CHAPTER 4

THE PLANT OF IMMORTALITY "AMARANTH"

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Fig 1. Amaranthus caudatus

History of Amaranth Plant

It has been consumed as a staple food It has been consumed as a staple food through history, including the Inca, Mayan and Aztec civilisations (Caselato-Sousa ve Amaya-Farfán, 2012. Amaranth, which was widely cultivated and consumed in Latin America, was banned after the Spanish conquest and continued to be produced only on a small scale (Berghofer and Schoenlechner, 2002).

Taxonomy of Amaranth

Amaranth belongs to the genus Amaranthus and the family Amaranthaceae, which consists of 65 genera and 850 species. This genus consists of 50-60 species, the leaves of which are edible. The most important foliage vegetables in tropical countries in South Asia, South East Asia, east Africa, centre Africa, west Africa, Ethiopia, the Pacific and the Far East.

Important species of the amaranth plant are given below. These are:

Amaranthus tricolor L.



Fig.2.https://seedcorner.com/amaranthus-perfecta-amaranthus-tricolor-seeds/

Amaranthus dubius L.



Fig.3.https://tr.wikipedia.org/wiki/Amaranthus_dubius

Amaranthus lividus



Fig.4.https://botany.cz/cs/amaranthus-lividus/

Amaranthus blitum



Fig 5.https://getplanta.com/plant/flowering-plants / RXLochCmycoW4mDC2yya/ amaranthus-blitum

Amaranthus tristis L.



Fig 6.https://www.organicgarten.com/products/amaranthus-tristis/47710200000022884

Amaranthus spinosus L.



Fig7.https://mrec.ifas.ufl.edu/research/weedsbyflowercolorgreen/amatanthusspinosus/

Amaranthus viridis L.



Fig 8. https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:316349-2

Amaranthus graecizans L.



Fig 9. https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:10641-2

Amaranthus-hypochondriacus



Fig 10. https://indianmedicinalplants.info/medicinalplants-gallery/ index. php/Medicinal-Plants-of-America/Amaranthus-hypochondriacus

Amaranthus cruentus



Fig 11. https://pladias.cz/en/taxon/overview/Amaranthus%20cruentus

The most popular grain-like Amaranth species are *Amaranthus Hypochondriacus L., Amaranthus cruentus L.* and *Amaranthus caudatus L.*

Amaranthus hypochondriacus is a disease-resistant species that grows in temperate conditions. Due to its excellent nutritional composition, it can be roasted and ground like corn used in bread making at home (Mlakar et al., 2009). It is grown as an ornamental plant in Africa. It is used in the computer industry and cosmetics industry due to the oil contained in the starch granule (Schippers, 2002, Grubben and Denton 2004). It is also used in the pharmaceutical industry due to the active ingredient squalene found in its grain (He ve ark. 2002; He and Corke, 2003). It has been reported that squalene has beneficial effects on cancers (Rao and Newmark, 1998) and reduces the cholesterol level in the blood (Smith, 2000).

Amaranthus cruentus is a widely adapted plant with neutral photoperiod requirements. The protein of *A. cruentus* has amino acids including methionine and cysteine and high amounts of sulfur (Martinez-Nunez et al. 2019). This makes it a good combination with cereals that can be used for the formulation of complementary foods and snacks. Its leaves and tender stems are used in various dishes. As a way to add value to extend shelf life, the leaf can be dried and ground into a powder

Amaranthus caudatus, is grown at high altitudes in South America and Asia. Its seeds can be dried, ground and used in human nutrition in the form of whole grain amaranth flour, crackers, gluten-free brown bread, biscuits and cookies. Interspecific and intervarietal hybridisation in nature has resulted in a wide variation in the colour and shape of the leaves and flowers of the plant and even in the time between sowing and harvesting.

Botanical Characteristics of Amaranth Plant

Amaranth is a dicotyledonous plant belonging to the Amaranthaceae family. It does not belong to the same family as cereals, but it is classified as pseudocereal (cereal-like) because its nutritional composition and intended use are the same (Berghofer and Schoenlechner, 2002).

Amaranth is an annual herb, erect or creeping, with few or many branches. Some species have developed fringing roots and some have developed taproots. Stem color is green to purple or mixed shades of these two colors, glabrous and succulent; leaf simple, alternate or opposite, leaf tip lanceolate, leaf color purple in young leaves, green in mature leaves; inflorescence terminal and axil, colors can be different colors from green to dark purple and orange. Flowers small, regular, mostly unisexual, monoecious. Filaments free or united at the base, anthers one- or two-parted, style one, two or three-branched.

The proportion of male and female flowers varies during the flowering period. Each glomerulus consists of an initial staminate flower and an

indeterminate number of pistillate flowers. The extent and degree of cross-pollination is governed by the ratio of staminate and pistillate flowers within an inflorescence and the position of the inflorescence on the plant.

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Cultivated for its leaves, Amaranthus is said to be native to India; the centers of Amaranthus diversity are Central and South America, India and Southeast Asia, with secondary diversity in West Africa and East Africa. Among the leafy species, *Amaranthus tricolor* has a dominant position in India with different morphological forms in terms of color and leaf shape. Amaranthus cruentus is cultivated in Guatemala. The species *Amaranthus caudatus* is cultivated mainly in the Andes Mountains of the Americas and is also distributed in Asia and Africa. The nutrient content of amaranth leaves is given in the table below (Table 1).

Table 1. Nutrient content of Amaranth leaves (g/100 g).

Composition	**Quantity**	**Composition**	**Quantity**
Water (g.)	10.0	Leucine (mg/g N)	403
Crude Fiber (g.)	9.6	Histidine (mg/g N)	121
Protein (g.)	2.5-3.5	Valine (mg/g N)	241
Fat (g.)	0.31-0.5	Tryptophan (mg/g N)	59
Carbohydrate (g.)	4-6	Phenylalenine (mg/g N)	273
Iron (g.)	2.3-3.2	Tyrosine (mg/g N)	236
Calcium (mg.)	215-260	Methionine (mg/g N)	111
Vitamin C (mg/100 mg)	43-55	Potassium (mg/100 mg)	508

(Uusikua et al. 2010)

The chemical composition of Amaranth seed is shown in Table 2.

Table 2. Chemical composition of Amaranth plant seed

Bileşim	**Miktar**	**Bileşim**	**Miktar**
Energy (kcal/100 g)	371	Vitamin C (mg/100 g)	4-7
Moisture (%)	11.29	Iron (mg/100 g)	7.61
Protein (%)	13.56	Zinc (mg/100 g)	287
Oil (%)	7.2	Magnesium (mg/100 g)	248
Ash (%)	2.88	Manganese (mg/100 g)	3.3
Carbohydrate (%)	65.25	Potassium (mg/100 g)	508
Fiber (%)	6.7	Calcium (mg/100 g)	159

(Berghofer and Schoenlechner 2002; Caselato-Sousa, and Amaya-Farfán, 2012; Barba de la Rosa., et al. 2009; Valcárcel Yamani B., et al.)

As can be seen from the tables, Amaranth leaves are higher in Vitamin C, fiber and Calcium than seeds, but lower in protein, fat and carbohydrates.

Sowing

Amaranthus is grown from seed. To grow plants outdoors, planting should be done after the last frost dates of the region, when the soil begins to warm up. The sowing time for our country is mid-March for the western and southern regions and mid-April for the eastern and northern regions. If Amaranthus is to be grown for seed, 200 g/ha of seed should be used; if it is to be grown for grass, 100 g/ha of seed should be used. 40-50 plants per square meter is ideal.

Since the seeds of the Amaranthus plant are small, the soil should be thoroughly broken up and crumbled in order to ensure easier germination. Good emergence could not be achieved when sowing in cloddy soils. The application of burnt barnyard manure before plowing the soil gives very good results for seed and seedling development. Amaranth sowing can be done with a grain seeder, hand sowing in rows or sprinkling sowing and seedling planting.

If direct sowing is to be done, two methods are applied. These are row sowing and sprinkle sowing. In row sowing, rows are opened at 50 cm intervals and seeds are sown in these rows by hand. A gap of at least 20-25 cm should be left between the two seeds. Then the seeds should be covered with about 1-1.5 cm of soil. If the sowing is to be done as sprinkling, the seeds are mixed with 10 parts of sand for even distribution of the seed and scattered on the field. Afterwards, the soil is not cultivated with any tool. If planting is to be done as a seedling, planting is done by leaving 50 cm between rows and 20-25 cm above the row, as in seed planting. Care should be taken to ensure that the seedlings are 15-20 days old.

Climate and Soil requirements

Amaranth can grow in a wide range of climatic conditions (Chauhan ve ark., 2016). However, it is sensitive to temperatures below 0°C. A temperature range of 20-30°C is ideal for good vegetative growth. A. caudatus, A. cruentus and A. edulis are short-day species, while the commonly cultivated cereal Amaranthus species, namely A. hypochondriacus, are neutral-day plants. However, all species have early and late varieties. Grain-type Amaranthus are highly drought tolerant. Leafy Amaranthus is best grown in the plains.

The most suitable soils for growing Amaranthus are loamy soils with good drainage, close to neutral pH (Sagar et al., 2023). However, they can be grown in all soils except heavy clay soils.

Fertilizer and Water Requirement

Amaranth responds very positively to fertilizers and organic matter. For amaranths to be grown for seed, it is recommended to add 2.5 tons of burnt farm manure per decare and mix it with the soil before tilling the soil, and then apply pure fertilizer at 5 kg N/da, 5 kg P/da and 5 kg K/da. For the Amaranth plant to be grown for its leaves, 2.5 tons of burnt farm manure per decare should be mixed into the soil before planting, then 3 kg N/da, 5 kg P/da and 5 kg K/da fertilizer should be applied with planting, and 3 kg N/da eight weeks after planting. It is also recommended to give . It has also been suggested that for high seed yield, leaf harvest should be done once 30 days after planting (Yawalkar and Ram 2004). Since the frequency of irrigation will increase during hot and dry summers, the amount of nitrogen in the soil must also be increased. In such cases, up to 12 kg N/da of fertilizer can be applied to the soil.

The crop should generally be planted in a field with sufficient moisture. However, if the moisture in the field is not sufficient during planting, the first irrigation should be done immediately after planting and then again on the third day. Subsequent irrigations are carried out at intervals of 3 to 5 days in summer and as needed in rainy seasons.

Drip irrigation is recommended as an irrigation method. Weed growth was also found to be less in lands irrigated with drip irrigation (Aras, 2006). As irrigation frequency and nitrogen levels increased, protein content also increased.

Treatments

Regular pulling of weeds in the early stages of cultivation reduces competition for nutrients, light, moisture and space between the plant and weeds. Thus, the plant can grow better. In addition, hoeing in the early stages not only destroys weeds, but also ensures better aeration of the soil. This

should be done until the plant reaches a height of 25-30 cm from sowing. After 10-15 days after sowing, thinning should be done so that 20 cm space is left between the plants. At the seedling stage, one fungicide spraying will be useful to prevent the plant from getting fungal diseases. At the seedling stage, one fungicide spraying will be useful to prevent the plant from getting fungal diseases.

Harvest

If harvested as leaves, the plants must be collected with their roots on the 25th day from the planting date, and if they are to be harvested as stems, the plants must be collected with their roots on the 40th day from the planting date. In amaranth, the grains ripen early, but the whole plant dries quite late. If the ears are left until the plant dries, it will cause excessive grain fragmentation and heavy grain loss. This is why it is important to minimize grain loss when the seeds begin to dry. Therefore, in order to minimize grain loss when the seeds start to dry, the head of the plant is cut off in the morning when the sun rises and the plant is a little wet, these heads are pounded to extract the seeds, and these seeds are left in the sun for 6-7 days to dry thoroughly. The product will be ready for harvest within 80-120 days, depending on the variety and season. A healthy crop with good management practices provides a grass yield of approximately 20 to 40 tonnes per hectare, depending on the variety. The crop planted in March yields higher yields than the crop planted in June.

Uses:

Amaranth is mostly used for seed production in the USA, but it is also used for different purposes in other parts of the world. In Africa and the Caribbean, the leaves of Amaranth are harvested at certain times and consumed as greens. In China, farmers use the plant as fodder for large pigs and cultivate over 100,000 acres. The vast majority of Amaranth produced in the US is used as mill flour, mixed with wheat flour or other flours to make breakfast cereals, crackers, cookies, bread and other bakery products. Utilization rate studies have shown that Amaranth can be blended with other flours to 50% or even 75% in bakery products without any change in properties or taste. FAO statistics do not list the production amount.

Amaranth contains about 13-14% protein. The protein content of amaranth is usually higher than that of cereals.Amaranth proteins consist of 40% albumin, 20% globulin, 2-3% prolamin and 25-30% glutenin.Amaranth globulins have been reported to have some functional properties such as emulsifying properties (Berghofer ve Schoenlechner, 2002). The lysine amino acid content of amaranth is rich compared to cereals such as corn, rice and wheat. In addition, the amount of sulfur amino acids in amaranth (2-5%) is higher than the amount of sulfur amino acids normally found in pulses at

1.4%. Amaranth, which contains amino acids such as alline, valine, leucine, arginine, arginine, phenylalanine, pralines, methionines, α aminobutyric acid, tryptophan, isoleucine and serine, is a quality protein source (Rastogi and Shukla, 2013). The protein content of amaranth is very close to the level recommended by FAO/WHO for a balanced diet (Maurya and Arya, 2018). The fact that it contains the amino acids histidine and arginine, which are essential for infants, makes amaranth important in infant nutrition (Berghofer and Schoenlechner, 2002).

Amaranth contains approximately 7% fat. The amount of fat contained in amaranth is higher than the amount of fat contained in grains. The ratio of saturated fatty acids to unsaturated fatty acids in amaranth is 1:4 (Maurya and Arya, 2018). Linoleic acid constitutes most of the unsaturated fat content of amaranth, which has a high rate of unsaturated fat. 50% of the total oil is linoleic acid, 20% oleic acid, 20% palmitic acid and approximately 1% linolenic acid. Phospholipids constitute 5% of the fat (Berghofer and Schoenlechner, 2002; Rastogi and Shukla, 2013).

Amaranth contains about two times more minerals than cereals. Amaranth also contains more minerals than buckwheat. 66% of these minerals are found in the bran and embryo layers. It contains especially high amounts of calcium, phosphorus, iron, magnesium, potassium, sodium and zinc (Mlakar and ark., 2009). Phosphorus in amaranth is produced in the presence of phytic acid. The amount of phytic acid in amaranth varies between 0.3-0.6%. Phytic acid has also been shown to lower cholesterol levels in humans (Rastogi and Shukla, 2013). Amaranth contains significant levels of vitamins and is a good source of daily essential vitamins. It contains more riboflavin and vitamin C than cereals. It is also a good source of vitamin E, which has antioxidant properties (Berghofer and Schoenlechner, 2002). Recent studies have focused on the bioactive components contained in amaranth because of their potential to reduce the risk of chronic diseases. Amaranth contains bioactive phytochemicals such as phenolic compounds, betanins and carotenoids.

As the world takes steps to tackle hunger, poverty and food insecurity, amaranth grain is being recognized again, especially for the African continent. However, its full potential has yet to be exploited. Continuous and detailed efforts in research and development are needed, as well as the coordination of all stakeholders for the effective implementation of relevant actions (Devaux et al., 2018).

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