

CEREALS – PRODUCTION, PROPERTIES AND ORGANIC FOOD

CEREALIJE – PROIZVODNJA, SVOJSTVA I ORGANSKA HRANA

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ABSTRACT

Man has always been using cereal grains in his diet. When traditional stone mills were replaced the mass white flour production began. Rejecting whole grain and orientating exclusively to white bread and bakery products, mankind eventually suppressed extremely valuable cereals (millet, barley, oat, rye, buckwheat, amaranth and even maize) from its nutrition. During the second half of the last century people became aware of a need to use again natural sources of food and high biological values of such food for the human organism. One of basic principals of correct and healthy nutrition is daily consumption of whole-grain cereals.

Based on the most recent trends in the world science of food, the objective of this study was to present the most important properties and prospective of the production development and utilisation of the most important cereals in our country and abroad. In terms of obtained scientific and research results, potential possibilities, status and needs on markets, and in accordance with recommendations made by nutritionists, the production of organic cereals and their products of high nutritive values and health safety, is considered remarkably actual and attractive. The aim of the study is to draw attention to this very important sector of the contemporary science and technology, for which it can be justifiably claimed that is full of real and great challenges.

Key words: cereals, production, properties, organic food.

REZIME

Čovek je oduvek u svojoj ishrani koristio zrno cerealija, odnosno žita. Tek je zamena klasičnih kamenih mlinova dovela do masovne proizvodnje belog brašna. Odbacujući celo zrno i orijentišući se isključivo na beli hleb i peciva savremeno čovečanstvo je postepeno potisnulo iz svoje ishrane izuzetno vredna žita: proso, ječam, ovas, raž, heljdu, štir, pa čak i kukuruz. Druga polovina prošlog veka donosi buđenje svesti o potrebi vraćanja na prirodne izvore hrane i visokim biološkim vrednostima koje ona ima za ljudski organizam. Jedan od osnovnih principa pravilne i zdrave ishrane jeste svakodnevna upotreba integralnih cerealija.

Cerealije su jedna od najzastupljenijih biljnih vrsta u organskoj proizvodnji u svetu. Sagledavajući najnovije trendove svetske nauke o hrani za zadatak ovog rada je postavljeno da se prikažu najbitnija svojstva i perspektive razvoja proizvodnje i korišćenja najvažnijih cerealija u našoj zemlji i u svetu. Polazeći od do sada ostvarenih naučnoistraživačkih rezultata, potencijalnih mogućnosti, stanja i potreba na tržištu, a u skladu sa preporukama nutricionista, proizvodnja organskih cerealija i njihovih proizvoda visoke nutritivne vrednosti i zdravstvene bezbednosti se smatra izuzetno aktuelnom i atraktivnom. Cilj rada je da skrene pažnju na ovaj veoma važan sektor savremene nauke i tehnologije za koji se sa pravom se može reći da je pun pravih i velikih izazova.

Ključne reči: cerealije, proizvodnja, svojstva, organska hrana.

INTRODUCTION

The first decade of the 21st century was characterised by paying full and real, that is fundamental attention to food importance that it has for life and health of man, which is reflected in its multidisciplinary roles and functions. Similar prognoses are made by many researchers in the world acknowledged centres for the whole 21st century (Biliaderis, 2008; Biliaderis and Lazaridou, 2009; Lazarides, 2009). These prognoses predict that this century will be the age of food and health. Food provides necessary energy for proceeding all processes in the organism. It is a source of elements for the formation of new tissues and regeneration, it also provides necessary components for all biochemical process, protection against diseases, genetic substance. Well balanced nutrition containing necessary constituents provides good health and protection against illnesses. The satisfactory state of nourishment and desirable body composition are the indicator of well balanced, correct nutrition. The satisfactory state of nourishment or a good nutritive status is a prerequisite for optimum health (Novaković and Miroslavić, 2002).

Significant changes have been occurring in agriculture and food production in accordance with scientific information, technical and technological innovations and the development of human population in general. The agricultural production in Serbia can make a greater economic effect than it does now. It can also offer high quality and safe food attractive to consumers not only in our country but abroad too (Banović et al, 2005). One of pri-

ority aims of the contemporary science is particularly the improvement of the food production, provision of its safety and high quality, as well as, general paying attention to the importance of food and nutrition related to health, which is an integral part of the health preservation and improvement and prevention against diseases. In order to better understand the basic issues of this study, it is necessary to establish key terms. Firstly, we need to provide the explanation of cereals. Cereals are any grass yielding starchy seeds suitable for food. The most commonly cultivated cereals are wheat, maize, rice, barley, oats, rye, sorghum, millet, triticale, buckwheat and amaranth. Cereals have enormous importance for food. Man has been using cereals in his diet since ever. Daily consumption of whole-grain cereals is one of the fundamental principals of correct and healthy nourishment. In our country, there is a lack of scientific literature within cereal production and processing. Žeželj, 1995 and 2005, systematically and in detail described cereals as a mill raw material, as well as, processing technology of cereals and their flour (Žeželj, 1995; Žeželj, 2005). In addition, these issues were presented in the book titled "Wheat Flour Milling", which was translated into Serbian (Posner and Hibbis, 2001). On the other hand, our esteemed researchers wrote two exceptional monographs related to organic agriculture (Kovačević and Oljača, 2005; Lazić et al, 2008, Lazić et al, 2008). The aim of these monographs, which universally unite almost all segments of organic agriculture, from production to marketing, was, in fact, to present contemporary trends within the field of the organic agri-

cultural production in the world and in our country. The idea of these authors was to present understandably to the scientific and professional public new aspects on agriculture and environments, giving back a positive and central role to man in environmental protection.

Cereals are the most present plant species in the organic production in the world. Considering stating, the objective of this study was to present properties and production of cereals in both, our country and the world, and to direct attention to their significance as organic food, which is considered as a very important sector of modern science and technology that is full of actual and great challenges.

PRODUCTION OF CEREALS

Maize, wheat and rice make 87% of the production of all cereals all over the world, and also provide 43% of all calories in food. The production of oats and rye has been drastically decreased down to its level in 1960. Other cereals, although very important in human nutrition, have a small global production and are not included into FAO statistics (<http://faostat.fao.org>).

Table 1 present trends in the global production of maize, wheat and rice during the last five years, while Table 2 shows the global trends in the production of barely, oats and rye during the same period. In 2007 the following countries were the greatest producers of cereals: maize (USA, China, Mexico, Brazil and Argentina), wheat (China, India, USA, Russia and France) and rice (China, India, Indonesia, Bangladesh and Vietnam) (<http://www.agrostats.com/world-statistic/world-production-statistics.html>).

Table 1. Global production of maize, wheat and rice during the last five years (in 1000 tonnes)

Year of production	Maize	Wheat	Rice
2005/06	698,786	619,563	418,441
2006/07	712,380	595,620	420,625
2007/08	791,870	609,697	433,398
2008/09	791,285	682,184	445,667
2009/10	792,545	656,062	433,655

Table 2. Global production of barley, oats and rye during the last five years (in 1000 tonnes)

Year of production	Barley	Oats	Rye
2005/06	136242	23841	14522
2006/07	136472	23083	12413
2007/08	133001	25150	14353
2008/09	153938	26507	17400
2009/10	147245	23952	16958

The national production of 8-10 million tonnes of cereals makes our country one of leading cereal producers in Europe. Maize is traditionally the most widely grown field crop under our conditions. The produced maize amounts significantly exceed the produced wheat amounts (Table 3). Table 4 presents the production of barely, oats and rye in Serbia during the last five years (<http://webzrs.statserb.sr.gov.yu/axd/index.php>).

Table 3. Wheat and maize production in Serbia during the last five years (in tonnes)

Year of production	Maize	Wheat
2005	7085666	2007060
2006	6016765	1875335
2007	3904825	1863811
2008	6158122	2095403
2009	6396262	2067555

Table 4. Production of barely, oats and rye in Serbia during the last five years (in tonnes)

Year of production	Barely	Oats	Rye
2005	310850	90480	15778
2006	275640	84439	15417
2007	258998	76880	10902
2008	344141	95560	13608
2009	302527	73640	12743

PROPERTIES OF CEREALS

Man has been using cereal grains in his nourishment since ever. One of the essential principle of correct and healthy nourishment is daily consumption of whole-grain cereals. The proper nourishment has become one of the most important issues of modern man. Health, working ability, creativity, efficiency and good and poor moods are caused by the nourishment methods. If a person is nourished properly and healthy he can easily face life difficulties and more efficiently protect himself against many physical and psychological illnesses that stalk him everywhere. Due to permanent research, modern medicine has provided information that the causes of the majority of diseases in man life is irregular nourishment. Many diseases are a result of incorrect food handling and insufficient taking in of nutritive matters, mainly vitamins and minerals. There is an old but a very actual proverb: "The way you eat is the way you think and the way you think is the way you live".

The food pyramid is a visual presentation for planning well balanced diet. Food products from the pyramid base should be consumed as a basic ones, while those from the pyramid top should be consumed sparingly and in small amounts. The pyramid base consists of food products that have to be basic food: cereals, bread, pasta, polenta and other cereal-based products. The greatest daily food intake should be from this group. A large number of different organic/healthy and balanced food pyramids has been presented already. The intensive advancement of the science resulted in significant changes in food science and recommendations for regular nourishment. In order to mitigate disadvantages and to incorporate contemporary consideration into the pyramid, in 2005 the pyramid was modified into so call my pyramid (www.mypyramid.gov, USDA).

One of the most important questions that can be asked from the aspect of the application and utilisation of cereals is: What is it that makes cereals so much valuable naturally renewable raw material? The answer to this question is very simple, as everything starts with a small mature cereal kernel. A chemical composition of cereal kernel is its most important trait from the aspect of the practical application, regarding both, its use for the industrial purposes and as food and feed. The content of carbohydrates in the whole-grain of the majority of cereals amounts to approximately 70%. Furthermore, the contents of proteins, fats, vitamins and minerals amount to 10-17%, 1.5-10%, and up to 2%, respectively. Also, the content of crude fibres and amino acids is high (Table 5). Carbohydrates are an important source of energy. Combustion of 1 g of carbohydrates releases 17kJ. Starch is main carbohydrate in human diet. Starch granules are composed of chains of amylose and amylopectin with a semi-crystalline structure. Such structure makes them water insoluble and slows down their decomposition under effects of pancreatic enzymes (Novaković and Mirošević, 2002). The optimum utilisation of cereals means harmonisation of grain traits with requirements of each individual utilisation.

Beside essential chemical composition of grain other cereal traits are also very important and of exceptional importance for their utilisation and use from the aspect of human nutrition. For

instance, wheat encompasses all vital and nutritive elements necessary for good functioning of the organism, as long as it is used in the whole-grain form.

Table 5. Essential chemical composition of cereal grain (Dodig et al, 2007; Kent, 1983; Pajić et al, 2010; Radosavljević et al, 1998; Radosavljević et al, 2005; Radosavljević, 2007; Radosavljević et al, 2010).

Cereals	Starch (%)	Proteins (%)	Oils (%)	Cellulose (%)	Ash (%)
Wheat	74.1-76.8	10.5-16.0	1.8-2.9	2.5-3.0	1.8-2.0
Maize	64-78	8-14	3.1-5.7	1.8-3.5	1.1-3.9
Rice	71.2-88.9	9.1-11.0	0.5-2.7	0.3-10.2	0.6-7.2
Barley	78.1	11.8	1.8	5.3	3.1
Oats	69.8	11.6	5.2	10.4	2.9
Rye	80.1	13.4	1.8	2.6	2.1
Sorghum	79.7	12.4	3.6	2.7	1.7
Millet	67.7-82.9	7.0-13.9	1.5-5.4	1.3-12.7	1.7-5.0
Amaranth	60	15.6	-	-	-

There are claims that wheat occurred 17,000 years ago. Even today it is one of the most distributed cereals, maybe due to a fact that contains gluten that makes it very suitable for expansion of dough and bread making. Standard grain quality maize hybrids, as well as, speciality maize (red- and white-seeded maize, dent, flint, waxy, high-oil, lysine maize, sweet maize, popping maize, blue-seeded maize and high-amylose maize) are important for maize utilisation. Many scientific papers dealing with studies on maize grain quality and utilisation have been published (Pajić et al, 2010; Radosavljević et al, 2002; Radosavljević et al, 2003, Radosavljević et al, 2004, Radosavljević et al, 2008, Radosavljević et al, 2009, Radosavljević et al, 2010). Consumption of whole-grain rice provides carbohydrates, proteins (although to a lower extent than wheat), vitamins (especially those of the B group), mineral elements (calcium, iron, phosphorous, sodium), oligoelements and enzymes to an organism. This cereal has anti-allergic, energetic and nutritive properties. Alimentary (dietary) fibres are an important parameter of barley quality. These fibres are a substance of a plant origin that is insoluble under effects of basic human enzymes. According to AACC (American Association of Cereal Chemists), alimentary fibres are insoluble polysaccharides, oligosaccharides, fructans, resistant starch and lignin. Oats is one of cereals that is richest in nutritive substances with a very high-calorie power. Furthermore, oats is rich in proteins, fats (unsaturated fats and essential fatty acids) and cellulose, mineral elements (calcium, iron, phosphorus and magnesium), vitamins of B, PP and D groups and fibres. Although, rye is traditionally considered poor food, it is not actually true. Rye encompasses the following important nutritive components: carbohydrates, proteins, mineral salts (iron, calcium, phosphorus), vitamins (B and E groups) and it is also rich in fibres and lysine. Sorghum is traditionally used as food in many regions of Africa, Asia, Central America and Middle East. Millet grain is rich in starch and encompasses fats, proteins, vitamins (A and B groups), mineral salts (iron, fluorine, phosphorus, magnesium, silicon) and amino acids that stimulate keratin production. Triticale is a young plant species. It was developed by crossing wheat with rye with inherited traits of both parents. It owns 2/3 genes of wheat and 1/3 genes of rye (Đurić et al, 2009). Buckwheat and amaranth are grouped into pseudocereals. Buckwheat is very balanced food and is exceptionally rich in protein matters. It also contains vitamins (B, E, P groups), mineral salts (calcium, iron phosphorus, magnesium) and essential amino acids (lysine and tryptophane) that are less present in other cereals. Buckwheat also has energetic properties. Amaranth, the second pseudocereal, can be easily considered the eldest cereal in the world. The modern food science ascribes great importance to this species due to its richness in high-quality proteins and lysine. It is gluten-free, encompasses important amounts of fats and it is rich in mineral substances, especially calcium, phosphorus and iron.

CEREALS AS ORGANIC FOOD

Food is a prerequisite of life and the development of a living organism. Why the production of organic food? There are three basic goals and reasons: 1) production of high nutritive and safe food; 2) organic agriculture is better for the environment because it does not affect a surface soil layer and sea life; 3) organic production provides higher incomes to producers.

What is organic food? Organic food is food which has been produced to standards designed to keep the production more 'natural'. An ORGANIC PRODUCT is a result of organic production that is performed with the application of cropping practices that exclude the use of synthetic and chemical agents. The term organic is accepted in our country for a certified product made in the organic production, but also terms ecological or biological can be used. The organic production is regulated by the *Law on Organic Production and Organic Products*, which has been complied with Regulations of European Union (RS Official Gazette, issue 62/06). Besides the Law, the organic production in our country has been legally regulated with another two regulations: Regulations on conditions which should be fulfilled by a legal person that issues a certificate, i.e. a recertificate for organic products and the way of their issuance (RS Official Gazette, issue 81/06) and Regulations on technological procedures in processing of products made by methods of the organic production, methods of cleaning and cleaning agents of technological lines, permitted ingredients, additives and auxiliary substances in food processing (RS Official Gazette, issue 62/06).

How is organic food designated? The designation "ORGANIC PRODUCT" is a mark or a label on a product by which that product is designated as made in accordance with the *Law on Organic Production and Organic Products* and Regulations passed on the Law. Products from the conversion period can be designated with a label "PRODUCTS FROM THE CONVERSION PERIOD". There are the following three levels of certification in the U.S.A.: 100%, 95% and lower than 95%.

Why should we consume organic products? There are six principal reasons for this: this food is healthier, safer, environmentally friendly, has better technological quality, higher biological value in relation to the conventional production, as well as, exceptional taste, colour and aroma. The organic production in the world has been becoming more and more popular and economically important. The production and sale of organic products has been increasing. In 2007, 31 million hectares of 633901 registered farms were under the organic production, which is less than 1% of the world agricultural land. The greatest areas under the organic production are in Australia, Argentina, China and the U.S.A. The organic production in the world mostly consists of the cereal production (Malešević et al, 2009).

Favourably climatic conditions and significantly conserved soils in Serbia make a basis for the agricultural and rural development according to organic principles. Parušić et al. published the data that Serbia has a great potential for the organic production (unpolluted soil, favourable climate, many agricultural producers), but at the same time it has insufficient number of certified producers orientated to export (Parušić et al, 2008). They emphasise that one of the methods to develop competitiveness of the complete agricultural sector in Serbia is a greater orientation of producers to the organic production. The organic food production in fact is a great challenge for the contemporary sustainable agricultural development, integral rural development, then for creating abundance, improving standard of living and increasing quality of life. The organic production is carried out on approximately 15000 ha in Serbia. This area makes only 0.3% of the total arable land (4.2 million hectares) (Ćurčin, 2009). On March 15, 2010, a leading national newspaper Politika, published a brief article titled "Hundreds Producers of Organic Food". The subtitles showed that only 80 producers produced organic food on 2400 hectares. The greatest part, almost 90% of

organic products, is exported. It is known that the prices of organic food are on the average higher by 10 to 40% than the prices of products from the conventional production. The export potential of organic product producers is practically unlimited. A good example for the production and processing of organic cereals is a US company Bob's Red Mill with a slogan 'Whole grain foods for every meal of the day' (<http://www.bobsredmill.com/organic-high-fiber-cereal.html>). In our country, a good example can be wheat whole-grain flour made from biologically grown wheat with a stone home grinder Bragal (http://www.mlinovibragal.rs/kucni_mlinovi.html) by the family Pavlović from Grabovac (BPG 738522000461).

An article titled "Hardships to Healthy Food", i.e. a mini-interview with the Ms. Dušanka Đukić, a manager of the organic food factory "Žito hem", was published in the Belgrade weekly NIN on December 31, 2009. Ms. Đukić stated that beside declarative support of the production and processing of organic food, little had been done for a concrete production. Furthermore, it was stated that there was a small number of contract farmers, certification documentation was complicated, there was a problem of plant legalisation, of export. On that occasion, a positive cooperation with Delta, Mekator and shops of organic food in which organic food was sold under the "Eko Banat" brand was highlighted (Jakovljević, 2009).

CONCLUSION

- Further development of organic food production – areas under certified production have been increasing in both, world and our country.
- Integration of organic agriculture and food industry into the production of food of high nutritive values and health safety.
- New potentials for cereals as the most present species in the organic production.
- Export potential of producers of organic products is almost limitless.

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