *Amaranthus hybridus* L.: (*Kumachwai*)

Fl. & Fr.: June-November.



Ecology: It is mainly growing in farms, waste places, and hillsides (India Biodiversity Portal).

Characters: Glabrous or glabrescent herb; stems erect, green or reddish purple, leaves petiolate, blade ovate, rhombic-ovate, or lanceolate, 2-15×1-6 cm, apex acute to obtuse, margins entire, base cuneate to broadly cuneate; inflorescences terminal and axillary; flowers tepals 5, stigmas 3, stamens 4-5; fruit utricles obovoid or elongate-ovoid (Efloras).

Uses: In Jaunsar-Bawar region of Uttarakhand, powder of seeds is taken internally as a remedy for dyspepsia (Bhatt *et al.* 2024).

6. *Amaranthus spinosus* L.: (*Sagoti, Chaulayi, Kadyasagoti, Katmarsa*)

Fl. & Fr.: July-October & October-December (Gaur 1999).

Ecology: The plant is commonly grown in wet places, waste places, roadsides, and river banks (Gaur 1999; India Biodiversity Portal).

Characters: Herb, 15-50 cm tall; stem branched, spinescent; leaves petiolate, ovate or oblong, 2.58×1.5-5 cm, apex obtuse or retuse, mucronate, margin subentire-repand, glabrous, except hairy nerve beneath; inflorescence axillary and terminal spicate clusters; flowers female flower in the lower parts and male flowers in the upper parts, perianth pale-green, tepals 5, nearly equal, mucronate, stamens 5 (Gaur 1999).

Uses: In Chamoli (Uttarakhand), traditional healers applied the paste of leaves as an herbal remedy on burns (Bisht *et al.* 2013). Furthermore, warm leaf paste, peach seeds paste and salt mixture used indigenously in Tehri Garhwal for unhealthy ulcers (Dangwal 2019). Tharu tribe of Uttarakhand mixed leaves paste along with turmeric powder then applied topically on boils as well as leaves juice is applied topically on eczema. The Gujjar community applied the paste of roots on boils and carbuncles (Sharma *et al.* 2014). Additionally, other traditional healers of Uttarakhand used fried leaves for snake and scorpion bites (Zakir 2020). Infusion of the leaves with salt is used to manage dysmenorrhea. Additionally, the plant is used for fodder and leaves are as vegetables (Gaur 1999).

7. *Amaranthus tricolor* L.: (*Lal Sag, Chaulai*).

Fl. & Fr.: August-October & October-November (Gaur 1999).

Ecology: The plant is occasionally cultivated and rarely in wasteland (Gaur 1999; India Biodiversity Portal)

Characters: Herb, 50-150 cm tall; stem obtusely angular, glabrous; leaves petiolate, ovate-rhomboid, 10-15×6-11 cm, apex acuminate, margin subentire, crenulate, base cuneate; inflorescence axillary and terminal paniculate, clustered spike; flower polygamous, tepals 3, nearly equal, oblong-obovate, stamens 3; fruit utricles (Gaur 1999).

Uses: In Uttarakhand, whole plant is used to treat cough (Verma *et al.* 2020). Root infusion with rice water is given against food poisoning (Gaur 1999).

8. *Amaranthus viridis* L.: (*Jangli chaulai*).

Fl. & Fr.: January to December.

Ecology: Plant is commonly found in open waste places, road side and open fields.

Characters: Herb, 20-60 cm tall; stem grooved; leaves petiolate, obovate, deltoid to ovate, 1.5-7×1.2-5 cm, apex acute, margin subentire, repand, glabrous, base cuneate; inflorescence axillary and terminal, paniculate spike; flower tepals 5, oblong-lanceolate, stamens 2 or 3; fruit utricles (Gaur 1999).

Uses: In Uttarakhand, traditional practitioners of Doon Valley, used roots for the treatment of urinary disorders and snakebites (Shahid *et al.* 2017). In Almora, local healers give the 2 gm powder of dried root orally thrice daily with water till complete relief in leukorrhea (Rawat *et al.* 2022). Moreover, in Uttarkashi, whole plant is used ethnomedicinally to heal wounds and boils (Monika 2020). Young shoots and leaves are cooked as vegetables (Gaur 1999).

The comparative table given below (Table 1) shows the medicinal uses of *Amaranthus* spp. found in Uttarakhand as well as in the world. The Table 2 gives the information of the production of *Amaranthus* in Uttarakhand for 2021-2022. According to reports production of *Amaranthus* in Uttarakhand (2021-22) maximum production of Amaranth is 14.667 quintal/hectare in Rudraprayag and minimum production is 10.417 quintal/hectare in Chamoli. It gives information that the weather conditions of Rudraprayag are more favorable for the production.

Nutritional values

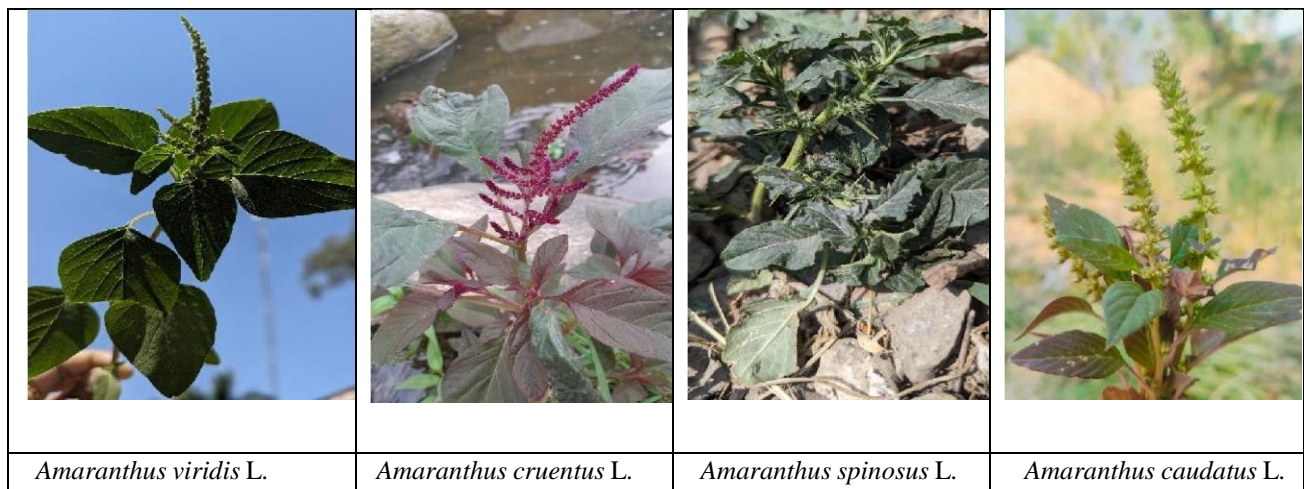
Amaranth is a highly nutritional herb that could give a variety of vital nutrients when took in different forms. The crop has high levels of protein and minerals as that can provide a range of important nutrients compared to the commonly utilized cereal grains such as millet, sorghum,

rice, wheat, and corn. Compared to the widely used cereal grains like wheat, millet, rice, corn and sorghum, the crop contains higher quantities of protein and minerals, which can provide a variety of essential elements. The food value of grain amaranth is much higher with then other cereals as Amaranth contain 16% protein, 62% carbohydrate, 8% lipids, and 3% minerals whereas wheat (12% protein, 69% carbohydrate, 1.7% lipids, and 2.7% minerals), rice (6.7% protein, 78% carbohydrate, 0.3% lipids, and 0.3% mineral), maize (11% protein, 66% carbohydrate, 3.5% lipids and 1.1% minerals), barley (11% protein, 69% carbohydrate, 1.3% lipids, and 1.9% mineral) contain low amounts comparatively. Because of the balance in its amino acid profile, grain amaranth's protein has been said to be extremely close to the amounts advised by the FAO and WHO (Aderibigbe *et al.* 2022; Raiger *et al.* 2023). Outstanding nutritional and physiological benefits as well as a great source of plant-based protein, calcium, iron, potassium, phosphorus, cobalt, copper, magnesium, manganese, fiber, sodium, lead, chromium, cadmium, nickel, zinc, and a number of essential vitamins have been reported from amaranth seeds (Baraniak and Kania-Dobrowolska 2022; Peña *et al.* 2023). Its leaves are also a highly nutritious, mineral-rich (iron, protein, β -carotene, calcium and magnesium) vegetable that is widely consumed around the world. Amaranth leaves are known for having a higher protein content than other edible leaves. Furthermore, flowers are amazing source of various

important nutrients. They contain vitamin A, vitamin C, folate, and potassium etc. as a major nutrient (Akubugwo 2008).

Bioactive compounds

Plant contains betacyans, tocopherols, tocotrienol and sterols (Bala *et al.* 2019), gallic acid, salicylic acids, chlorogenic acid, protocatechuic acid, gentistic acid, ferulic acid, quercetin, 2,4-dihydroxybenzoic acid and rutin (Peña *et al.* 2023), betaxanthins, betacyanins, vanillic acid, flavonoids, sinapic acid, syringic, ellagic, p-coumaric, kaempferol, and epigallocatechin gallates (Singhania *et al.* 2023). Shoots and seeds contain ferulic, caffeic and p-coumaric acids, betalains, amaranthin, quercetin, amaricin, amaranthoside, carotenoids and flavonoids such as, isoquercitrin and rutin (Jimoh *et al.* 2019). Leaves contain anthocyanins, betalain, β -cyanin, β -xanthin, ascorbic acid, phenolic acids, flavonoid (Singhania *et al.* 2023), amaranth, betaxanthin, arginine, betaxanthin, betalamic acid, bephacianin and isocaramantine (Bala *et al.* 2019). Leaves and seeds contain squalene, polyphenols, saponins, phytin and nitrates (V), and oxalates (Baraniak and Kania-Dobrowolska 2022). Flowers contains phenolic compounds such as gallic acid, chlorogenic acid, protocatechuic acid, 2,4dihydroxybenzoic acid, genistein, ellagic acid, feluric acid, salicylic acid, rutin, quercetin, and kaempferol-3-rutinoside and chlorogenic acid (Peña *et al.* 2023). Seeds are mainly containing lipids (Baraniak and Kania-Dobrowolska 2022) squalene and tocopherols (Wolosik and Markowska 2019).



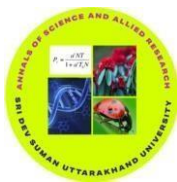


Table 1: Medicinal uses of *Amaranthus* spp. in Uttarakhand and World with their plant parts used

Botanical Names	Parts used	Medicinal Uses (Uttarakhand)	Other Medicinal Uses
<i>Amaranthus blitum</i> L.	Whole plant	Ulcers, pharyngitis, tumor (Bano <i>et al.</i> 2017).	Roundworm, biliousness, hemorrhagic-diathesis, and blisters (Rahman and Gulshana 2014).
<i>Amaranthus caudatus</i> L.	Whole plant	Hemorrhoids, sores (Ratha <i>et al.</i> 2018).	Bladder distress, hemorrhoids, dentalgia, hematological disorders, dysentery (Martinez-Lopez 2020), and urolithiasis (Shukla <i>et al.</i> 2017).
<i>Amaranthus cruentus</i> L. (syn. <i>Amaranthus paniculatus</i> L.)	Seed	Killing of liver worm in children, throat infections and fever (Zakir 2020; Kala and Nautiyal 2023).	Constipation (Azab 2020), anemia, renal complaints, limbs pain, worm infestation, wound and tumors (Torane <i>et al.</i> 2019).
<i>Amaranthus graecizans</i> L.	-	-	Edema, mastitis, ulcers, sores, itching, scorpion sting, snake bites (Mohammad <i>et al.</i> 2012), and constipation (Azab 2020).
<i>Amaranthus hybridus</i> L.	Seed	Dyspepsia (Bhatt <i>et al.</i> 2024)	Intestinal bleeding, diarrhea and excessive menstruation (Olusola and Anslem 2010).
<i>Amaranthus spinosus</i> L.	Leaf, Root	Ulcers, boils, eczema, burns, carbuncle, Snake and scorpion bites (Bisht <i>et al.</i> 2013; Dangwal 2019; Sharma <i>et al.</i> 2014; Zakir 2020)	Bronchitis, biliousness, nausea, anorexia, blood diseases, burning sensation, leukorrhea, gastrointestinal disorders, leprosy, piles, wounds, rheumatism and hemoptysis, jaundice, gonorrhea, eczema, menorrhagia, diabetes, sores, malaria, pyrexia, odontalgia, cataract, wound, skin disorders, bone fracture, dentalgia, ophthalmia (Kumar <i>et al.</i> 2014; Azab 2020).
<i>Amaranthus tricolor</i> L.	Whole plant	Cough (Verma <i>et al.</i> 2020)	Post-partum problems, strengthen hair roots, dentalgia, leukorrhea, impotence, ascaricide, otalgia, sore throat, bronchitis, skin disorders, diabetes, impotence, menorrhagia, gastrointestinal disorders, ulcer, inflammation, orchitis, hemorrhoids, bladder disorders, calcium retention, colds. cough, animal bites, colic, and gonorrhea (Bala <i>et al.</i> 2019; Rahmatullah <i>et al.</i> 2013).
<i>Amaranthus viridis</i> L.	Whole plant, root	Wounds, boil, leukorrhea, urinary disorder and snake bite (Shahid <i>et al.</i> 2017; Rawat <i>et al.</i> 2022; Monika 2020).	Improve eye sight (Azab 2020), burning sensation, menorrhagia, hallucination, leprosy, bronchitis, hemorrhoids, leukorrhea and constipation (Rahman and Gulshana 2014).

Table 2: Scenario of *Amaranthus* production in Uttarakhand (2021-22)

Districts of Uttarakhand	Area (Hectare)	Total production (Metric ton)	Average Yield (Quintal/hectare)
Chamoli	1839	1916	10.417
Dehradun (Hilly area)	245	342	13.959
Dehradun (Plain area)	*	*	*
Dehradun	245	342	13.959
Haridwar	*	*	*
Pauri Garhwal	102	142	13.950
Rudraprayag	278	408	14.667
Tehri Garhwal	717	1032	14.396
Uttarkashi	1629	2345	14.396
Almora	171	196	11.484
Bageshwar	274	315	11.484
Champawat	12	14	11.500
Nainital (Hilly area)	23	26	11.304
Nainital (Plain area)	*	*	*
Nainital	23	26	11.304
Pithoragarh	11	13	11.484
Udham Singh Nagar	*	*	*

* Means no production.

(Source: Uttarakhand Agriculture Government, 2021-2022).

DISCUSSION

Amaranth is considered as a staple Indian diet and is described as a “superfood” because of its high protein content and well-balanced amino acid profile. The components of *Amaranthus* are benefited for various diseases as bladder distress, hemorrhoids, dentalgia, hematological disorders, diabetes, cancer, menstrual disorders and various gynecological disorders, *etc.* Accordingly, here is a huge possibility that it could be beneficial for more critical diseases as well. So, we need to try to elaborate its phytochemical study.

Moreover, *Amaranthus graecizans* is a valuable plant found in Uttarakhand and has many medicinal properties, which is used in various types of diseases all over the world, but due to the greater use of other species of *Amaranthus* in Uttarakhand, this species has become less popular among the local people of Uttarakhand. It can be used in many diseases, hence there is a need for additional research on this plant, so that in future all major diseases can be avoided by using it. Various types of diseases and ill effects of allopathic

medicines can be avoided by adopting all the species of *Amaranthus* in one's diet as much as possible.

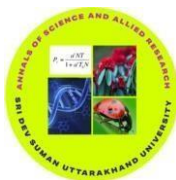
As it is known from Table 2 that the maximum production of *Amaranthus* has taken place in Rudraprayag, then we should increase its production at commercial level, this will also provide employment opportunities to the local people, the economic growth of Uttarakhand state will also increase. People across the country and the world will benefit from its properties and it is also a very good option for those on a gluten-free diet.

Conclusion

Medicinal plants provide individuals with a natural kind of healthcare. Local people of Uttarakhand traditionally use *Amaranthus* spp. easily available medicinal and nutritious plants for health without any side effects. There are a lot of chance to exploit it. Government should be responsible to conserve these species and make awareness programs for peoples.

Conflict of Interest

Authors declare that they have no conflict of interest.



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