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A REVIEW ON CHEMICAL COMPONENT OF *AMARANTHUS CRUENTUS* SEEDS AND VEGETABLE: TAXONOMY, NUTRITIONAL COMPOSITION AND LITERATURE

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ABSTRACT

A few decades ago, the extremely promising plant genus amaranthus was identified as having the potential to provide exceptional protein, unsaturated oil, and a number of other health benefits. Only three of the 60–70 Amaranthaceae species produce grain, and *Amaranthus cruentus* is one of them. Its distinctive chemical composition makes it stand out Amaranthus is a highly promising plant genus that has recently come to light. It may provide exceptional protein, unsaturated oil, and a number of other health benefits. This in-depth analysis focuses on topics including chemical makeup, nutritional content, and taxonomy categorization.

KEYWORDS: *Amaranthus cruentus*, Seeds, Chemical composition.

1. INTRODUCTION

Amaranthus is a member of the Amaranthaceae family which has over 60 recognised species.[1] *Amaranthus hypochondriacus, Amaranthus hybridus, Amaranthus cruentus*, and *Amaranthus caudatus* are a few of the species. Amaranths have been domesticated for use as ornamental plants, food, and leafy vegetables. In Malawi, the diversity of amaranthus species and their profusion of environmental adaptations set them apart. Information on the genetic

diversity as well as nutritional variation among the species and their wild relatives is essential for the efficient use of plant genetic resources, such as crop development of amaranth.[2] Several amaranth species are taken from wastelands and forests for their non-woody wood products. Rural communities in Malawi have grown amaranth as a grain and leaf vegetable in crop fields and communal spaces, and some have made explicit attempts to conserve the species around their homesteads. This is true even though many tribes in Malawi gather amaranth in the wild, oftentimes in forested areas.[3] Given the environmental, genotypic, and agro-ecological parameters on which the plant genotypes have evolved and are appropriate, it is anticipated that the nutritional characteristics of amaranthus will differ greatly.[4] Depending on the habitat, genotype, and suitability to a particular agro-ecological site under which the plant genotypes have evolved and are acclimated, amaranth nutritional properties are anticipated to differ greatly.

The ancient crop genus Amaranthus, which is indigenous to Central and South America, is represented by about 400 species in amaranthaceae family.[5] Amaranthus is a plant with great economic importance due to the fact that both its leaves and seeds can be consumed. The nutritional value of leaves and seeds is linked to their high protein, vitamin, and mineral content.[5] Amaranth seeds are essential for people with celiac disease because they are free of gluten, high in protein, and have a better balance of amino acids than cereals like wheat, maize, and sorghum.[5] The use of amaranth has been promoted in many countries with the aim of supplying fresh sources of nutrients and bioactive compounds.[6]

Amaranthus species vary widely in their ability to fight off germs, act as antioxidants, and scavenge free radicals.[7] Although there are about 60 different varieties of amaranthus, not all of them are frequently found on menus. *Amaranthus blitus, Amaranthus tricolour, Amaranthus cruentus, Amaranthus dubius,* and *Amaranthus hypochondriacus* plants' young leaves are used in salads and soups. The grains of *Amaranthus cruentus, Amaranthus caudatus, Amaranthus hypochondriacs, Amaranthus hybridus, and Amaranthus mantegazzianus* are used to manufacture breads, cakes, pastries, confectionary, and soups as opposed to species like *Amaranthus retroflexus, Amaranthus viridis,* and *Amaranthus spinosus.* An annual plant that is endemic to temperate and tropical climates is called *Amaranthus cruentus.* It is grown for the nutritional value of the seeds.[1,5,8] It is a valuable raw material because all components can be used for both food and non-food purposes. The amaranth seed may have a lipid fraction (7-8%) high in squalene of vegetal origin (5-6%).[9]

The production of cholesterol, steroid hormones, and vitamin D for humans requires the triterpene squalene, which is primarily used as a supplement or in cosmetics.[10] Because of its moisturizing and anti-external agent effects, such as those against air, light, UV rays, environmental contaminants, etc., squalene is generally employed in pharmaceutical formulations, and particularly in cosmetic formulations, for the treatment of skin disorders.[11] The cosmetics industry uses it specifically to make moisturizers, cosmetics, lipstick, and hair care products since it is a great emollient. Due to its better oxidation stability and lack of double bonds, squalane, a hydrogenated derivative of squalene, is typically preferred to squalene.[12] Additionally, 15% of the weight of an amaranth seed is made up of proteins. Due to their biocidal, antioxidant, and protein-reinforcing characteristics, the latter could be used in bread flours.[13] The capacity to emulsify (surfactants for food or in creams for cosmetics)[14] or their adhesive properties in the panel industry[15–17] are further potential uses for them. Lastly, the starch content of amaranth seeds can reach up to 55% of their weight.

After being plasticized/gelatinized (along with the denaturation of proteins) by a thermo-mechano-chemical pre-treatment using twin-screw extrusion technology, amaranth seed (or cake) may theoretically be turned into thermoplastic granules for injection-molding applications.[18,19] In the process of growing amaranth, a stem is also produced. Up to 80% (w/w) of the plant aerial part is made up of a pith fraction in the inside and a bark fraction on the outside (also referred to as a woody component or ligneous fraction). To our knowledge, no projects that have already used the amaranth stem to generate bio-based materials, particularly for construction purposes, have been documented in the scientific literature. But using natural fibers (or aggregates) in place of mineral fillers, glass, or carbon fibers in composites has a number of advantages. Particularly recyclable, economical, and society-safe are composites made from natural by products. For instance, it has been shown that flax and jute fibers can be utilized to reinforce acrylic resin, and the resulting composites can be applied to the automotive sector.[20] The structure of the amaranth stem, which has a pith in the center and a bark on the outside, is also comparable to that of the sunflower, which is already used in the building sector. It is possible that the amaranth stem's pith and bark pieces could be used for these numerous reasons to create bio-based composite materials for construction, which would immediately benefit society.


Fig. 1: Seed and Plant of *Amaranthus cruentus.*

Taxonomical Classification of *Amaranthus cruentus*[21]

- Kingdom: Plantae
- Subkingdom: Tracheobionta
- Order: Caryophyllales
- Family: Amaranthaceae
- Genus: Amaranthus L.
- Species*: A. cruentus*

2. Description of *Amaranthus cruentus*

Amaranthus cruentus, a tall perennial with clusters of dark pink blossoms on top. The plant can grow up to 2 meters (6 feet) tall and blooms from summer to fall. *Amaranthus hybridus*, which is assumed to be its ancestor, and several of its morphological traits are similar. An Inca ritualist reportedly produced a purple variant of the plant, despite the fact that it is generally green. Trees in Wayanad, Kerala, can grow as tall as 13 feet.

Amaranthus cruentus is an annual herbaceous plant that reproduces only through seed and has a 4-6 week growth season.[22] There is only one dominant, substantial and Central root formed. Frequently straight, branched, ribbed, and red-dyed stems are found on thick stems. They are between 0.1 and 2.0 meters tall. The leaves are simple, stipule-free, spirally arranged, and range in shape from oval to rhombic-ovate. The surfaces of leaves and stems are coated in little, fine hairs. With numerous green unisexual blooms that form finger-like spikes, axillary spikes and a tall, thick terminal panicle are produced. Frequently, the final surge is lax. Due to the presence of 5 lanceolate, sharp, 2 to 3 mm long tepal segments with long, pointy points, the inflorescence is visibly prickly. Five 1 mm long stamens make form the male bloom, while an ovary with one cell and three stigmas on top makes up the female

bloom. When the plant reaches maturity, the entire thing could turn scarlet.[23] A large number of concentrated cymes that are arranged axillarily and terminated with spikes and racemes make up the inflorescence, which is both extensive and complicated. The upper branch is perpendicular and includes numerous laterals in addition to short branches that can grow to a length of 45 cm. Bract length is about 2-3 mm. The inflorescence is about 50 cm long and features a variety of hues. Each of them yields more than 50 000 shiny, dark-brown, spherical, or, more frequently, lenticular seeds with a diameter of 1–1.5 mm.[24] Only light or light mixed with high temperatures will cause germination. Light and temperatures between 20 and 35 °C are the main contributors to the growth.[25]

3. Nutritional Composition of *Amaranthus cruentus* Seeds

According to studies, Pseudocereal Amaranthus cruentus has a comparably high nutritional value.

- There are many protein fractions present, such as albumin, glutelin, globulin, and prolamin. Patients with celiac disease can eat seeds because they don't contain gluten.
- The great nutritional quality of the seed is mostly attributed to the high concentrations of the amino acids lysine, tryptophan, and sulfur.
- Antioxidant, anticancer, anti-allergic, and antihypertensive bioactive peptides and lunasin-like peptides.
- Starch, which has good gelatinization properties and freeze/thaw resilience that are valued in the food industry, makes up the majority of the carbohydrate fraction found in the seeds. Amaranth has a substantial physiological impact due to the presence of fiber.
- Amaranth grain contains significant amounts of easily absorbed iron, magnesium, calcium, and potassium.
- Amaranth seeds have a comparable nutritional profile to other cereals, including folic acid, pantothenic acid, niacin, and B vitamins. However, they also include significant quantities of - and -tocotrienols.
- The amaranth grain contains considerable biologically relevant flavonoids and phenolic acids.
- Compared to other cereals like quinoa, wheat, barley, rye, and oats, seeds have more total fat. Linoleic acid predominates among the unsaturated fatty acids that make up the lipid fraction. Palmitic and oleic acids were also present in amaranth seeds. Squalene, which contains a wide spectrum of biological activities and antioxidant properties, is also abundant in grains.

Table 1: Chemical Composition of *Amaranthus cruentus* Seeds.

Composition	Quantity	References
Moisture	6.23-6.71	[26–29]
Crude Protein (% dmN * 6.25)	13.2 – 17.6	
Total lipids (% dry matter (%dm)	6.3 – 8.1	
Crude fiber (% dry matter (%dm)	3.4 – 5.3	
Crude ash (% dry matter (%dm)	2.8 – 3.6	
Sodium*	31.0	
Potassium*	290	
Calcium*	175	
Magnesium*	244	
Iron*	17.4	
Zinc*	3.7	
Copper*	1.2	
Manganese*	4.6	
Riboflavin*	0.19 – 0.23	
Niacin*	1.17 – 1.45	
Ascorbic acid*	4.5	
Thiamine*	0.07 – 0.1	
Phytate (%)	0.50 – 0.58	
Tannin (Catechin equiv. %)	0.043 – 0.13	

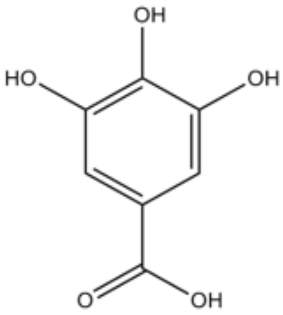
*****(mg/100g dry matter)

Table 2: Phenolic acid concentration of Amaranth cruentus cultivars' seeds (µg/100mg dry weight).

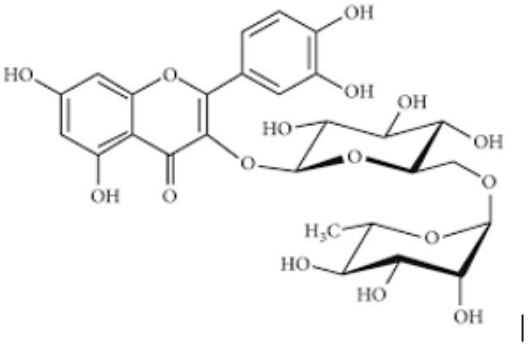
Phenolic compounds	Seeds	Reference
Gallic acid	958.69	[49]

Table 3: Flavonoids concentration of Amaranth cruentus seeds (µg/100mg dry weight).

Flavonoids	Seeds	Reference
Rutin	107.65	[49]



Gallic Acid



Rutin

4. Literature study of Pharmacological uses of *Amaranthus cruentus* Seeds

4.1 Antioxidant Properties

In vitro antioxidant and xanthine oxidase inhibitory activity were reported by Nana et al. in a Study based on Hydroacetonic, Methanolic, and Aqueous extracts made from aerial part of *Amaranthus cruentus* and *Amaranthus hybridus*.[31]

The maximum antioxidant capacity was found in *Amaranthus cruentus*, which scavenged 85.6% of DPPH at the applied concentration, according to Nsimba *et al.* evaluation of antioxidant capacity and TPC in defatted amaranth seeds. A. hypochondriacus seeds had the greatest TPC, measuring 133.2 mg/g tannic acid equivalents, which is noticeably greater than the defatted seeds examined in our study.[32]

4.2 Anti-cancerous properties

Polyphenols have demonstrated in vitro antiproliferative and chemopreventive efficacy. A. cruentus aqueous extract was investigated for antiproliferative activity on human peripheral lymphocytes by Gandhi et al. They hypothesised that it may be employed as a less expensive, more biocompatible, and commercially available alternative to currently known anti-proliferative therapies.[33]

Based on their observations of the lipid profile and liver histoarchitecture in Wistar rats, Escudero *et al*. came to the conclusion that the presence of phenols in the protein concentrate and flour of *Amaranthus cruentus* seeds increases antioxidant defences, acting as a protective factor in the liver.[34]

4.3 Anthelmintic Activity

Minor adjustments to Nargund's method were made for the anthelmintic assay. The adult Indian earthworm Eicinia feotida was used for the test because of its morphological and physiological similarities to the human intestinal round worm infection. To get rid of all feces, these earth worms were washed in regular saline. For the experiment, ten-centimeter-long earth worms were used. Before beginning tests, the test solution and standard solution were both freshly produced. The same dilutions of extracts in normal saline solution were utilized for the experiment, where normal saline served as the control, and various dilutions of albendazole with normal saline were employed as standards. The earthworms were separated into various groups, each of which had six worms. Each extract was made at two distinct con^{c}. (0.1 mg/ml and 0.25 mg/ml). The duration of the paralysis was measured using

external stimulation. When a worm stops moving, that period of time is referred to as its paralysis time, and the deadly period is determined by the worm's death and the fading of its body color.[35]

4.4 Anti-anemia

The ability of *Amaranthus cruentus* to treat anemia has been demonstrated by Chaudhary B et al (2016) to greatly boost hemoglobin and RBC. The plant also has high levels of folic acid, Calcium, iron, and Vitamins A, E, and C. The leaf is the part of the plant that is used. Phenylhydrrazin 60 mg/kg intraperitoneally injected test animals were stimulated for three days in a row. The duration of this observation was around 25 days. In this therapy, Amaranthus cruentus extract was utilized at a dose of 200 mg/kg, phenylhydrazine at a dose of 60 mg/kg as an induction, and phenylhydrazine at a dose of 400 mg/kg as a comparison of test animals given Ferritop-Z. White blood cells (7.65 x 103/mm3), hemoglobin (9.87 g/dL), and hematocrit (38.78%) microhematocrit technique from Baker and Silverton (1985) all showed a substantial increase (P 0.001) after the studies. When erythrocyte count (7.23 x 106/mm3) and hemoglobin (10.65 g/dL) in group 3 (Ferritop-Z) are compared, it can be said that *Amaranthus cruentus* extract at a dose of 400 mg/kg is similar to Ferritop-Z as a substitute treatment for anemia.[36]

Animal, clinical, and in vitro experiments evaluating Amaranthus species

Amaranth	Subjects	No.	Time period	Results	Reference
Amaranthus cruentus flour	Individual sensory panel	Ten	--	The "gluten free" label is on the cookies.The cookies had a significant protein content, which raised their nutritious value.	[37]
Amaranthus cruentus seed	Male Buffalo rat	sixty	--	The liver contained 10% less triacylglycerol.	[38]
Amaranthus cruentus seed	Male Buffalo rat	sixty	28 days	A content of these lipids was unaffected by the amaranth and lard diets.	[39]
Amaranthus cruentus seeds & its oils	Hamster	--	4 week	Amaranth affected the amount of hepatic cholesterol, how much was produced, where cholesterol lipoproteins were distributed, and how much cholesterol and bile acids were absorbed.	[40]
Protein concentrates from *Amaranthus cruentus*	Male Wistar rat	Twenty	28 days	The rat's antioxidant defense mechanisms, hepatic lipid metabolism, and effects on hypotriglycerides are all impacted by the protein concentrate from A. cruentus.	[41]

Amaranthus cruentus extruded	women	Eleven	7days	The amaranth snack raises blood sugar and insulin levels.	[42]
Amaranthus cruentus flour	member sensory panel	Thirty nine	--	Amaranth shown potential for producing high-nutritional biscuit goods for both the general public and gluten-sensitive consumers.	[43]
Amaranthus cruentus seeds	*In- vitro*	--	--	Amaranth is a food with a high glycemic index. The popping, roasting, and flaking methods dramatically enhanced the hydrolysis index, anticipated glycemic index, and amounts of quickly digested starch.	[44]
Amaranth protein isolate from *Amaranthus cruentus*	Golden Syrian Hamster	Fourty four	4 weeks	Total plasma cholesterol concentrations in animals fed meals containing amaranth protein isolate were 27%, with non-HDL fractions being most affected.	[45]
Amaranthus cruentus	*In vitro*	--	--	The protein that had been digested by alcalase exhibited the greatest levels of inhibition both before and after in vitro digestion.	[46]
Amaranthus cruentus seeds	Male Wistar rats	Thirty six	5 weeks	A moderate level of protection can be provided by amaranth seeds against fructose-induced changes in rats by reducing lipid peroxidation and increasing antioxidant capability.	[47]
Amaranthus cruentus seeds	*In vitro*	--	--	Compared to seeds, sprouts have a higher antioxidant activity because to variations in the concentrations of polyphenols, anthocyanins, and other compounds.	[48]

CONCLUSION

After detailed study on the *Amaranthus cruentus* seed we concluded that the seed of *A. cruentus* are rich source of variety of phytoconstituents such saponins, tannins, phenols, flavonoids, vitamins, minerals etc. from this review we have concluded that this plant can be useful for the prevention for numerous diseases because this plant have variety of phytoconstituents.

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