

## Provocative health benefits of nutritional superfood Rajgira/Amaranth

Renu Singhal<sup>1</sup>, Garima Modi<sup>2\*</sup>, Manisha Choudhary<sup>3</sup>, Monika Chamoli<sup>4</sup>, Sulochana Sharma<sup>5</sup>, Raaz K Maheshwari<sup>6</sup>

<sup>1</sup> Department of Chemistry, DS PG College, Aligarh, Uttar Pradesh, India

<sup>2</sup> Department of Zoology, JNVU, Jodhpur, Rajasthan, India

<sup>3</sup> Department of Chemical Sciences, Central University of Punjab, Bathinda, Punjab, India

<sup>4</sup> Department of Chemistry, Pt LR College of Technology, Faridabad, Haryana, India

<sup>5</sup> Department of Chemistry, JTTU, Jhunjhunu, Rajasthan, India

<sup>6</sup> Department of Chemistry, SBRM Govt PG College, Nagaur, Rajasthan, India

### Abstract

Grain amaranth is a pseudocereal with unique agricultural, nutritional, and functional properties. Amaranth is a healthy grain often used as an alternative to gluten-rich grains. As amaranth is gluten free, it is a great replacement grain for all people who suffer from any form of gluten intolerance, especially those who suffer from celiac disease. Amaranthus grain is the perfect example of the nutraceutical. Amaranth oil with tocotrienol and squalene has potential in medicinal foods. Amaranth oil has antibacterial, anti-tumor, and burn and wound-healing properties. Amaranthus oil also lowers blood serum cholesterol. Amaranth is an excellent source of protein which contains those amino acids that are usually found only in animal foods. It is loaded with fiber, iron, calcium, vitamins and minerals, and is significantly more nutritious than whole wheat. It is also the best plant source of squalene, a powerful antioxidant used as a dietary supplement for diabetics and those suffering from hypertension and metabolic disorders. Amaranth grain that is becoming rapidly popular has many nutritious benefits and having applicability treating many disorders with remarkable “Nutraceutical Properties”. One of the nutritional powerhouse that we seem to forget about the plain and simple amaranth or otherwise known as rajgira or ramdana is one such super-ingredient that had lost its prominence in the recent years, though lately there has been a small spike of interest in it. Therefore, it is of great importance to summarize the reasons of its importance and the chemistry behind it. This review paper describes the contents of macronutrients (such as starch, proteins, lipids), micronutrients (such as vitamins and minerals) and therapeutic importance bequeathed by amaranth grain.

**Keywords:** squalene, tocopherols, phytosterols, lysine, amaranth grain, gluten, micronutrients

### Introduction

Amaranth (*Amaranthus* spp., Greek “eternal”) originates in South America, specifically Ecuador, Peru and Bolivia. Botanically, amaranth belongs to the family of dicotyledonous plants *Amaranthaceae*, which includes more than 60 species, most of which are weeds. They can grow in width and in height, and there are both low and varieties that grow up to 4 meters high. Three varieties of amaranth are the most important: *A. hypochondriacus* (Mexico), *A. cruentus* (Guatemala) and *A. caudatus* (Peru and other countries in the Andes). The variety *A. hypochondriacus* is examined the most widely and thoroughly. Amaranth (In Latin *Amarantus*) is a pseudo-cereal superfood. The English name Amaranth comes from Latin *amarantus*. Rajgira or Amaranth has been grown in India, South America and what is now Mexico for over 8000 years for its nutritional benefits. It was the main staple of The Aztecs (modern Mexico) till the arrival of Spanish invaders. When the Spanish arrived with Cortez, they not only converted the natives into Christianity but also outlawed many native traditions and cultural practices. Rajgira was banned because The Aztecs built statues of their deity using Amaranth grains and honey. After the worship, they would break these statues and distribute for eating. Even though the Spanish tried their best to destroy Amaranth by burning fields and punishing farmers, it survived in remote areas as a

wild plant. It was rediscovered and introduced in the US in the 1970s as a wonder grain. While it was almost dead in the west, Rajgira continued to thrive in India. It was named Rajgira (Royal grain) or Ramdana (God’s grain) because of its powerful health benefits. According to modern research, Rajgira is a powerhouse that can help prevent several chronic health conditions such as heart disease, cancer and stroke. It’s also helpful in treating inflammatory issues like arthritis. It’s hard to believe that these tiny seeds pack so much nutrition. It provides most of the nutrition we need for a healthy life. Even NASA astronauts used amaranth as part of their diet in the universe.

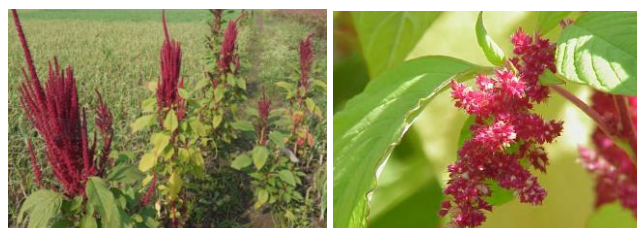


Fig 1 & 2: Rajgira plants

Grain amaranth has the potential to contribute to improvement in nutrition of populations, especially in developing countries, because of its unique agricultural,

nutritional, and functional properties. It is fast-growing, high-yielding, stress-resistant, nutritious, and has nutraceutical properties. The color of the grain varies from milky white to yellow, gold, red, brown and black, which depends on the content of the betalaine pigments.



Fig 3 & 4: Rajgira Grains

Grain amaranth is rich in proteins, lipids, energy, and fiber. Grain amaranth protein is of superior amino acid profile compared to proteins found in most other plant foods. Amaranth grains contain 2x the level of Ca in milk, 5x the level of iron in wheat, higher sodium, potassium, and vitamins A, E, C, and folic acid than cereal grains. Amaranth grain contains 6 to 10% unsaturated oil that is good for your health. Rajgira has about 13 % protein. This translates into 26 grams/ cup of raw Rajgira, which is much higher than most other grains. The protein in Rajgira is called “complete protein” because it contains Lysine, an amino acid that helps in building body muscles. Lysine is missing from or is present in negligible quantity in other grains. Lysine is a building block for protein. It is also an essential amino acid that plays a role in calcium absorption. Since our bodies can't produce essential amino acids, we need to obtain them from food. Lysine plays an important role in supporting our immune system. Lysine (Fig. 5) is absent from most vegetables and grains.

Soluble fibre found in Amaranth grain helps in improving digestion. The dietary fibre can eliminate constipation, bloating, cramping, and more serious conditions, like colon cancer and gastric ulcers. Fibre attaches to cholesterol in the digestive system and takes it out of the body. It benefits heart as well as helps in digestion. Dietary fibre also helps body in absorbing nutrients from the food. As Rajgira is a nutrient rich food, its dietary fibre helps the body absorb these nutrients. Rajgira grain may have probiotic properties. Probiotics help improve digestion by supporting the growth of beneficial gut bacteria. Rajgira can increase insulin levels in the body and bring down sugar levels in the blood. Surprisingly the anti-diabetic and antioxidative properties on Rajgira help keep blood sugar levels in check even though its GI is high. But more research is needed to prove this beyond conclusively.

### Chemical Constituents in Rajgira Grain

The total carbohydrate content of the amaranth grain is slightly lower than in the wheat grain. Starch represents the main carbohydrate component, constituting 48-69% of dry grain matter. The content of amylose is very low, from 0.1 to 11.1%. Although the starch content is also subject to large variations, it is generally lower compared to common cereals. The content of dietary fibre in amaranth grain is slightly lower than in wheat, and is generally similar to quinoa and common cereals - about 20% of dry grain matter. As per reports of researchers content of total dietary fibers, soluble and insoluble, is between 9.8 and 14.5%,

depending on the variety. Only small quantities of mono- and disaccharides were detected in amaranth grain. Sucrose is dominant, but glucose, galactose, fructose, maltose, raffinose, stachyose and inositol are also detected.

Proteins are the second most common component of amaranth grains. It is believed that the amino acid composition of the amaranth protein is close to the ideal protein. All varieties of amaranth are characterized by high protein content, from 13 to 18% dry matter which is generally higher than in cereals, and other pseudocereals. Unlike cereals, amaranth proteins consist of albumins (about 40%), 5 (25-30%) and globulins (20%), and contain very small amounts of prolamins (2-3%), which are the main group of proteins in cereals. Amaranth does not contain gluten, therefore it is therefore suitable for the diet of celiac patients. Albumins and globulins contain less glutamic acid and proline than prolamins, and are richer in essential amino acids, such as lysine, which makes amaranth proteins closer to the composition of animal proteins. Due to their favorable chemical content and the application in developing functional food products, the use of pseudocereal species in human nutrition is constantly increasing.

Gluten is a mixture of proteins found in wheat, and rye, barley and triticale. Gluten helps foods maintain their shape, acting as a glue that holds food together. The gluten protein complex accounts for 75 to 85% of the total protein in bread wheat. It is conjoined with starch in the endosperm of various grass- related grains. Gluten proteins are termed prolamins. It is a protein that is attached to starch in the endosperm of various grass-related grains. Wheat prolamins are called gliadins and glutenins, barley prolamins are hordeins, rye prolamins are secalins and oats prolamins are avenins. Prolamins are a group of plant storage proteins found in the seeds of cereal grains: wheat (gliadin) [Structure Shown], barley (hordein), rye (secalin), corn (zein), sorghum (kafirin) and as a minor protein, avenin in oats. They are characterised by a high glutamine and proline content and are generally soluble only in strong alcohol solutions. Some prolamins, notably gliadin, may induce celiac disease in genetically predisposed individuals.

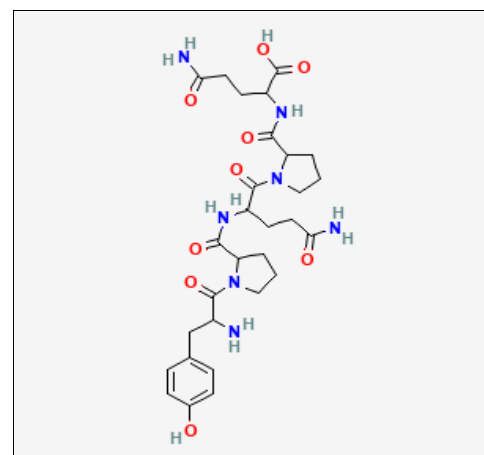


Fig 5

Amaranth is one of the three pseudocereals, next to buckwheat and quinoa, most frequently used in modern formulations of functional bakery, pastry and confectionary food products. The content of lipids in amaranth grain is higher than in common cereals, 6-9%. The content of lipids in amaranth is 2 to 3x higher than in buckwheat grains and

common cereals. Amaranth lipids consist of fatty acids, triglycerides, sterols, phospholipids, glycolipids, tocopherols, and hydrocarbons. Amaranth lipids are characterized by high content of unsaturated fatty acids, with a particularly high content of linoleic acid. Linoleic acid makes up over 50% of total fatty acids and therefore represents the most common fatty acid. Phospholipids make up about 5% of the lipid fraction, the most common are lecithin, cefalin and phosphoinositol.

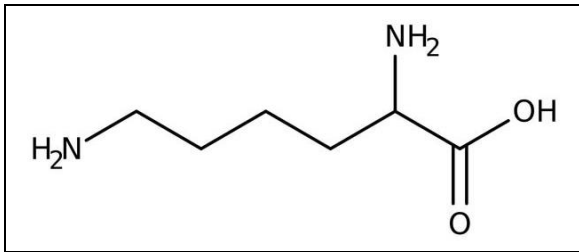


Fig 6: Chemical Structure of Lysine

Generally, amaranth is not an important source of vitamins. However, it does contain more riboflavin (vitamin B2), folic acid (vitamin B9) and ascorbic acid (vitamin C) compared to common cereals. The content of total tocopherols (tocopherols and tocotrienols) in amaranth grains may vary significantly. The most common tocopherol is  $\alpha$ -tocopherol. Some report signify appropriate concentrations of  $\beta$ - and  $\gamma$ -tocotrienols. The mineral content is about two times higher than in common cereals. The content of Ca, Mg, Zn and Fe is particularly high. The Ca/P ratio is very suitable, being in the range 1: 1.9-2.7. Recommended ratio is 1: 1.5. The high content of Ca in amaranth grain is particularly significant in patients suffering from celiac disease, due to the onset of osteopenia and osteoporosis in these individuals.

Phenolic compounds Amaranth grain contains following phenolic acids: protocatechuic, hydroxybenzoic, caffeic, and ferulic acid. Polyphenolic substances, such as rutin, nictiflorin and isoquercetin, were also detected. It is known that rutin has an effect on preventing the aging process, quercetin inhibits oxidation processes, and nictiflorin participates in the preservation of memory functions. Squalene (Fig. 6) is a biosynthetic precursor of all steroids in plants and animals. It is a highly unsaturated open chain triterpene, which is widely used in the cosmetics industry (in skin care products) and as an industrial lubricant resistant to oxidation. The richest source of squalene is a small shark liver (*Squalus acanthus*), from which comes its name, as well as some other marine species. It is also present in some vegetable oils, such as olive oil (0.1-0.5%), but particularly high concentrations are detected in amaranth oil (3-8% and 0.3-0.4% of total grain weight). The non-saponifiable lipid fraction of amaranth grain consists primarily of squalene. Amaranth is the richest source of squalene in the plant world.

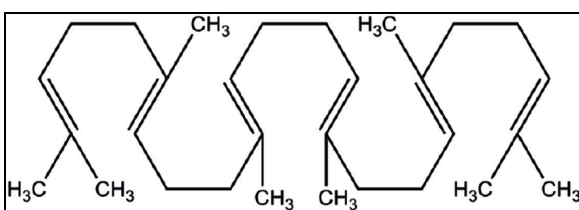


Fig 7: Chemical Structure of Squalene

Amaranth is richer in proteins and lipids, but contains less starch, compared to common cereals. Amaranth grain is rich in phytochemicals (secondary metabolites), such as rutin, nictiflorin and isoquercetin, which have a positive effect on human health. It does not contain gluten, so it can be used in the diet of celiacs.

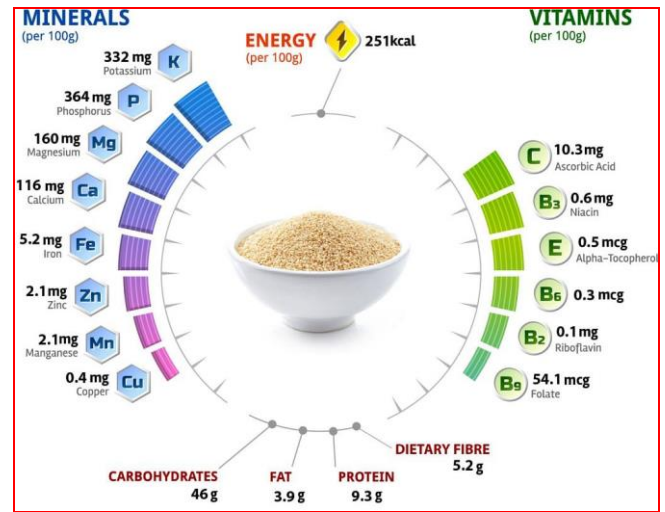


Fig 8

Amaranth grain contains pigments – betacyanins, belonging to the group of betalain pigments (Fig. 7). Two types of these pigments are present in amaranth grain: amarantin and iso-amarantin.

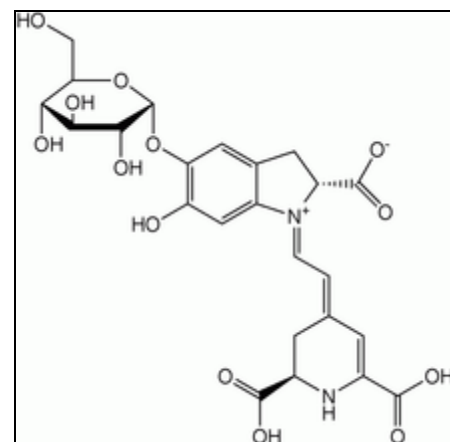


Fig 9: Chemical structure of Betalain Pigment

Tannins are present in high concentrations in the grain hull, so with grain peeling they are mostly removed. They can form complexes with proteins and digestive enzymes, thereby inhibiting protein digestion. Also, depending on the chemical composition, they can inhibit starch digestion. The phytic acid is distributed uniformly in the grain, so its content cannot be reduced by removal of the external grain layers or by water extraction. It is already known that the phytic acid has the inhibitory effect on starch digestion, and the positive effect on lowering cholesterol in the blood. However, phytic acid can produce complexes with proteins and mono- and divalent cations. Amaranth grains contain smaller amounts of protease inhibitors (trypsin and chymotrypsin) compared to common cereals. However, protease inhibitors have been found to have anti-cancer, antioxidant, and anti-inflammatory effects, as well as

affecting the regulation of blood glucose levels.

Grain amaranth has been suggested as an alternative to marine animals as a natural source of squalene. Oil contents, squalene contents, and fatty acid profiles were determined in 11 genotypes of four grain amaranth species. Although the oil contents of grain amaranth were low (from 5.1% in *Amaranthus tricolor* to 7.7% in *Amaranthus cruentus*) as compared to other oil-containing grains, high concentrations of squalene were found in total lipids, ranging from 3.6% in *Amaranthus hypochondriacus* to 6.1% in *A. tricolor*. The major fatty acids in Amaranthus oil consisted of palmitic acid (19.1-23.4%), oleic acid (18.7-38.9%), and linoleic acid (36.7-55.9%). A high degree of unsaturation was observed in Amaranthus oils, with S/U ratios of 0.26-0.32. A method to isolate and purify the squalene from Amaranthus oil was developed. After the saponification of K112, the squalene content increased from 4.2% in the crude oil to 43.3% in the unsaponifiables by the removal of the saponifiables. The unsaponifiables were fractionated by silica gel column chromatography to get highly purified squalene. The squalene purity in certain fractions was as high as 98%. Combining the fractions rich in squalene gave a 94% squalene concentrate, with a yield of 90%. The structure of squalene in the purified sample was confirmed by comparison of its ultraviolet spectrum with a standard and from its NMR spectra.<sup>[10]</sup>

Inflammation can cause many common diseases, including heart problems. Many studies have found that Rajgira or Ramdana may have anti-inflammatory benefits. It may even help in the treatment of arthritis. Amaranth grain contains phytochemical compounds like rutin and nicotiflorin and peptides with the ability to help lower hypertension and incidences of cancer. Rajgira oil contains Squalene, unsaturated fatty acids and Vitamin E. These are essential nutrients for healthy skin and hair. Lysine (Fig. 7) found in Rajgira can strengthen your hair. Lysine has been linked to a stronger, healthier hair, better roots, and a reduction in hair loss. Rajgira oil (Fig. 8) is often used in beauty products to protect, moisturize, and nourish the skin and hair.



Fig 10: Rajgira Oil

### Nutritional Value of Rajgira

Amaranth is one of the three pseudocereals, next to buckwheat and quinoa, most frequently used in modern formulations of functional bakery, pastry and confectionary food products (Fig. 9 & 10). Amaranth flour can be used as a gluten-free flour option to thicken soups and stews, sauces, and more. It can also be used with other gluten-free flours and gums in baking. Rajgira is one of the best sources of vegetable protein in the world. This whole grain is full of fibre, ensuring that one stay satiated for a longer duration. It slows absorption of sugar and even aids digestion.

Moreover, the amino acid – lysine also metabolizes fatty acids. Gluten free is another added advantage of this ingredient, making it fit for consumption for almost everyone. Calcium is another important nutrient in Rajgira. Calcium content in Rajgira is more than 4x that of other grains. In fact, it has more calcium than milk. Rajgira is go to food for Calcium for lactose intolerant (meaning one can't digest milk). Amaranth flour can be used in the production of various types of breads, such as chapatti and tortilla, but not yeast bread. There is no gluten (Fig. 11), so there is no ability to retain gases. In order to produce bread and pasta, it can be added to wheat flour up to 20% (according to current achievements), without a product quality change. Amaranth grain can be popped, similarly to the grain of corn. It can be used in the production of soy sauce, which is commonly used in Southeast Asia. In addition to the common application of barley malt, beer can also be produced from amaranth. Since amaranth grains contain a relatively large starch content, strong alcoholic beverages can also be produced. Popped Rajgira seeds is a great option for a healthy and quick breakfast cereal. The popped Rajgira seeds sprinkled on soup or salad will make it crunchy, add slight savoury flavour to it and load it with all the good nutrients. Rajgira or Ramdana laddus made with jaggery are quite popular and tasty. Rajgira parathas or Puris are a favourite meal during fasting. In addition to eating Rajgira seeds (grains), leaves that come in vibrant colors like red, orange, and purple (Amaranth greens) are eaten.



Fig 11 & 12: Popped Rajgira dishes

### Conclusion

Amaranth has a good amount of lysine which helps the body absorb calcium, build muscle, and produce energy. Vegetables and grains are often lacking in this essential amino acid. Amaranth is a very rich source of minerals like Ca, Cu, Zn, Mg K and P. It is also a good source of zinc, potassium, and phosphorus. These build strong bones and muscles, aid hydration, boost energy, and are vital in thousands of processes throughout the body. Amaranth is also a good source of many essential vitamins, too, including vitamins A, C, E, K, B5, B6, folate, niacin, and riboflavin. These act as antioxidants, raise energy levels, control hormones, and do much more. Amaranth helps prevent premature graying, mainly due to the minerals this grain has in abundance. The fiber and phytonutrients in amaranth can lower BP. This grain tackles cholesterol, inflammation, and blood pressure, making it an all-around good food for heart health.

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