Review paper
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NON-TRADITIONAL GRAINS FOR A BALANCED DIET

Dasha Mihaylova[1], Aneta Popova[1*]

[1]Department of Biotechnology, University of food technologies, 26 Martisa blvd., 4000 Plovdiv, Bulgaria

[*]e-mail: popova_aneta@yahoo.com

Abstract

People are becoming more and stricter on the topic of quality and salubrious eating. Food provides much more than just nutrition. It is a fundamental part of people's cultures and social interactions. A healthy lifestyle is a coalescence of conscious human actions, and when we verbalize about dietary plans and nutrition, the interest in non-traditional grains is indisputable.

The main task of the rational alimentation is to provide a balanced, corresponding to age diet, which fully satisfy the energy the body needs. Grains are in the base of the Countrywide Integrated Non-communicable Disease Intervention (CINDI) dietary guide. Many non-traditional grains have entered into commerce, reflecting not only the cosmopolitan nature of big cities, but also a general and widespread interest in a diverse range of food genres. Today, non-traditional grains are frequently grown in home gardens, allotments and community gardens and are often intimately linked with the ethnic ancestry of the growers.

In Bulgaria, underutilized grains are an essential source of: vitamins, micronutrients, and protein, and, thus, a valuable component to attain nutritional security. Some of these crops are: amaranth, quinoa, buckwheat, spelt, кhorasan and einkorn wheat.

***Key words**: Grains, Nutrition, Beneficial, Healthy, Balanced diet.*

1. Introduction

Consumers have a growing interest in foods that offer high nutritional value and deliver health benefits. In 1992, at the International Conference on Nutrition (Rome) and the World Summit on Food and Nutrition in 1996 and 2002, it was emphasized that access to safe, diversified and healthy food is one of the fundamental human rights. Healthy food is a prerequisite for strengthening the wellbeing of population and reducing the risk of many diseases.

In the second half of the 20th century, there has been a significant change in the pattern of world population's morbidity. At the same time, significant changes in diet and lifestyle have emerged, and contributed to the epidemic of non-infectious diseases such as cardiovascular diseases (coronary heart disease, hypertension, and stroke), certain cancers, type 2 diabetes, obesity, osteoporosis, and caries.

The main unfavorable trends and characteristics of population's nutrition include: increase in total fat consumption (up to 35 - 45%); increased intake of saturated fatty acids; low intake of raw fruits and vegetables in winter and spring; reduction of fiber intake related to lower consumption of whole grains, vegetables and fruits and increase in consumption of white bread and bakery products. The average daily intakes of many of the vitamins (thiamine, riboflavin, L-ascorbic and folic acids) and minerals (iron, zinc, calcium, magnesium) are below the dietary intake reference, especially for those in risk, like adolescents, pregnant women and the elderly.

Many studies show a link between health and income, with the poorest sections of the population being the most vulnerable. Nutrition studies and nutritional status of the population provide a reliable basis for accurate assessment of dietary issues in individual population groups and for the identification of risk groups.

For many years, the basis of human nutrition lies on *Gramineae* family's seeds like: rice, barley, oat, wheat, rye, etc. Grains are often an indispensable part of a healthy and nutritious diet because of their nutritional value and chemical properties. There is a great variety of grain usage in culinary practice. They can be effortlessly transported and stocked for long periods. Research has shown that whole grains are beneficial to health and aid in the chronic diseases prevention due to their higher fiber content, vitamin and mineral richness and healthpromoting phytochemicals, many with antioxidant activity [1]. Scientific reports suggest that increased whole grains intake leads to the reduction of coronary artery disease and ischemic stroke [2], maintenance of healthy body mass index (18.5 < BMI > 24.9) and weight, regulation of insulin response and blood glucose levels, gastrointestinal health through fiber content [1]. Slavin *et al*., [3], report that whole grains contain higher number of positive compounds (dietary fiber, minerals, vitamins, omega 3 fatty acids, polyphenols, phytosterols, prebiotic oligosaccharides) which interactively contribute to their nutritional value.

Ancient or heritage wheat is defined as wheat that was used by ancient civilizations. Einkorn, emmer, khorasan and spelt fulfill this definition. In the last couple of years, such "ancient grains" have been reintroduced as alternative cereals which have not been subjected to extensive genetic improvements, and are healthy. These marketing tools have led to the growing awareness regarding foods considered natural and therefore to an increased interest in their consumption. Heritage grains (khorasan wheat, barley, spelt, rye, millet, oat and sorghum) and pseudo cereals (i.e. quinoa, amaranth and buckwheat) are considered healthy due to their higher content of specific components [4] and to their common use as whole grains.

This review provides an overview of the nutritional value, utilization and future prospects of some of the ancient grains like: amaranth, quinoa, buckwheat, spelt, khorasan wheat, and einkorn wheat. The manuscript presents useful, summarized information, not only to consumers, but also to researchers as a basis of further investigations connected to human well-being and health and how grains impact and contribute to it.

2. Non-traditional grains for a balanced diet

2.1 Classification

2.1.1 Amaranth

The Inca, Maya and Aztec civilizations have used amaranth (*Amaranthus* spp.) as a staple food. Amaranth (Figure 1) is an annual herbaceous, warm-season, broadleaf plant that can be grown as a grain, ornamental, leafy vegetable, or forage crop.

Figure 1. Amaranth plant (left) and grains (right)

The amaranth grain belongs to the order *Caryophyllales*, amaranth family *Amaranthaceae*, sub-family *Amaranthoideae*, genus *Amaranthus*. The genus *Amaranthus* includes approximately 60 species, most of which are cosmopolitan weeds. The cultivated amaranth species can be used as food grain, leafy vegetables, forage and ornamentals. The amaranth grain belongs to a group of cereal-like grain crops or pseudo cereals. Pseudo cereals are dicotyledonous plants that resemble in function and composition those of the true cereals [5].

2.1.2 Quinoa

Quinoa (*Chenopodium quinoa* Willd.) is a seed-producing crop, which has been cultivated in the Andes for thousands of years (Figure 2). This crop was an important food for the Incas and still remains as an important food crop for the Quechua and Aymara peoples of the rural regions. Quinoa belonging to the *Chenopodiaceae* family, genus *Chenopodium*, is a facultative halophyte [6], and a dicotyledonous annual herbaceous plant comprising wild relatives and domesticated populations.

Figure 2. Quinoa plant (left) and grains (right)

The genus *Chenopodium* is the largest in the family *Chenopodiaceae* and has a worldwide distribution, with about 250 species [7]. The classification of quinoa was first made from the colour of the plant and fruits - white, red, and black. Subsequently, it was based on the morphological types of the plant. Despite the wide variation observed, quinoa is considered to be one single species. Quinoa, like amaranth, belongs to the group of pseudo cereals.

<u>*2.1.3 Buckwheat*</u>

Buckwheat (Figure 3) is a dicotyledonous plant, belonging to the *Polygonaceae* family, and originating from the Southwestern mountainous area of China. Buckwheat is non-glutinous and is often referred a pseudo cereal due to similarity of use and chemical composition to cereals [8].

Figure 3. Buckwheat plant (left) and grains (right)

Its leaves are broadly heart shaped dark green. Buckwheat can be divided into groups of species: annual and multiannual [9]. Two buckwheat species are commonly cultivated: common buckwheat (*F. esculentum*) and tartary buckwheat (*F. tartaricum*) [10]. The buckwheat grain consists of a triangular seed with two cotyledons running through the endosperm and surrounding it [11].

<u>*2.1.4 Spelt*</u>

Spelt (*Triticum aestivum* var. *spelta*) (Figure 4) is a subspecies of wheat that is primarily used as an alternative feed grain for livestock. It is an old European crop, grown for centuries, including the first half of this century, in several countries of central Europe. In Italy, it is known as farro, while in Germany they call it dinkel. In prehistorical times, spelt was mainly grown in the Near East.

Figure 4. Spelt plant (left) and grains (right)

Spelt (*Triticum aestivum* subsp. *spelta*) is one of the husked hexaploid wheats which possesses the same genomes as bread wheat (*Triticum aestivum* L.) [12]. Compared to wheat, spelt is taller (150 ± 200 cm), has long, lax ears (15 ± 20 cm), a brittle rachis and adherent glumes [13].

<u>*2.1.5 Khorasan wheat*</u>

Khorasan wheat (Kamut™) is an ancient grain with widely acclaimed beneficial effects on human health (Figure 5). The exact origin of Khorasan wheat remains unknown but khorasan production is associated with a historical region in modern-day northern Iran in the and parts of Central Asia including modern-day Afghanistan.

Figure 5. Khorasan wheat plant (left) and grains (right)

Khorasan wheat is a variety form of *Triticum turgidum* subsp. *turanicum* (also known as *Triticum turanicum*). Sometimes, there are incorrect identifications as *T. polonicum*, although long-grained, lack the long glumes of this species. Recent genetic evidence from DNA fingerprinting suggests that the variety perhaps derives from a natural hybrid between *T. durum* and *T. polonicum*, which would explain past difficulties agreeing on a certain classification [14].

<u>*2.1.6 Einkorn wheat*</u>

Einkorn (*Triticum monococcum* ssp. *monococcum* L.) is a diploid ancestral wheat, related to durum (*T. turgidum* ssp. *durum*) and to bread (*T. aestivum* ssp. *aestivum*) wheats. The term einkorn is derived from the German language and interpreted to mean "single grain".

Figure 6. Einkorn wheat plant (left) and grains (right)

Triticum monococcum L. (Einkorn wheat) has been cultivated since about seven thousand BC (Harlan and Zohary [15]). It can be found in the Middle-East, the Balkans and Caucasus, Turkmenistan, Central and

Mediterranean Europe, North-Africa, Western and Northern Europe. Einkorn wheat differs from varieties of modern wheat, but it is similar to other ancient forms of crop like spelt and emmer. Einkorn is classified as "covered wheat".

2.2 Nutritious value

2.2.1 Amaranth

On average, the amaranth grain is composed of crude protein (13.1 - 21.0%); crude fat (5.6 - 10.9%); starch (48 - 69%) which is higher than most cereal grains; dietary fiber (3.1 - 14.2%) and ash (2.5 - 4.4%) [16, 17]. Approximately 76% of the fatty acids are unsaturated. The content of linoleic fatty acid is in the range of 25 - 62%, oleic acid 19 - 35%, palmitic acid 12 - 25%, stearic acid 2 - 8.6%, and linolenic fatty acid 0.3 - 2.2% [18]. Linoleic acid is an essential fatty acid in human nutrition because it cannot be synthesized by humans. The amaranth seed is also a source of tryptophan and sulphur containing amino acids - these usually do not appear enough in grains. Amaranth has a pleasant, nut-like flavor.

The amaranth starch mostly contains amylopectin (88.9 - 99.9%) and, thus, is classified as "waxy type" starch with some unique characteristics (high viscosity and gelatinization at higher temperature) in comparison to normal starches with 17 - 24% amylase content. The amaranth starch is very desirable in the food industry because of its stability [19].

It has been proven that the amaranth grain is a rich source of Fe (72 - 174 mg/kg^{-1}), Ca (1,300 - 2,850 mg/kg^{-1}), Na (160 - 480 mg/kg^{-1}), Mg (2,300 - 3,360 mg/kg^{-1}) and Zn (36.2 - 40 mg/kg^{-1}), as well as vitamin B_2 (0.19 - 0.23 $mg/100g^{-1}$) vitamin C (4.5 $mg/100g^{-1}$), vitamin B_3 (1.17 - 1.45 $mg/100g^{-1}$), and vitamin B_1 (0.07 - 0.1 $mg/100g^{-1}$) [20].

2.2.2 Quinoa

The benefits of quinoa are due to its high nutritional value. Its grain is a rich source of a wide range of minerals, vitamins, oil containing large amounts of linoleate, natural antioxidants [21, 22] and high-quality protein containing abundant amounts of sulphur rich amino acids [21]. Quinoa leaves contain: 3.3% ash, 1.9% fiber, 0.4% nitrates, 2.9 mg/100 g vitamin E, 289 mg/100g Na, 1.2 - 2.3 g/kg vitamin C, and 27 - 30 g/kg of proteins [23]. The total amount of phenolic acids varied from 16.8 to 59.7 mg/100 g and the proportion of soluble phenolic acids varied from 7 to 61%; which is low compared to common cereals like wheat and rye, but similar to levels found in oat, barley, corn and rice [24]. The quinoa grain contains 15.16 to 17.41% protein content on a dry weight basis; amino acids (higher contents of most essential amino acids, especially lysine) and minerals [25]. In pseudo cereals, such as quinoa, albumins and globulins are the major protein fraction (44 - 77% of total protein), which is greater than that of prolamins (0.5 - 7.0%). Quinoa is considered to be a gluten-free grain because it contains very little or no prolamin [26].

According to Tari *et al.*, [27] the content of amylopectin in quinoa starch is 77.5%. Quinoa amylopectin has a unique chain length distribution as a waxy amylopectin, with 6700 glucan units for the amylopectin fraction of quinoa starch [28].

Quinoa seed carbohydrates contain between 58 and 68% starch and 5% sugar, making it an ideal source of energy that is slowly released into the body owing to its high fiber content [29]. Kumpun *et al.*, [30] reports that quinoa seeds are rich in: proteins and free essential amino acids, starch, minerals, ecdysteroid content and oils, but also contain low amounts of several vitamins and antioxidants.

Quinoa contains from 2 - 10% fat. Quinoa and soya oils exhibit similar fatty acid compositions; thus, quinoa is a rich source of essential fatty acids such as linolenic (18:2n-6:52%) and linolenic (18:3n-6:40%) [26].

2.2.3 Buckwheat

In literature, the protein content of buckwheat grains has been reported to range from 12 to 18.9% [31, 32], with major protein fractions of water-soluble and salt-soluble albumins and globulins representing almost one-half of all buckwheat proteins. Buckwheat grains may constitute a valuable source of dietary proteins with a high content of essential amino acids, which is important for people with celiac disease [33] or with proteins deficiency in the diet. Starch is a major component of buckwheat grains. The amylose content of buckwheat starch granules fluctuates between 15 and 52% [34]. Buckwheat grains contain 1.5 - 4% of total lipids [11]. Buckwheat is rich in potassium (K), magnesium (Mg), calcium (Ca), and sodium (Na) and also contains vitamins: B_1, B_2, B_6 [35].

2.2.4 Spelt

The nutritive value of spelt is similar to wheat's [36] or even higher as shown by numerous studies. It contains eight of the essential amino acids and is naturally high in fiber. Spelt consists of approximately 57.9% carbohydrates (excluding 9.2% fiber), 17.0% protein, 3.0% fat, and dietary minerals and vitamins. For example, in comparison to wheat, spelt was found to be higher in minerals [37]; higher in selenium content [38]; higher in protein content [39]; abundant in soluble fibers [40] and has more favorable ratio of unsaturated to saturated fatty acids [41]. Spelt is reported to have higher protein content than common bread wheat [42]. Abdel-Aal [43] determined a 15.4% of proteins in laboratory milled whole meal spelt flour. The rich flavor of this wheat is sweet and nutty.

2.2.5 Khorasan wheat

Khorasan wheat, in addition to always being grown organically and preserved from modification or hybridization, is an excellent source of protein (14%), fiber (10%), zinc, phosphorus, magnesium, vitamin B_1 and vitamin PP. The dietary fibers aid in digestion and help in the prevention of constipation some types of cancer. Khorasan wheat is also high in many minerals such as selenium, copper, manganese and molybdenum. In addition, a higher content of total carotenoids in khorasan wheat compared to common wheat was reported [43] with lutein as the major component. It has a buttery, nutty flavor.

2.2.6 Einkorn wheat

Einkorn wheat has a lipid content 50% higher than that of bread wheat [44]. Abdel-Aal *et al*., [45], identified in einkorn wheat: 415 mg/100 g phosphorus, 390 mg/100g potassium, 190 mg/100g sulfur, 4.4 mg/100g manganese, and the presence of: thiamine (0.50 mg/100g), riboflavin (0.45 mg/100g), niacin 3.1 mg/100g pyridoxine and 0.49 mg/100 g of vitamins from the B group [45]. The many B vitamins help with metabolism, and the production of energy from food. Depending on the einkorn wheat genotype, the average value of iron is 47.04 mg/kg, 54.81 mg/kg zinc, 49.29 mg/kg manganese, and 6.40 mg/kg copper [46]. Iron aid in the generation of hemoglobin (for red blood cells) and myoglobin (for muscles), both of which help carry and store oxygen. Manganese activates many important enzymes in the body that are crucial to metabolism of carbohydrates, amino acids, and cholesterol. It is also essential to the formation of healthy cartilage and bone.

2.3 Utilization

2.3.1 Amaranth

The amaranth grain has been used as an ingredient for whole grain tasteful soups, stews, sauces, porridges, and soufflés. When boiled it can be used as rice and kus-kus. The amaranth grain contains a certain amount of starch which gelatinizes while boiling, leading to the formation of a thick porridge structure. It often occurs that the embryo encircled gelatinous perisperm is separated during cooking. Amaranth can also be germinated for sprouts, malted for beer production (traditional beer *chicha* in Peru), and fermented (as compound for *ogi* – traditional product of lactic fermentation of cereal porridges in Africa, or could be used instead of soy in shoyu). It can serve as a starchy material in spirit production. The grain can be ground and used as a flour ingredient in different mixtures for: pancakes, bread, muffins, dumplings, crackers, cookies, puddings, etc. [47, 18]. Amaranth can be used as a supplement in culinary technology because it contains high content of proteins. Furthermore, amaranth, like buckwheat, can be popped through intense, short and dry heat without the addition of fat. Amaranth is also suitable for the production of muesli and granola bars. The amaranth leaves are usually picked fresh, used in salads or blanched, steamed, boiled, stir fried, or baked to taste. Cooked greens can be used as a side dish, in soups, as an ingredient in baby food, casserole, lasagne, pasta, pie, soufflé, etc.

2.3.2 Quinoa

Quinoa seeds are used to make different food products like: breads, biscuits, cookies, crepes, muffins, and pancakes. Attention has been given to quinoa for people with celiac disease, as an alternative to the: cereals wheat, rye and barley, which all contain gluten [48]. Quinoa can be eaten as rice replacement, hot breakfast cereal, or can be boiled in water to make infant cereal food. The seeds can be popped like popcorn. Seeds can be ground and used as flour, or sprouted. The sprouts need to get green before they can be added to salads [26]. Quinoa flour can be mixed with other types of wheat like maize. Several levels of quinoa flour substitution have been reported, for instance, in bread (10–13% quinoa flour), noodles and pasta (30 - 40% quinoa flour), and sweet biscuits (60% quinoa flour) [26]. The flour is also suitable for noodles, which have bitter taste due to the saponin content. Seeds are used boiled like rice or to thicken soups and porridges. So far limited information is available concerning the nutraceutical potential of the green parts of quinoa.

2.3.3 Buckwheat

Due to its neutral taste, buckwheat combines well with vegetables and cheeses, making it a great addition to salads. Buckwheat can be a good addition to soups, fish, vegetables, desserts, milk and fruit.

It can also be used:

- boiled for breakfast with butter and cheese or with dried fruits and agave juice;
- boiled and chilled in salads;
- in soups, instead of rice;
- for sprouts;
- boiled and then cooked with vegetables and olive oil;
- as flour for bread, pancakes, cookies and biscuits;
- in combination with other flours, for example 1:3 buckwheat and spelt;

2.3.4 Spelt

Spelt is intended both for animal feeding (as a ground grain) [49], and human consumption [50, 51]. Nowadays, commercially available products like flour, bread, breakfast cereals, pasta, crackers [52], and number of regional specialties are based on spelt. Spelt flour is rather suitable for pasta production [53]. However, Abdel-Aal [42], described using spelt for the preparation of: bread, sour dough bread, biscuits, cookies and muffins and Hempel *et al.*, [54] applied spelt in the manufacture of prebiotic wafer crackers enriched with inulin syrup. Furthermore, there is some evidence that spelt extracts can be active ingredients to the cosmetics industry [55].

2.3.5 Khorasan wheat

The culinary use of khorasan wheat requires pre-treatment (soaking in water for 24 h). It is often consumed boiled and chilled, suitable for breakfast cereals with butter, cheese, etc. It also combines with nuts, dried fruit and honey. This wheat is an essential ingredient to some sophisticated salads and dishes (spinach with khorasan wheat). In addition to seeds, sprouts from khorasan wheat can also be eaten. Khorasan wheat flour is an ingredient to pasta, bread, crackers, beets, sweets. It is often combined with other types of flours. It is low in gluten and thus a good alternative for people with gluten intolerance. In addition to this beer can be produced from khorasan wheat.

2.3.6 Einkorn wheat

Today einkorn wheat is used to make pasta, flour, bread and animal feed. Einkorn wheat has a high content of protein, phosphorus and potassium, compared to other types of wheat. Minced einkorn is used very successfully for the preparation of different types of dough. Dietetic biscuits and bread are often produced from einkorn. It is important to know that einkorn flour almost does not contain gluten, which makes it ideal for consumption by people with gluten intolerance. Einkorn can also be used in different salads or mixed with tahana, honey and nuts. Healthy sprouts are made from einkorn.

2.4 Future prospects

There is a global trend toward overconsumption of calories. Even though many people around the world remain hungry, people are becoming overweight and obese, harming human health and contributing to rising healthcare costs and lost productivity. It is crucial to take steps in shifting eating patterns towards healthier ones. Purchases are typically based on habit and unconscious mental processing rather than on rational, informed decisions. Furthermore, attributes like price, taste, and quality tend to be more important than purchasing decisions feasibility. Different food related seminars aim at providing information and educating the consumers in making a healthier choice. Changing food consumption behavior typically involves changing ingrained habits. What people eat is highly influenced by cultural environment and social norms. Informing and educating consumers, along with efforts to make the preferred food more socially desirable or the food to be shifted from less socially desirable, can influence or change the underlying social and cultural norms that underlie people's purchasing decisions.

Nowadays, consumers are becoming increasingly aware of the benefits of including a variety of cereal grains as a major portion of their diets. Grains account for about half of human caloric intake. Due to their nutritional value pseudo cereal present an interesting alternative in order to increase the range of used plants for nutrition. The growing interest in healthy living, quality food and culinary variety means ancient grains and traditional plants are receiving more attention from people. Many of them are a source of phytochemicals, which provide key antioxidant properties. It has been found that the beneficial influence on human health of the plants is associated with the presence of specific biologically active substances. In the diet of primitive men, natural ingredients constitute a major part of the daily intake and are characterized by a large amount and variety of biologically active substances. Now, the contemporary consumer uses three times more limited variety of natural plant food and is placed within stressful factors affecting adversely the health status. Fortunately, due to the re-discover of traditional food ingredients, people are experiencing the "forgotten" nutritional advantages of the newly developed recipes with pseudo cereals, leafy vegetables, green leaves, etc.

3. Conclusions

- Now that consumers are increasingly interested in health and their knowledge of the relationship between diet and well-being has raised, ancient grains are likely to gain even more popularity. Their nutritional quality has been a subject of research and existing evaluations suggest that the consumption of grains is associated with long-term weight loss (sources of fiber) and well-being. Grains can be incorporated in the production of various products such as pasta, flakes, etc., with good sensorial and nutritional properties.

- To a significant number of people the absence of gluten in their diet is extremely important. Therefore, gluten free grains play an important role in their dietary plan. Non-gluten-containing sources frequently used in product formulation include cereals (rice, corn and sorghum), and pseudo cereals (buckwheat, quinoa and amaranth). Considerable efforts have been made in different nutrition education actions.

- Public awareness campaigns intend to change the food component modern society focuses on. The nutritional value of amaranth, quinoa, buckwheat, spelt, khorasan wheat, einkorn wheat, etc. gives a reason to promote them as a healthy food that makes a comeback in modern cooking. In addition to the basic benefits of grains, they help maintain optimum health due to the phytochemicals they contain – many of which are still being identified.

4. References

[1] Jonnalagadda S., Harnack L., Liu R. H., McKeown N., Seal C., Liu S., Fahey G. C. (2011). *Putting the Whole Grain Puzzle Together: Health Benefits Associated with Whole Grains. Summary of American Society for Nutrition 2010 Satellite Symposium.* J. Nutr., 141, (5), pp. 1011.

[2] Steffen L. M., Jacobs D. R., Stevens J. (2003). *Associations of whole-grain, refined-grain, and fruit and vegetable consumption with risks of all-cause mortality and incident coronary artery disease and ischemic stroke: The Atherosclerosis Risk in Communities (ARIC) Study*. American Journal of Clinical Nutrition, 78, pp. 83-90.

[3] Slavin J. L., Jacobs D., Marquart L. (2001). *Grain processing and nutrition*. Critical Reviews in Biotechnology 21, pp. 49-66.

[4] Wijngaard H. H., Arendt E. K. (2006). *Buckwheat*. Cereal Chemistry 83, pp. 391-401.

[5] Minodora I., Florina R., Lia R. (2016). *Amaranthus Hypochondriacus and Chenopodium Quinoa, Ingredients with High Nutritive Value in Gluten - Free Sweet Products Formulations*. Revista de Chimie, 67, (5), pp. 902-907.

[6] Adolf V. I., Shabala S., Andersen M. N., Razzaghi F., Jacobsen S. E. (2012). *Varietal differences of quinoa's tolerance to saline conditions*. Plant and Soil, 357, pp. 117-129.

[7] Giusti K. (1970). *The genus Chenopodium in Argentina. I. Number of chromosomes* (in Spanish). Darwiniana, 16, pp. 98-105.

[8] Ohnishi O. (2004). *On the origin of cultivated buckwheat*. Proceedings of the 9th ISB, Prague, Czech Republic, pp. 16- 21.

[9] Li S., Zhang Q. H. (2001). *Advances in the development of functional foods from buckwheat*. Critical Reviews in Food Science and Nutrition, 41, pp. 451-464.

[10] Krkošková B., Mrázová Z. (2005). *Prophylactic components of buckwheat*. Food Research International 38, pp. 561-568.

[11] Steadman K. J., Burgoon M. S., Lewis B. A., Edwardson S. E., Obendorf R. L. (2001). *Buckwheat seed milling fractions: Description, macronutrient composition and dietary fibre*. Journal of Cereal Science, 33, pp. 271-278.

[12] Yan Y., Hsam S. L. K., Yu J. Z., Jiang Y., Ohtsuka I., Zeller F. J. (2003). *HMW and LMW glutenin alleles among putative tetraploid and hexaploid European spelt wheat (Triticum spelta L.) progenitors*. Theoretical and Applied Genetics, 107, pp. 1321-1330.

[13] Onishi I., Hongo A., Sasakuma T., Tawahara T., Kato K., Miura H. (2006). *Variation and segregation for rachis fragility in spelt wheat, Triticum spelta L.* Genetic Resources and Crop Evolution, 53, pp. 985-992.

[14] Khlestkina E. K., Röder M. S., Grausgruber H., Börner A. (2006). A DNA fingerprinting-based taxonomic allocation of Kamut wheat. Plant Genetic Resources, 4, (03), pp. 172-180.

[15] Harlan J. R. and Zohary D. (1966). *Distribution of wild wheats and barley*. Science, 153, pp. 1074-1080.

[16] Leon-Camacho M., Garcia-Gonzalez D. L., Aparicio R. (2001). *A detailed study of amaranth (Amaranthus cruentus L.) oil fatty profile*. European Food Research and Technology, 213, (4), pp. 349-355.

[17] Berganza B. E., Moran A. W., Rodrigez G. M., Coto N. M., Santamaria M., Bressani R. (2003). *Effect of Variety and Location on the Total Fat, Fatty Acids and Squalen Content of Amaranth*. Plant Foods for Human Nutrition, 58, pp.1-6.

[18] Berghofer E., Schoenlechner R. (2002), *Grain Amaranth*. In: Belton P. and Taylor J. (Eds.), Pseudocereals and less common cereals, grain properties and utilization potential, Springer- Verlag, Berlin, Germany, pp. 219-260.

[19] Pal J., Singhal R. S., Kulkarni P. R. (2001). *Physicochemical properties of hydroxypropyl derivative from corn and amaranth starch*. Carbohydrate Polymers, 48, pp.19-53.

[20] Becker R., Wheeler E. L., Lorenz K., Stafford A. E., Grosjean O. K., Betschart A. A., Saunders R. M. (1981). *A compositional study of Amaranth grain*. Journal of Food Science, 46, pp. 1175-1180.

[21] Koziol M. J. (1992). *Chemical composition and nutritional value of quinoa (Chenopodium quinoa Willd.)*. Journal of Food Composition and Analysis, 5, pp. 35-68.

[22] Repo Carrasco R., Espinoza C., Jacobsen S. E. (2003). *Nutritional value and use of the Andean crops quinoa (Chenopodium quinoa) and kañiwa (Chenopodium pallidicaule)*. Food Reviews International, 19, (1-2), pp. 179-189.

[23] Bhargava A., Shukla S., Ohri D. (2006). *Chenopodium quinoa - An Indian perspective*. Industrial Crops and Products, 23, pp. 73-87.

[24] Repo-Carrasco-Valencia R., Hellström J. K., Pihlava J. M., Mattila P. H. (2010) *Flavonoids and other phenolic compounds in Andean indigenous grains: Quinoa (Chenopodium quinoa), kañiwa (Chenopodium pallidicaule) and kiwicha (Amaranthus caudatus)*. Food Chemistry, 120, pp. 128-133.

[25] Stikic R., Glamoclija D., Demin M., Vucelic Radovic B., Jovanovic Z., Milojkovic Opsenica D., Jacobsen S. E., Milovanovic M. (2012). *Agronomical and nutritional evaluation of quinoa seeds (Chenopodium quinoa Willd.) as an ingredient in bread formulations*. Journal of Cereal Science, 55, pp. 132-138.

[26] Tari T., Annapure U., Singhal R., Kulkarni P. (2003). *Starch-based spherical aggregates: Screening of small granule sized starches for entrapment of a model flavouring compound, vanillin*. Carbohydrate Polymers, 53, pp. 45-51.

[27] Valencia-Chamorro S. A. (2003). *Quinoa*. In: Caballero B. (Ed.), Encyclopedia of Food Science and Nutrition. Academic Press, Amsterdam, Netherlands, 8, pp. 4895-4902.

[28] Tang H., Watanabe K., Mitsunaga T. (2002). *Characterization of storage starches from quinoa, barley and adzuki seeds*. Carbohydrate Polymers, 49, (1), pp. 13-22.

[29] Food and Agriculture Organization of the United Nations. (2011). *Quinoa: An ancient crop to contribute to world food security*. FAO, Geneva, Switzerland.

[30] Kumpun S., Maria A., Crouzet S., Evrard Todeschi N., Girault, J. P., Lafont R. (2011). *Ecdysteroids from Chenopodium quinoa Willd. An ancient Andean crop of high nutritional value*. Food Chemistry, 125, pp. 1226-1234.

[31] Wei Y., Hu X., Zhang G., Ouyang S. (2003). *Studies on the amino acid and mineral content of buckwheat protein fractions*. Nahrung/Food, 47, pp. 114-116.

[32] Stempińska K., Soral-Śmietana M. (2006). *Chemical components and physicochemical evaluation of buckwheat kernels - comparison of three Polish varieties* (in Polish). Żywność Nauka Technologia Jakość, 13, (Supplement 2/47), pp. 348-357.

[33] Aubrecht E., Biacs P. A. (2001). *Characterization of buckwheat grain proteins and its products*. Acta Alimentaria, 30, pp. 71-80.

[34] Campbell C. G. (1997). *Buckwheat Fagopyrum esculentum Moench*.

<URL: http://www.bioversityinternational.org/uploads/tx_news/Buckwheat__Fagopyrum_esculentus_Moench_343.pdf. Accessed 3 11.2017.

[35] Fabjan N., Rode J., Košir I. J., Zhang Z., Kreft I. (2003). *Tatary buckwheat (Fagopyrum tartaricum Gaertn.) as a source of dietary rutin and quercetin*. Journal of Agricultural and Food Chemistry, 51, pp. 6452-6455.

[36] Grela E. R. (1996). *Nutrient composition and content of antinutritional factors in spelt (Titicum spelta L.) cultivars*. Journal of the Science of Food and Agriculture, 71, pp. 399-404.

[37] Piergiovanni A. R., Rizzi R., Panacciulli E., della Gatta C. (1997). *Mineral composition in hulled wheat grains: a comparison between emmer (Tritium dicoccon Scrank) and spelt (T. spelta L.) accessions*. International Journal of Food Sciences and Nutrition, 48, pp. 381-386.

[38] Zhao F. J., Su Y. H., Dunham S. J., Rakszegi M., Bedo Z., McGrath S. P., Shewry P. R. (2009). *Variation in mineral micronutrient concentrations in grain of wheat lines of diverse origin*. Journal of Cereal Science, 49, pp. 290-295.

[39] Siemianiowska E., Skibniewska K. A., Warechowska M., Jędrzejsczak M. F., Tybirski J. (2011). *Flour and bread quality of spring spelt*. World Academy of Science, Engineering and Technology, 59, pp. 170-175.

[40] Bonifácia G., Galli V., Francisci R., Mair V., Krabanja V., Kreft I. (2000). *Characteristics of spelt wheat products and nutritional value of spelt wheat-based bread*. Food Chemistry, 68, pp. 437-441.

[41] Ruibal-Mendieta N. L., Dekezser A., Delacroix D. L., Mignolet E., Larondelle Y., Meurens M. (2004). *The oleate/palmitate ratio allows the distinction between wholemeals of spelt (Triticum spelta L.) and winter wheat (T. aestivum L.)*. Journal of Cereal Science, 39, pp. 413-415.

[42] Bojnanská T., Francáková H. (2002). *The use of spelt wheat (Triticum spelta L.) for baking applications*. Rostl. Výr., 48, pp. 41-147.

[43] Abdel-Aal E. S. M, Hucl P., Sosulski W. F. (1995). *Compositional and Nutritional Characteristics of Spring Einkorn and Spelt Wheats*. Cereal Chemistry, 72, (6), pp. 621-624.

[44] Brandolini A., Hidalgo A. (2011). *Einkorn (Triticum monococcum) Flour and Bread, Flours and Breads and their fortification in health and disease prevention*. In: Preedy, P., Watson, R., Patel, V. (Eds.), Flour and Breads and their Fortification in Health and Disease Prevention, Elsevier, Amsterdam The Netherlands, pp.79-88.

[45] Abdel-Aal, E. S. M. (2007). *Effects of baking on protein digestibility of organic spelt products determined by two in vitro digestion methods*. LWT- Food Science and Technology, 41, pp. 1282-1288.

[46] Ozkan, H., Brandolini, A., Torun, A., AltIntas, S., Eker, S., Kilian, B., Braun, H. J., Salamini, F., Cakmak, I. (2007). *Natural Variation And Identification Of Microelements Content In Seeds Of Einkorn Wheat (Triticum Monococcum)*. In: Buck H. T., Nisi J. E., Salomón N. (Eds.), Wheat Production in Stressed Environments, Developments in Plant Breeding, Vol 12, Springer, Dordrecht Netherlands.

[47] Bejosano F. P., Corke H. (1998). *Protein quality evaluation of Amaranthus whole meal flours and protein concentrates*. Journal of the Science of Food and Agriculture, 76, pp. 100-106.

[48] Jacobsen S. E. (2003). *The Worldwide Potential for Quinoa (Chenopodium quinoa Willd.)*. Food Reviews International, 19, pp. 167-177.

[49] Büren M., Stadler M., Luthy J. (2001). *Detection of wheat adulteration of spelt flour and products by PCR*. European Food Research and Technology, 212, pp. 234-239.

[50] Rozenberg R., Ruibal-Mendieta N. L., Petitjean G., Cani P., Delacroix D. L., Delzenne N. M., Meurens M., Quetin-Leclercq J., Habib-Jiwan J. L. (2003). *Phytosterol analysis and characterisation in spelt (Triticum aestivum ssp. spelta L.) and wheat (T. aestivum L.) lipids by LC/APCI-MS*. Journal of the Cereal Science, 38, pp. 189-197.

[51] Zielinski H., Ceglinska A., Michalska A. (2008). *Bioactive compounds in spelt bread*. Eur. Food Res. Technol., 226, pp. 537-544.

[52] Marques C. D., Auria L., Cani P. D., Baccelli Ch., Rozenberg R., Ruibal-Mendieta N. L., Petitjean G., Delacroix D. L., Quetin-Leclercq J., Habib-Jiwan J. L., Meurens M., Delzenne M. (2007). *Comparison of glycemic index of spelt and wheat bread in human volunteers*. Food Chemistry, 100, pp. 1265-1271.

[53] Radic-Miehle H., Saam C., Hüls R., Kling C. I., Hesemann C. U. (1998). *Characterization of spelt (Triticum spelta L.) forms by gel-electrophoretic analyses of seed storage proteins. III. Comparative analyses of spelt and Central European winter wheat (Triticum aestivum L.) cultivars by SDS-PAGE and acid-PAGE*. Theoretical and Applied Genetics, 97, pp. 1340-1346.

[54] Hempel S., Jacob A., Rohn H. (2007). *Influence of inulin modification and flour type on sensory quality of prebiotic wafer crackers*. European Food Research and Technology, 224, pp. 335-341.

[55] Georgieva-Krasteva L., Hristova I., Mihaylova D., Dobreva K. (2017). *Spelt (Triticum aestivum ssp. spelta) - from field to cosmetics*. International Journal of Pharmacognosy and Phytochemical Research, 9, (5), pp. 613-617.