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The Use of The Ancient Amaranth *(Amaranthus)* Grain in Traditional Turkish Cuisine

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ABSTRACT

With its culinary use dating back more than six thousand years, amaranth is known as the ancient grain and the food of the future. Recently recommended for consumption by FAO/WHO, the amaranth plant is a prominent, "forgotten," functional food that can be used in human nutrition because of its drought-resistant cultivation, gluten-free, and protein and fiber-enriched content. This study evaluates amaranth's botanical character, functional properties, impacts on health, preparation-cooking methods, and use in local and traditional Turkish cuisines. Numerous studies have indicated the association between amaranth's chemical composition and its anti-oxidative, anti-tumor, gluten-intolerance, and cholesterol-lowering properties, and its assistance with intestinal flora and protein digestibility. Manifold dishes can be made using amaranth seeds and flour in traditional cuisines. Raw and cooked amaranth grains are used in rice, soup, and breakfast cereal. In the food industry, it is a crucial grain alternative to various bakery products, such as bread, pasta, cookies, manti, noodles, biscuits, and crackers, made from amaranth flour. There is a need for alternative recipes to increase the use of amaranth in the kitchen. In this context, it is thought that awareness should be increased by applying it to recipes that can replace semolina and bulgur in traditional cuisines. For this purpose, this study aims to increase the consumption of the ancient grain amaranth by including it in recipes in traditional Turkish cuisine.

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Introduction

Growing population, drought concerns, and increasingly tricky climatic conditions worldwide have led producers to search for new crops. In line with all these concerns, amaranth has recently been considered a crucial food in the pseudocereal group by producers because of its drought resistance and easy cultivation (Alvarez-Jubete, Arendt & Gallagher, 2009). Dicotyledonous plants such as amaranth (*Amaranthus sp.*), quinoa (*Chenopodium quinoa willd*), and buckwheat (*Fagopyrum sp.*) are known in botany as "pseudocereals or grain-like" unlike most monocotyledonous grains such as wheat, rice, and barley. Since the functions and composition of these plants are similar to true cereals, they are categorized as cereals but are called pseudocereals (Köten, Karahan & Satouf, 2002). Carbohydrates are stored in the endosperm of these plants, and grains and pseudocereal plants are energy sources in the human diet (Pickersgill, 2007). The high nutritional value of amaranth, one of the most popular and edible natural grains such as quinoa and buckwheat, has led to it being called the "new millennium food" (Rastogi & Shukla, 2013).

With consumers' and producers' growing interest in protecting health, nutritional trends have changed, and consumers' interest in functional foods has increased. Recent publications have focused on buckwheat, amaranth, quinoa, mung bean, and soybean as nutritional alternative products. In this context, amaranth is a "new food" that can be used as a functional food in human nutrition (Alandia, et al., 2021; Kumari, et al., 2023; Paśko, et al., 2009). Studies are, therefore, needed to increase its use in the kitchen. In this regard, raising awareness of ancient grains by supporting them with traditional recipes is essential (Onur & Ceylan, 2023). To this end, this study aimed to increase the consumption of the ancient grain amaranth by including it in traditional recipes.

Method

Research on pseudocereal amaranth use in gastronomy is limited. In this sense, the study aims to explain the history, rituals, use, recipe examples, and health effects of amaranth, an ancient grain, in culinary culture. For this purpose, the study utilized document analysis for data collection. Documents were analyzed using databases such as Google Scholar, Scopus, Elsevier, Directory of Open Access Journals (DOAJ), BioMed Central, Ulakbim, and Dergipark. At the same time, the authors prepared sample recipes by adapting them to traditional Turkish dishes to promote their use in the national cuisine.

Conceptual Framework

Amaranth's General Properties

Amaranth derives from the Greek ἀμάραντος (amárantos), "unfading, endless, eternal," and originated from the Greek word ἄνθος (ánthos), meaning flower (Lucian, et al., 2018). Amaranth is a plant belonging to the *Amaranthus* genus, with more than 70 species (Wyatt, 2002). Some of the species produce edible seeds and leaves. The seeds of some species, such as *A. caudatus, A. cruentus, A. hypochondriacus,* and *A. mantegazzianus,* are rich in starch, protein, and other *nutrients* (Zhu, 2023).

Evidence shows that the cultivation of American-originated amaranth dates back to 6700 BC. Amaranth, one of the world's oldest food crops, was consumed by hunter-gatherers in North and South America. These civilizations developed the first cultivation techniques of amaranth (Sauer, 1950; Sauer, 1967). Amaranth is widely cultivated in countries such as China and India since it is a drought-tolerant plant (Schmidt, 2023).

Amaranth is a crucial product with high nutritional value for celiac patients and consumers due to its gluten-free, rich protein and fiber content (Arendt, et al., 2009; Martinez, et al., 2014). It also has properties that can be an alternative to vegan, vegetarian, and ketogenic diets (Özçelik & Yılmaz, 2022). With more than six thousand years of culinary use, amaranth is also called "ancient grain" (Kahlon & Chiu, 2015). Despite its significant place in the African diet, Amaranth's use in global and traditional cuisines has remained limited (Olufolaji & Tayo, 1980). However, some countries, such as Peru, have recently launched projects encouraging amaranth's reuse (Early, 1990). In addition, amaranth is among the foods recommended for consumption by FAO/WHO (Maurya & Arya, 2018).

Amaranth's circular seed structure differs from other cereal varieties (Taylor & Parker, 2002). Approximately 70 species and 400 varieties of amaranth worldwide, and only a few have been domesticated and used in different countries. The most common domesticated species are *Amaranthus cruentus*, *Amaranthus caudatus*, and *Amaranthus hypochondriacus* (Aderibigbe, et al., 2022). Flower, leaf, and stem colors vary in species grown for their seeds, but they are chestnut or dark red. Amaranth, generally a tall plant with broad leaves, resembles the red-rooted cockscomb (Celosia) plant in shape. The plant bears large, colorful spikes and has a robust, hairy stem like a sunflower. The species grown for their seeds are 1.5-2.1 m long and have a hairy hard body. Their leaves vary in size and are purple, green, or red, and the seeds of species grown for cereal are generally white-grey. Figure 1 presents Amaranth plant and seed.

Amaranthus tricolor, Amaranthus husblitum, Amaranthus dubius, Amaranthus spinosus, and *Amaranthus viridis* are the most common species grown mainly as leafy vegetables. Among the various amaranth species domesticated for use in different parts of the world, *Amaranthus cruentus*, *A. hybridus*, and *A. dubius* are commonly grown in West Africa, while A. tricoris is mainly grown in East Africa, China, and India (Aderibigbe, et al., 2022). It is not grown for agricultural purposes in Türkiye but grows spontaneously in the fields as a weed (Ergun, et al., 2014). Amaranth seeds grown as vegetables are tiny and bright black (Kahlon & Chiu, 2015).

With its ability to tolerate biotic and abiotic stress conditions, amaranth has the potential to be an alternative crop in drought- and salt-affected areas. Many consider amaranth the future crop due to its C4 photosynthesis system and its productive structure proliferating in dry regions or poor soils with high soil salinity (Barba De La Rosa, et al., 2009; Hilou, et al., 2016). It is possible to procure a grain yield of 450-700 kg/ha in arid regions or 900-2000 kg/ha in areas with high rainfall (Williams & Brenner. 1995). It is an essential plant, especially for countries with dense populations, as it requires little water to cultivate. For this reason, amaranth cultivation has become widespread, especially in China, Russia, South America, and India, as a precaution against the threat of global famine and hunger (Aderibigbe, et al., 2022; Ruth, et al., 2021).

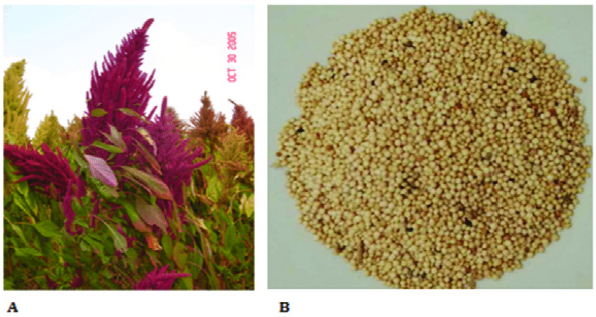


Figure 1. Amaranth plant (A) and seed (B)
(Soriano-García, et al., 2018).

Amaranth's Nutritional Value and Functional Properties

Amaranth is utilized in food production, the pharmaceutical industry, and various industrial fields due to its functional properties (Rastogi & Shukla, 2013). Amaranth grains are gluten-free and contain many nutrients such as starch, protein, fat, dietary fibers, unsaturated fatty acids (linoleic acid), squalene, phenolic compounds, betalains, minerals, phytosterols and vitamins. Due to these properties, it is a promising product compared to other herbal products (Baraniak & Kania-Dobrowolska, 2022; Hilou, et al., 2016; USDA, 2023). Table 1 presents a comparative summary of amaranth with pseudocereals concerning some nutrients (USDA, 2023).

Amaranth also contains many essential micronutrient components such as calcium, magnesium, iron, vitamin C, β-carotene, and folic acid (Priya, et al., 2007). It is also the only grain that contains vitamin C, with its young leaves consumed (Tang, et al., 2016).

Table 1. A comparison of nutritional values of pseudocereals and amaranth (per 100 g)

Energy and Nutrients	Buckwheat	Quinoa	Amaranth
Energy (kcal)	343	368	371
Protein (g)	13.25	14.12	13.56
Carbohydrate (g)	71.50	64.16	65.25
Fat (g)	3.40	6.07	7.02
Saturated fat (g)	0.741	0.706	1.459
Single SFA (g)	1.040	1.613	1.685
Multiple SFA (g)	1.039	3.292	2.778
Pulp (g)	10.0	7.0	6.7
Sodium (mg)	1	5	4
Potassium (mg)	460	563	508
Calcium (mg)	18	47	159
Iron (mg)	2.20	4.57	7.61
Zinc (mg)	2.40	3.10	2.87
Magnesium (mg)	231	197	248
Folate (µg)	30	184	82
Thiamine (mg)	0.101	0.360	0.116
Niacin (mg)	7.020	1.520	0.923
Riboflavin (mg)	0.425	0.318	0.200
Vitamin A (IU)	0	14	2
Vitamin E (mg)	-	2.44	1.19
Lysine (mg)	672	766	747

Source: (USDA, 2023)

Amaranth contains high amounts of protein (average 13-14%). The energy and nutrients of amaranth and other products are higher in nutritional quality, protein content, and balanced essential amino acid content of amaranth seed (Table 1). It is also rich in lysine, missing in amaranth cereal grains. The mineral content is generally higher than cereal grains, especially calcium and magnesium. Additionally, it has higher dietary fiber and lipid content than most grains. Furthermore, regarding the mineral content of cereal-like products, amaranth has a higher content of manganese, iron, zinc, magnesium, calcium, and phosphorus than quinoa and buckwheat (Sanz-Penella, et al., 2013).

Amaranth's small polygonal starch structure gives it properties different from other starch sources, such as corn, rice, and wheat, contributing significantly to the properties and functionality of starch. The core and shell parts of amaranth grains contain vitamin E and polyphenols with high antioxidant capacity (Barba De La Rosa, et al., 2009). Protein digestibility is 0.40 in wheat flour, 0.57 in oat flour, and 0.64 in amaranth flour. Therefore, amaranth is an essential source of protein digestibility (Bejosano & Corke, 1998).

Amaranth, quinoa, and buckwheat are alternatives to grain varieties because they do not contain gluten protein. These grains are preferred as they produce gluten-free products and improve their nutritional value (Yaver & Bilgiçli, 2020). Amaranth contains albumin and globulin proteins. It does not contain prolamin proteins, which have a toxic effect on celiac patients with gluten allergy. Therefore, it is an alternative product to help celiac patients eliminate malnutrition problems (Alvarez-Jubete, et al., 2010).

The fat in amaranth's composition contains high levels of natural organic compounds tocotrienol and squalene, which are involved in cholesterol metabolism and significantly lower LDL-cholesterol in the blood. In addition, phytosterol in amaranth seed is a beneficial fatty acid that reduces cholesterol absorption and effectively lowers LDL cholesterol. In addition to being a source of energy, the fat in amaranth's composition plays a crucial role in fat-soluble vitamins (Sanz-Penella, et al., 2013). Clinical studies have determined that various enzymes, unsaturated fatty acids, and amino acids in amaranth seeds have a cholesterol-lowering effect (Ajayi, et al., 2021; Hosseintabar-Ghasemabad, et al., 2022).

The glycosamine streptomycin, quercitin glycoside, and rutin flavonoids in amaranth cause it to show antibiotic properties (Filipčev, et al., 2011; Iqbal, 2012). Also, the increased antioxidant activity of amaranth after digestion may help tumor treatment (Barrio & Añón, 2010; Silva-Sánchez, et al., 2008). Amaranth seeds and leaves have anti-cancer properties. The seeds are rich in amino acids such as lunasin, peptides, and lysine that help the body fight cancer (Orona-Tamayo & Paredes-Lopez, 2024). Amaranth is also a suitable plant for cancer patients as it stops the irregular growth of cancer cells in the breast, colon, and liver (Hongyan, et al., 2015).

Lunasin is a unique substance found extensively in amaranth seeds and consists of 43 amino acid elements. Amaranth, rich in beneficial fatty acids and amino acids, can reduce the risk of serious diseases such as cancer, diabetes, cholesterol, and heart attack (Hernández-Ledesmaa, et al., 2013).

Amaranth seed is an oily seed that does not contain gluten and has a high protein value (Skwarylo-Bednarz, et al., 2020). For this reason, dishes made with amaranth seeds are essential for people who want to lose weight and diabetic patients. Rich in vitamin K, this oilseed is especially recommended for the nutrition of people with weak bones (Ruth, et al., 2021).

Amaranth in rituals

Amaranth was first utilized as a grain in Central America over 6,000 years ago (Kahlon & Chiu, 2015). Civilizations such as the Aztecs, Mayas (Central America),

and Incas (South America) used this product, frequently consumed in their daily diets, to cook various dishes in their kitchens. The Aztecs not only cultivated the plant for food but also used it in religious rites and rituals. Although it spread from colonial times to tropical and subtropical regions of the Old World, the dietary consumption of amaranth declined significantly after the collapse of Central American culture (Chemutai, et al., 2019; Kahlon & Chiu, 2015).

Amaranth was also considered an important ritual and cash crop in Mesoamerica (Sauer, 1950; Sauer, 1967). Another ritual in which amaranth was used was religious rituals. Amaranth flour "tamales" and a mixture of "popped amaranth" and sweet maguey syrup called "tzoali" were offered to specific deities (Wyatt, 2002). The amaranth seed was considered sacred by ancient civilizations because of its unique properties. For the Aztecs, amaranth was as holy as cacao beans and honey. They combined honey and amaranth to form the figure of a god in their ceremonies (Dietz, 2022).

Amaranthus caudatus and *Amaranthus hypochondriacus* were used for decorative purposes. Especially in Victorian times, *A. caudatus* conveyed the meaning of despair or hopeless love (Jerome, 2001). Amaranth has a special significance in Mexico, where the bright red seeds, similar in color to blood, were considered the holiest of human substances (Wyatt, 2002).

Use of Amaranth in Gastronomy and Food Industry

Use in breadmaking: Bread is a traditional and religiously valued food commonly consumed in the culinary cultures of many countries. It is a staple food, although daily bread consumption varies according to individuals' characteristics, eating habits, living, working, and dietary patterns (Ardiç Yetiş, 2020). The nutrients found in wheat pass into the bread since bread's raw material is generally wheat flour. However, the flour's nutritional content decreases during the milling stage, depending on the purification state, since the vitamins and minerals in wheat are mainly found in the core (embryo) and outer shell (bran) of grain. Therefore, a product that can enrich bread's nutritional content is crucial in increasing the public's nutrient intake (Ayo, 2001). Recent studies have also focused on using pseudo-creal grains such as buckwheat and quinoa to enrich bread's nutritional content. In this context, amaranth flour is richer in micro and macro elements such as energy, protein, fat, calcium, iron, magnesium, and lysine than other pseudocereal grains. In addition, among the quality characteristics of flour used in bread making, the water retention capacity of the flour is expected to be high (Ozan & Karababa, 1997). The starch structure of amaranth flour has small granules (average diameter 1 mm) and high water absorption capacity (Singhal & Kulkari, 1988).

In a study, amaranth-wheat blended breads were developed using different mixture formulations. Amaranth flour was added to wheat flour at different rates, such as 5, 10, 15, 20, and 30%, and the prepared mixtures were baked at 220ºC for 18 minutes. It was found that bread's nutritional value increased as the amount of amaranth increased, and adding up to 10% of amaranth flour improved bread's sensory and quality properties (Emire & Arega, 2012). Sanz Penella et al. (2013) found that adding amaranth flour to wheat flour in bread making significantly increased the bread's protein, lipid, ash, dietary fiber, and mineral contents (Sanz-Penella, et al., 2013). Since the phytic acid naturally present in amaranth's composition must be reduced or removed by various technological processes, it was determined that lactic acid fermentation might be successfully applied to eliminate the negativities due to the natural composition of pseudocereals containing phytic acid, such as amaranth (Özçelik & Yılmaz, 2022).

Machado Alencar et al. (2015) reported that the volume, texture, and water activity values of bread made with amaranth and quinoa flour showed similar results with standard bread (Machado Alencar, et al., 2015). Ayo (2001) found that adding 15% amaranth flour had no adverse effect on wheat bread's physical and sensory properties and recommended the consumption of amaranth bread for infants, children, and pregnant and lactating women. Another study found that the protein content of bread with 25% amaranth flour added increased, and the staling process slowed down (Miranda-Ramos, et al., 2019). It was found that breads made from amaranth flour were more nutritious and contained higher levels of fiber and minerals than breads made with wheat. It was also reported that they had less volume increase and darker color (Özçelik & Yılmaz, 2022).

Use in biscuit making: Biscuits are bakery products frequently consumed in almost every society. They can be eaten on the go and are considered healthier for consumers than chocolate. With an essential place in non-meal nutrition, biscuits are increasingly consumed daily for their long storage time without staling (Demir, 2015). Flours used in biscuit production are generally of *Tr. aestivum* species, which is too weak to be used in the bread industry. The protein content and quality of the grain are low. The particle fineness of biscuit flour is a significant factor in biscuit quality. A crisp and good quality biscuit is made from fine particle flour. Since excessive swelling and volume are not desired in biscuits, wheat with a soft grain structure, high starch content, and low gluten content are the properties of wheat accepted for the biscuit industry. The flour used for biscuits must also have a controlled and average spread (Bilgiçli & Soylu, 2016). Biscuits and cookies are dough products prepared by mincing. The starch structure forming the bulk of amaranth flour provides the desired flour quality properties for the biscuit industry because of its granular structure (average diameter 1 mm) (Singhal & Kulkari, 1988) gluten-free nature, and high spreading rate. Therefore, as consumers become healthier and more conscious, research is conducted on alternative products to enrich the nutritional content of biscuit production. While they focus on using pseudocereal grains such as corn, buckwheat, and quinoa as gluten-free products, research seems to focus on whole-grain wheat flour regarding its rich nutritional content. However, although amaranth flour meets the desired flour criteria in biscuit production and is rich in nutrients, the literature contains only limited studies.

A study stated that amaranth flour can be used in products with high viscosity and dry matter, especially in gluten-free breakfast products prepared for celiac patients, such as biscuits and crackers, since it can absorb more water during kneading than wheat flour (Boz, 2013). In this context, Sindhuja, Sudha, and Rahim (2005) replaced

wheat flour with up to 35% amaranth flour and found that the product's color, taste, flavor, and appearance improved positively. In another study, cookies were made with a 25% amaranth flour mixture, and it was determined that the product with amaranth flour substitute was the best in terms of organoleptic properties and color (Sindhuja, et al., 2005). The products were also reported to be sensory acceptable when 100% was added (Renu & Anirban. 2015). Schoenlechner, Siebenhandl, and Berghofer (2008) used amaranth, buckwheat, and quinoa to produce gluten-free biscuits and found that amaranth is suitable for replacing wheat flour (Schoenlechner, et al., 2008). Chauhan et al. (2016) produced gluten-free biscuits with raw and sprouted amaranth flour and found that adding up to 60% was acceptable (Chauhan, et al., 2016).

Use in pasta, noodle and manti: The flour used in the dough for making traditional foods such as pasta, noodles, manti, pastry, and baklava should be high-yield, first-quality durum wheat flour and semolina. These flours yield 70-80% and are full white. The starch content of wheat used in pasta production is also an essential criterion in determining pasta quality. In particular, since damaged starch constitutes a substrate for amylases during pasta making and increases the amount of solids that break down and pass into the cooking water, the flour used should be low in damaged starch to avoid disintegration after cooking (Bilgiçli & Soylu, 2016). The flour criteria required for preparing pasta, noodles, and manti, especially water-boiled, are explained above. Durum wheat's protein content is another desired factor. In pasta production, wheat with a protein content above 13% is preferred because durum wheat's protein content and quality significantly determine the cooking quality of pasta produced from this wheat. However, various studies have recently been conducted in the literature to increase the nutritional value of the foods consumed. They have mainly focused on dishes at the forefront of world cuisine, such as pasta, noodles, and manti. Manifold studies have been conducted in the literature on making pasta, noodles, and manti using amaranth grain.

Cárdenas Hernandez et al. (2016) cooked pasta with dried amaranth leaves and amaranth seed flour. They found that adding amaranth to pasta samples could increase the product's functional properties compared to the control but also reduce the cooking time, increase cooking loss, and decrease the brightness value (Cárdenas-Hernández, et al., 2016). Another study reported that amaranth-based pasta samples had higher cooking loss and lower stickiness than durum wheat pasta, while no difference was observed in taste perception (Chillo, et al., 2008). While protein, fat, ash, phytic acid, phenolic matter, and mineral matter content increased, the brightness value of noodle samples produced with pseudocereal (e.g., amaranth, quinoa, buckwheat) flours added to wheat flour in different combinations at a rate of 30% decreased (Öncel & Demir, 2019). As the amount of amaranth increased, the baked dough became softer, and the disintegration properties increased. Cárdenas -Hernandez reported the same findings as a result of sensory analysis.

Additionally, researchers investigated the color and sensory analysis characteristics of pasta samples containing 30% amaranth and revealed a passing grade (Fiorda, et al., 2013). Martinez et al. (2014) examined the technological and sensory quality of pasta made from bread wheat flour substituted with Amaranthus mantegazzianus at 15, 30, 40 and 50%. Findings indicated the nutritional and functional properties of the pasta with 30% amaranth flour were acceptable when compared with the pasta made from bread wheat flour in the other control groups (Martinez, et al., 2014). In a study by Aygün (2021), nine different manti doughs were obtained using 0, 5, 10, 15, and 20% quinoa and amaranth flours. They determined that manti containing 20% amaranth and quinoa flour increased the amount of fat, protein, phenolic substances, and cooking time and were perceived positively. An examination of the weight increase in amaranth and quinoa manti samples indicated that those containing amaranth flour had a higher weight rise after cooking (Aygün, 2021).

Research has commonly shown that pasta, noodles, and manti produced by adding 20-30% amaranth flour increase nutritional benefits and have acceptable sensory and taste quality. Table 2 summarizes the disadvantages and solutions for using amaranth in making bread, biscuits, pasta, noodles, and manti.

Amaranth's Traditional Culinary Uses

More than 70 species of amaranth are used as food in both tropical and temperate regions of the world (Olufolaji & Tayo, 1980). In different cultures, amaranth is also called purple amaranth, red amaranth, red stem, bush greens, African spinach, and Indian spinach (Chemutai, et al., 2019). It has been named differently in different countries: bayam (Indonesia, Malaysia), kalunay (Philippines), chaulai (Uttar Pradesh, Bihar-India), chua (Uttarahkand), harive (Karnataka-India), cheer (Kerala), mulaikkira (Tamil; Nadu), shravani math (Maharashtra), khada saga (Orissa), rau dền (Vietnam) (Jerome, 2001).

Amaranth is a leafy vegetable in the Nigerian diet, and the soft parts of the stems and leaves of wild amaranth are used as ingredients in green salads and stews in African cuisine (Olufolaji & Tayo, 1980). In Mexico, amaranth grains are mixed with honey to make "alegria" candy. In Peru, "turron," made by mixing amaranth seeds with molasses, is consumed as a snack. Obtained by grinding amaranth seeds on stone, amaranth flour (pinol in Mexico; mash'ka in Peru) is widely used.

Table 2. Challenges in amaranth use in bakery products and proposed solutions

Challenges	Proposed Solutions
Reduction in bread volume	Usage up to 25% Preference in breads that do not require volume, such as lavash and phyllo
Disintegration of pasta and noodles when cooked in water	Mixing with wheat flour at a maximum of 30% in pasta and noodle dough
Disintegration of unleavened dough when cooked in water	Preferring different baking methods (oven) for unleavened doughs

Source: Author's work

Table 3. Uses of amaranth species in traditional cuisine

Amaranth Species	As a vegetable	As a grain	Uses in the Kitchen	Countries of Cultivation	Reference
Amaranthus cruentus	X	X	As an ingredient in food, snacks, soups, vegetable dishes or sauces	West Africa	Grubben & Denton, 2004
Amaranthus caudatus		X	Crackers, gluten-free brown bread, biscuits, cookies	South America, Argentina, Peru, Bolivia	Mekonnen et al., 2018
Amaranthus hypochondriacus		X	Marinating bread and fish	South America, Asia	Mlakar et al., 2010 He et al., 2002
Amaranthus tricoris	X		Dishes and salad	East Africa, China and India	Herbst, 2001
Amaranthus dubius	X	X	Potherbs sauce	West Africa Caribbean and China	Herbst, 2001; Aderibigbe et al., 2022
Amaranthus hybridus	X		Dishes and salad	West Africa, Indonesia, Malaysia, Mexico, Thailand, Philippines, Nepal	Herbst, 2001

Source: Author's work

Table 4. Cooking methods using amaranth used as a vegetable

Cooking Method	Procedure
Boiling	Wash the amaranth, place the banana leaves in the pot to prevent burning, sprinkle salt between the unchopped amaranth, and boil without turning (about 1 hour) until the water dries up to prevent steam from escaping.
Sauteing	Fry the onion and tomatoes in oil. Add the chopped amaranth and cook for about 10 minutes while stirring.
Frying	Wash the amaranth, dry it in the sun to drain the water, then fry it with oil, onions, and tomatoes.
Steaming	Wash the vegetables and placein sufuria. Add chopped onions, tomatoes, salt, and steam for 10-15 minutes.
Boiling and fermenting	Boil amaranth for 20 minutes, add salt to taste, and heat once a day while adding milk each time for 2 to 3 days, (mostly done in combination with other vegetables).

Source: (Nyonje, et al., 2022).

In Peru, the seeds are used as a fermenting agent in beer making, while the red flowers of amaranth are added to color corn and quinoa in local cuisines (Early, 1990). In Northern India, amaranth (rājgeerā) is mixed with palm sugar (jaggery) and used to make "laddoos," a sweet (Kahlon & Chiu, 2015). Amaranth flour is used to make flatbread in Latin America and the Himalayas, to prepare different types of curries (Yulee, palya, majjigay-hulee) in India, and as an ingredient in soups in China. In Greece, green amaranth (A. viridis) is used to prepare βλήτα, vlita, or vleeta (a type of salad served with fish) (Lucian, et al., 2018). Amaranth is essential in people's nutrition in the Ouagadougou Region of Africa (Hilou, et al., 2016). Called "huautli" in Nahuatl, amaranth is ground into flour, similar to corn, and used to make tamales and amaranth tortillas, specially prepared as a gourmet meal for nobles (Wyatt, 2002). The Indians, on the other hand, used amaranth seeds whole in drinks, sauces, and porridges and powder form in different formulations in bread, cereal products, and medicinal areas (Mlakar, et al., 2010). The literature review reveals this plant's use mostly in various dishes in African cuisines.

Specific beliefs and negative attitudes have led to the neglect of the amaranth plant over the years. Such attitudes include considering the plant a weed and a poor person's food. In particular, a study in Africa found that rural communities in parts of Kenya and Tanzania consumed leafy amaranth at higher rates than urban dwellers. Factors such as amaranth's unfamiliar taste, small leaf size, short shelf life (leaf parts), and seasonality were found to reduce consumption levels (Nyonje, et al., 2022). *A. caudatus* is consumed as a grain crop in South America, with *A. dubius* as a vegetable in the Caribbean and China. *A. hybridus* is also used as a vegetable in countries such as Indonesia, Malaysia, Mexico, Thailand, the Philippines, and Nepal in the southwestern United States (Table 3), (Aderibigbe, et al., 2022).

Amaranth's Preparation and Cooking Techniques

In traditional cuisine, amaranth's leaves and stems are used as vegetables and seeds as grains. Amaranth is added to various salads and casseroles as a vegetable. The type of amaranth used as a vegetable does not contain poisonous species. However, since its leaves are known to contain oxalic acid and nitrate, it is generally recommended to be used after soaking in boiling water. Table 4 presents cooking methods using amaranth used as a vegetable.

As a grain, amaranth seeds are used in raw and cooked forms to prepare various dishes. Raw amaranth seeds are often ground and utilized to make gluten-free bread and pasta and traditionally to produce a sugar-type product from the grains (Martinez, et al., 2014).

Table 5. Forms of raw and cooked amaranth seed use in foods

Product	Amaranth's Usage Forms
Sweets	Popped grain
Bread	Ground form (from raw amaranth seeds)
Soup	Grain form (from cooked amaranth seeds)
Rice	Grain form (from cooked amaranth seeds)
Couscous	Grain form (from cooked amaranth seeds)
Baby foods	Grain and ground forms (from raw or cooked amaranth seeds)
Breakfast cereals	Grain form (from raw or cooked amaranth seeds)
Ready sauces	Ground form (from cooked amaranth seeds)
Pasta, manti	Ground form (from cooked amaranth seeds)
Cookie/cracker/biscuit	Ground form (from raw amaranth seeds)
Cake/pancake/crepe/muffin	Ground form (from raw amaranth seeds)
Beverages	Grain and ground forms (from raw or cooked amaranth seeds)

Source: (Arendt & Zannini, 2013).

Table 6. Nutrient content of wheat and amaranth flour

Compounds	Amount[a]	Wheat Flour	Amaranth Flour
Ash	g/100 g	0.53 ± 0.01	2.44 ± 0.08
Microelements			
Cu	ug/g	1.83 ± 0.03	6.94 ± 0.01
Mn	ug/g	5.82 ± 0.01	36.55 ± 0.12
Zn	ug/g	7.35 ± 0.10	42.08 ± 0.32
Fe	ug/g	12.66 ± 0.04	82.13 ± 0.17
Macroelements			
Ca	mg/g	0.22 ± 0.01	2.04 ± 0.01
Mg	mg/g	0.25 ± 0.01	2.69 ± 0.01
P	mg/g	1.11± 0.22	5.30 ±0.02
Na	mg/g	112.4 ±1.4	8.21± 0.27
K	mg/g	1.56± 0.01	4.70 ±0.03

a: Units expressed in terms of dry matter Source: (Yaver & Bilgiçli, 2020)

Cooked amaranth seeds are added to soups, curries, sauces, and stews to enhance the dish's sensory and nutritional profile and are also used as an alternative thickener to replace cream, eggs, cornstarch, and wheat flour. Cooked amaranth seeds can be used instead of couscous, rice, or pasta in porridges, pastries, and stews. The weight of raw and cooked amaranth seeds in grams is 200 g for 1 cup of raw amaranth seeds and 245 g for cooked amaranth seeds. Table 5 presents culinary usage forms for amaranth seeds.

As with any food, the nutritional benefit of amaranth depends on many factors, including the species, production method, and cooking techniques (Nyonje, et al., 2022). In particular, amaranth grains must be cooked for nutritional benefit and flavor. They must be soaked, rinsed, and boiled to obtain cooked amaranth grains.

Amaranth does not contain gluten and increases the nutritional content of the foods, making it a preferred alternative product in bakery products (Kılınççeker & Büyük, 2019). It has been described as a "super grain" with great prospects and high commercial potential for product development in the food industry, especially in the bakery sector. A. spinosus, A. hypochondriacus, and A. cruentus species are generally preferred in baking (Ramos, et al., 2019). Amaranth grain is used alone or as mixed flour in making bread, biscuits, pasta, crackers, pancakes, noodles, cakes, pancakes, pancakes, crackers, muffins, and breakfast cereals (Aderibigbe, et al., 2022; Alvarez-Jubete, et al., 2010). Unlike wheat, amaranth is a potential substitute raw material in gluten-free products. The small structure of starch granules contributes to amaranth use in film coating and emulsified formations (Lindeboom, et al., 2004) and its use in various products such as salad dressings and milk alternative beverages (Özçelik & Yılmaz, 2022). Oil is also obtained from amaranth seeds (He, et al., 2002). Amaranth flour is richer in macro and microelements than wheat flour in terms of dry matter (Table 6).

Amaranth is a plant frequently consumed, especially in its homeland, South American countries. It is possible to see this grain popped and sold like corn on the streets. It is also used to prepare breakfast porridge in regions such as Nepal, India, Mexico, and Peru (Aderibigbe, et al., 2022) "Dulce de alegria," a popular Mexican food, is made by mixing popped amaranth with honey or sugar. Amaranth grain can also be used in popular foods such as bread, crackers, muffins, and pancakes (Dietz, 2022; Wyatt, 2002).

Amaranth seed dishes are varied. Amaranth is a plant that can be consumed in salads or mixed with rice. The seeds of amaranth, of which soup is also made, can be cooked with legumes, and dishes with olive oil can be made from fresh leaves (Arendt & Zannini, 2013). Amaranth malt has been used to make gluten-free beer. In recent years, the demand for high-quality gluten-free food, including gluten-free beer, has increased rapidly, and

gluten-free, healthy, and tasty beer has significantly improved people's well-being and perception of ordinary social life. Therefore, it can also produce gluten-free alcoholic beverages (Dabija, et al., 2022; Manassero, et al., 2020). It is also possible to prepare amaranth tea. That tea is known as cockscomb and is straightforward to make. It is obtained by finely pounding fresh ginger, masala, and amaranth seeds and drying them under the sun for two days (Tibagonzeka, et al., 2014).

Amaranth in Traditional Turkish cuisine

Turkish cuisine harbors more than 2500 types of food (Ceyhun-Sezgin & Sanlier, 2019), Turkish culinary culture includes various food types, such as soups, pastries, desserts, and meat dishes (Güler, 2010). The Mesopotamian grains, the Mediterranean vegetable and fruit culture, and the South Asian spices have influenced Turkish culinary culture (Öncel & Demir, 2019). Grains are particularly an essential part of Turkish culinary culture. Throughout history, agriculture and animal husbandry have been crucial sources of income in Turkish culinary culture.

For this reason, many types of dishes are made from grains and grain products in Turkish culinary culture (Karaman & Ceyhun-Sezgin, 2021). In Turkish culinary culture, it is consumed in every type of food, such as soup, meatballs, rice, stuffed vegetables, desserts, salads, and breakfast. Grain consumption is, therefore, very high in Turkish culinary culture. Wheat and bulgur are Turkish cuisine's most consumed grain products (Kasar, 2021). Amaranth can be used as an alternative to bulgur, wheat, semolina, and rice in Turkish culinary culture. In Turkish cuisine, amaranth seeds can be boiled and mixed into salads and dishes, and the seeds ground into flour can be used in all pastries, including bread.

Carrot Soup

Soup is “a hot and juicy beverage made with meat, vegetables and grain products” (Turkish Language Association, 2023). It is also considered a main dish in Türkiye. Simple porridges made with flour and wheat in Central Asia are the first representatives of today’s soups (Yerasimos, 2019). Soup is a type of meal that has always been on the table as the essential product from past to present and is consumed at breakfast, lunch, and dinner (Çolakoğlu & Sarıışık, 2023). Although approximately 300 soup recipes exist in Turkish cuisine, there are over 1000 soup types with various ingredients and cooking techniques varying from region to region (Özbey & Köşker, 2021). According to the Turkish Patent and Trademark Office (2022), dishes and soups rank second with a rate of 20.7% among foods divided into 13 registered subgroups (Turk Patent, 2022). In Turkish cuisine, most soups contain grains, grain products, and legumes as the main ingredients (Arlı & Gümüş, 2007).

Wheat was one of the traditional ingredients of Central Asian and Seljuk Turks, and soups with wheat were consumed frequently. However, the demand for wheat soups in Ottoman cuisine decreased over time. Nowadays, wheat is commonly used in local soup varieties. Many soup types are included in the documents related to the seasonal food list given to palace employees, estimated to date back to the 16th century (Topkapı Palace Archive No. D.9599). Carrot soup is one of the soups found in the relevant documents (Yaman, 2022). In Turkish cuisine, carrot soup is among the vegetable soup groups. Since soups are consumed as main meals in Turkish cuisine, they are considered not only as a beverage but also as a food group. Therefore, wheat flour, bulgur, barley, and rice can thicken vegetable soups. The recipe for carrot soup, given below, was prepared using amaranth instead of wheat.

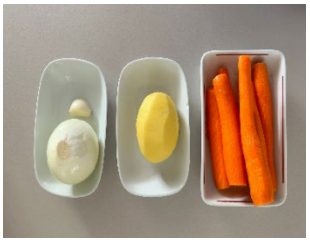
Carrot Soup

Ingredients

5 medium-sized carrots (200 g)
1 medium-sized potato (170 g)
1 large onion (90 g)
1 clove of garlic
1 cup of amaranth seeds (170 g)
2 bay leaves
5 cups of vegetable fondue (1 lt/1000 ml)
2 teaspoons of salt (12 g)
4 tablespoons of olive oil (40 g)

Procedures

Add 1 cup of boiling water to 1 cup of amaranth seeds and cover it for 30 minutes.



Prepare the carrots, potatoes, onions and garlic. Dice them later.

Fry the vegetables and bay leaf in olive oil.

Add the amaranth seeds previously soaked with hot water and mix. Boil for 10 more minutes and then remove from the stove. It is prepared to serve.

Crush the cooked vegetables using a blender.

Add 1 liter of previously prepared vegetable fondue and let it boil over medium heat for 10 minutes covered.

Source: Author’s work

Halva

Dessert is an essential part of Turkish cuisine. Halva is one of the crucial desserts of today's Turkish cuisine. Halva is a dessert made with oil, honey/sugar, semolina/flour/starch, and water/milk (Turkish Language Association, 2023; Yerasimos, 2019). Halva is consumed and distributed on special occasions (important days, feasts, holidays, deaths, weddings) and dates back to ancient times. Cooking halva is one of the most well-known traditions of Turkish cuisine, and it has been practiced as a ritual since Central Asian times. Since Göktürks believed in the afterlife and that souls would exist forever, they would make halvah and distribute it after the dead people (Bozagcı, 2023). As of February 2023, there are 32 different types of halva with geographical indications belonging to Turkish cuisine (Turk Patent, 2023). In the following halva recipe, some semolina is removed and replaced with amaranth.

Halva

Ingredients
1 cup of amaranth seeds (170 g)
Half a glass of semolina (90 g)
1 cup sugar (170 g)
2 tbs of butter (15 g)
1 glass of milk (200 ml)

Procedures

Prepare the ingredients.

Melt two tablespoons of butter in a pan. Add one cup of amaranth seeds and half a cup of semolina to the butter and roast them.

Add a glass of milk to the roasted amaranth seeds and semolina.

Place the prepared amaranth halva into molds and serve.

Cover the lid and wait for the milk to absorb over low heat.

Add sugar to the mixture of milk, semolina, and amaranth seeds.

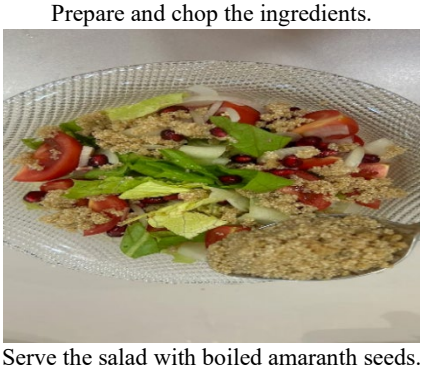
Source: Author's work

Salad

Ingredients
6 cherry tomatoes
4 leaves of lettuce
1 small onion (45 g)
½ lemon
½ pomegranate
Olive oil (5 g)
½ teaspoon salt (2 g)
1 cup of amaranth seeds (170 g)
1 glass of water (200 ml)

Procedures

Prepare and chop the ingredients.



Serve the salad with boiled amaranth seeds.

Add one cup of hot water.

Boil for 30 minutes.

Source: Author's work

Hasıda

Hasıda is a type of dessert known as hesida, hasude and hasita in the Eastern Anatolia Region of Türkiye. Hasıda is one of the traditional halvas of Erzurum's local cuisine. Its main ingredients are wheat starch, white sugar, butter, and water. Erzurum Hasıta / Erzurum Hasuta is a dessert registered by the Turkish Patent and Trademark Office and received a geographical indication (Turk Patent, 2022). Amaranth seeds are used instead of wheat starch in the recipe for hasıda dessert.

Hasıda

Ingredients

1 teacup of amaranth seeds (90 g)
1 teacup of sugar (100 g)
1.5 tbs of butter (70 g)
3.5 teacups of hot water (250 ml)
Walnut

Procedures

Place 1 teacup of amaranth seeds into the saucepan and add hot water. Simmer for 20 minutes over low heat until the water is absorbed.

Add butter to the cooked amaranth and melt it.

After it turns into mush, add water and mix for 3 minutes. Serve with walnuts.

Add sugar and stir.

Source: Author's work

Conclusion

Having been used as a livelihood and commercial crop in the past, amaranth is a crucial ancestral but forgotten food of the future with good potential for third world agriculture. Amaranth can grow in arid and barren lands with minimal water requirement, does not contain gluten, and is richer in nutritional value than other grain products, increasing its use in the food industry and traditional cuisines. It is, therefore, widely used in content enrichment of food formulations not only for celiac patients but also for consumers. This study sought to show that amaranth might be an alternative source to other grains, especially in traditional recipes. The study also provided information on cooking methods to increase the applicability of amaranth in various culinary cultures.

One disadvantage of products made with amaranth is disintegration during cooking in local products with amaranth flour added, such as pasta, noodles, and manti. Prospective researchers might use different cooking methods (first in dry heat, then boiling in water or steaming) for products made with unleavened dough, such as pasta, baklava, and pastry. In addition, since breads to which more than 25-30% amaranth is added lose volume and have a hard structure, new research is needed to increase the use of amaranth in formulations, especially for traditional bread types (lavash, phyllo, cornbread, flatbread, basmati, fetil, güdül, kartalaş, kömeç, tortilla bread) where rising is not desired.

Future studies revealing the culinary practices of amaranth and their recipes might be crucial to increasing its awareness, recognition, and consumption. In addition, qualitative studies should be conducted to increase the number of written sources in the literature, revealing the recipes used in the past and ensuring that amaranth is transferred to future generations as cultural heritage. Amaranth can be used as a substitute for cooked grain-like foods, and its awareness can be heightened by ensuring that flour and raw grain forms are included in the food industry and market shelves. Additionally, increasing the number of dishes containing amaranth as an ingredient in the local culinary culture can grow its use at home. Projects for functional food studies should be conducted, emphasizing that amaranth is gluten-free.

Implications for Gastronomy

Amaranth is an ancient and forgotten grain. Today, however, it is considered the food of the future. Adapted to arid soils and requiring a small amount of water for

cultivation, it is an essential product that can be evaluated as an alternative to cereals commonly grown in regions where climate crisis is predicted in the future. Therefore, this study aims to raise awareness of amaranth, which can be adapted to today's culinary culture, by creating various recipes by adapting it to modern recipes. On the other hand, it is thought that awareness will be raised to increase the use of amaranth, which is unknown in the culinary cultures of different countries, as a grain alternative in recipes. This study includes examples of healthy and alternative recipes using amaranth as an ingredient for consumers on a gluten-free diet.

Highlights

- Amaranth can be grown anywhere because it can adapt to ecologically difficult conditions.
- Amaranth is a plant beneficial for health, thanks to the components it contains.
- Gluten-free grains have an important place in the treatment of celiac disease.
- Flour and grain forms of buckwheat have been consumed with increasing interest in traditional foods in different countries for a long time.
- It is a good alternative for enriching menus in commercial kitchens.

Declarations

Ethics approval and consent to participate not applicable. Consent for publication All authors agree for this publication. Competing interests All authors declare there are no competing interests regarding this publication.

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First and second author contributed for the writing main draft, concept, structure, resources, reviewing and editing, reviewing.

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