https://dergipark.org.tr/tr/pub/food
OPEN ACCESS JOURNAL

ISSN 2667-5803

FHTI Journal of Food Health and Technology Innovations
June Vol 2, No 4 (2019)

DergiPark AKADEMİK

Research Article

Associations between nutritional composition and farming type of organically and conventionally grown cereals

Mirjana Menkovska[1*], Gordana Brankovic[2], Vesna Pajic[2], Gordana Surlan Momirovic[2], Desimir Knezevic [3]

Abstract

Objective: To determine the nutritional composition including the health beneficial dietary component β-glucan of different cereals grown by organic and conventional farming, and to find out the influence of the cereal kind and farming method on their values, as well as the possible associations between particular nutritive components in cereal samples and farming type.

Material and Methods: 27 different cereal samples grown at three locations were analysed by standard AOAC methods of analysis for their nutritional composition. A mixed-linkage β-glucan assay kit (Megazyme Ireland) was used for determination of the health benefit dietary component β-glucan value. Cereal kind-farming method by chemical-technological trait bi-plot analysis was done within R 2.9.0 program environment for investigation of associations between average value of cereal nutrients and farming type.

Results: A significant increase in the content of ash, dry matter, protein and fat in organically produced cereals was noticed in comparison with those which were produced either by conventional or in conversion method. Cereal kind-farming method by chemical-technological trait bi-plot revealed existence of positive and negative associations between the average value of particular cereal nutrient and farming type.

Conclusion: Based on the cereal kind-farming method by chemical-technological trait bi-plot the possibilities are derived that could be used for agronomic practice, breeding and food processing industry at improving the important properties-dry matter, protein, fat, ash, moisture and β-D-glucan in cereal crops. Organic farming method proved to be effective for oat for the all examined chemical–technological traits except moisture and ash, and for barley for dry matter, beta-glucan, ash and protein contents.

Keywords: cereals, organic farming, conventional farming, nutrition, β-glucan, associations

Introduction

Food is essential to life and wellbeing of the population. A food system operates on the basis of the following stages: growing, harvesting, processing, packaging, transporting, marketing, consumption, and disposal of food and food-related items. Food systems are either conventional or alternative according to their model of food lifespan from origin to plate (1).

According to the EU platform for an action on diet, physical activity and health, changes in diet must be done because recent decades have been seen a trend towards less sustainable and less healthy diets, with European citizens consuming too much energy, too many calories, too much fat and sugar, and salt. As a consequence wide-spread diet-related diseases are: obesity, type 2 diabetes, hypertension, osteoarthritis, and cancer. Many studies have proved that cereals are naturally rich with health benefit components such as dietary fibre components (2).

There is evidence that the soluble dietary compound (1→3)-(1→4)-β-D-glucan has health claim related to cereal-derived β-glucan that may significantly reduce the risk of diseases and strengthen the immune system (3-10).

Organic food systems in comparison with the conventional ones, are characterized by a reduced dependence on chemical inputs and an increased concern for transparency and information (11, 12). Principles of organic food production are: biodiversity, ecological balance, sustainability, natural plant fertilization, natural pest management, and soil integrity. Organic food products are grown or raised by a producer who uses practices in balance with the natural environment, using methods and materials that minimize negative impact on the environment. They are produced on land that has been free of known and

1 Ss. Cyril and Methodius University, Institute of Animal Science, Dept. of Food Technology and Biotechnology, Skopje, Macedonia
2 University of Belgrade, Faculty of Agriculture, Dept. of Genetics, Belgrade, Serbia
3 University of Prishtina, Faculty of Agriculture, Kosovska Mitrovica, Dept. of Agriculture, Lesak, Kosovo and Metohia, Serbia
*Corresponding Author: Mirjana Menkovska E-mail: Menkovska06@yahoo.com

TÜBİTAK ULAKBİM

perceived toxic and persistent chemical pesticides and fertilizers for at least three years prior to certification,

and synthetic fertilizers and pesticides are not used in production. Organic foods are planted on a rotating basis within the farm system. Crops are rotated from field to field, rather than growing the same crop in the same place year after year. Cover crops such as clover are planted to add nutrients to the soil and prevent weeds. Organic meat, poultry and egg products come from farms that use organic feed, do not administer added hormones to promote growth or any antibiotics and they allow animals the space and freedom to behave naturally.

In 1992 the European Community developed organic standards and a certification scheme (13). The International Federation of Organic Agriculture Movements (IFOAM) also has a set of organic principles which were the basis of the guidelines for organically produced foods of the internationally recognized Codex Alimentarius (14) of the World Health Organization and Food and Agriculture Organization of the United Nations (WHO/FAO food standards). Codex Alimentarius is the internationally accepted food safety standard for all food products traded worldwide. There is a set of standards within the Codex Alimentarius that covers organic food.

In October 2002, the production and marketing of organic food came under regulation by the US Department of Agriculture's (USDA) National Organic Program. The National Organic Standards Board, a federal advisory panel to the USDA for developing organic legislation.

The low for organic agricultural production, food products and food in Republic of Macedonia was introduced in 2009, and the changes and supplements in 2011 (15).

Material and Methods

The content of nutritive components (moisture, ash, dry matter, crud protein and crud fat) in 27 different cereal samples: wheat, rye, barley, oat, and millet, grown at three locations during 2013 was analysed by standard AOAC methods of analysis.

Determination the content of β-glucan

A mixed-linkage β-glucan assay kit (Megazyme Ireland) was used for determination in the analysis of the health benefit dietary component β-glucan value, based on the method published by McCleary and Codd 1991 (16). The method has been accepted by the AOAC (Method 995.16), AACC (Method 32-23.01) and ICC Standard Method (No.166).

The principle of the method in brief is that cereal samples (1 g in duplicate) were suspended and hydrated in sodium phosphate buffer pH 6.5 for hydrolysis with highly purified lichenase enzyme and filtered, than hydrolysis with β-D-glucosidase. ß-D-glucan is specifically hydrolysed by lichenase to oligosaccharides, which are quantitatively cleaved to glucose by ß-glucosidase. Glucose is measured using glucose oxidase - peroxides - buffer mixture.

The results have been shown as a mean values ± standard deviation. The value of β content was calculated on dry weight basis.

Cereal kind-farming method by chemical-technological trait bi-plot analysis

In order to find out the existence of associations between average value of cereal nutrients and farming type, cereal kind-farming method by chemical-technological trait bi-plot analysis was done within R 2.9.0 program environment (17).

Statistical analysis

Data were tested for significance using analysis of variance, the F-test using the software package Statgraph 3.0 (Statistical Graphics, Warrenton, Virginia, USA).

Results

Determination the content of cereal nutrients

The results obtained from the investigations on the content of cereal nutrients: ash, protein, fat and dry matter are presented in the Figures 1-8.

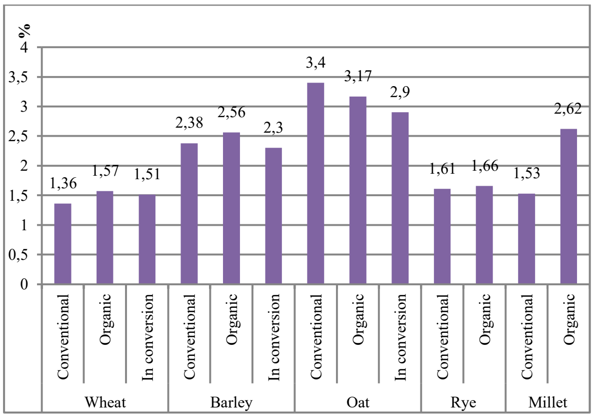

Figure 1. Content of ash in cereal samples cultivated conventionally and organically

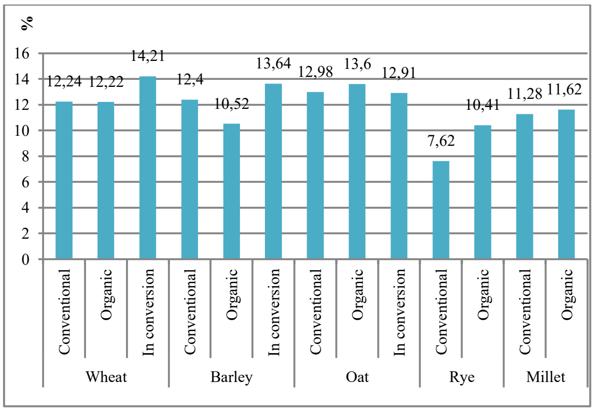

Figure 2. Content of protein in cereal samples cultivated conventionally and organically

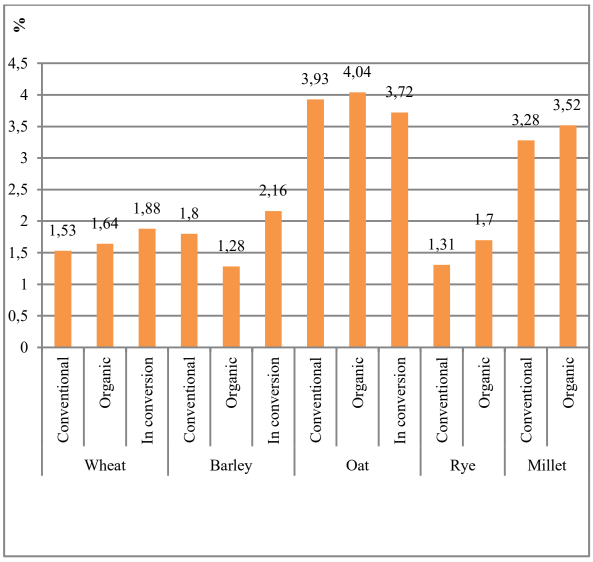

Figure 3. Content of fat in cereal samples cultivated conventionally and organically

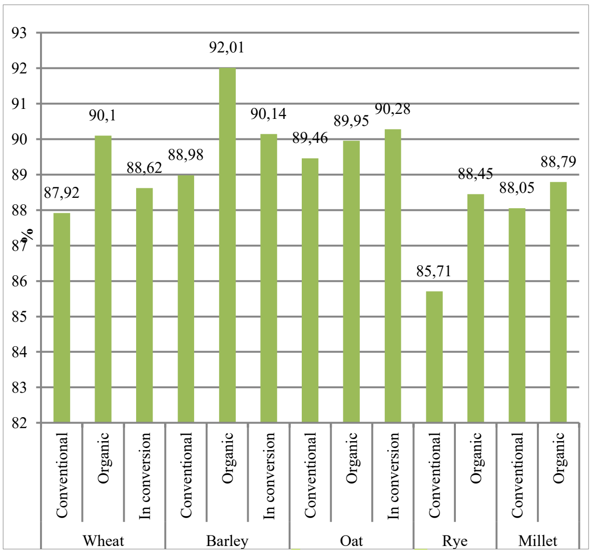

Figure 4. Content of dry matter in cereal samples cultivated conventionally and organically

From the Figures (1-4) can be seen that there was a significant increase in the content of ash, dry matter, protein and fat in organically produced cereals in comparison with those which were produced either by conventional or in conversion method: the increase of ash content was 15% with wheat, 7% with barley, and 71% with millet, the increase of protein content was 37% with oat and 3% with rye, and the decrease of 15% with barley, and the increase of crude fat content was 15% with wheat, 3% with oat, 29% with rye and 7% with millet.

Determination the content of β-glucan content in cereal samples

The results obtained from the investigations on β-glucan content in cereal samples are presented in Figures 5.

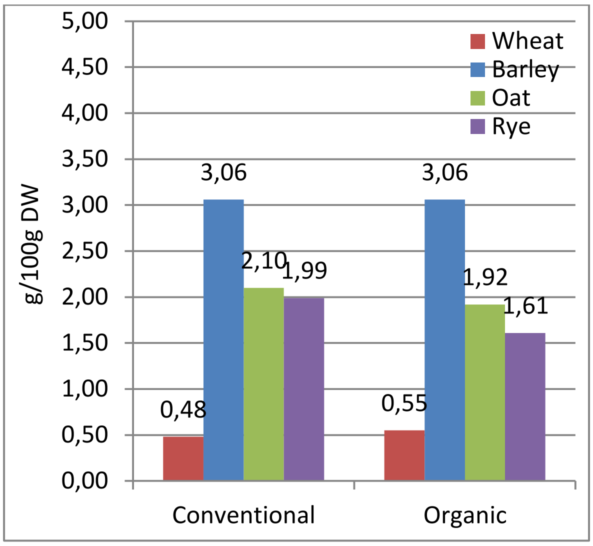

Figure 5. Content of β-glucan in wheat, Barley, oat and rye cultivated conventionally and organically.

Comparing the values of β-D-glucan in organic and conventional cereals (Figs. 5-8), it was noticed the following: slight increase in organic wheat (9.84%), and slight decrease in oat (2.91%), and small decrease in rye (18.06%).

Associations between average value of nutrients and cereal farming type

Figure 6 re-present the associations between average value of nutrients: ash, dry matter, crud protein, crud fat and β-glucan in cereals investigated, and the farming type.

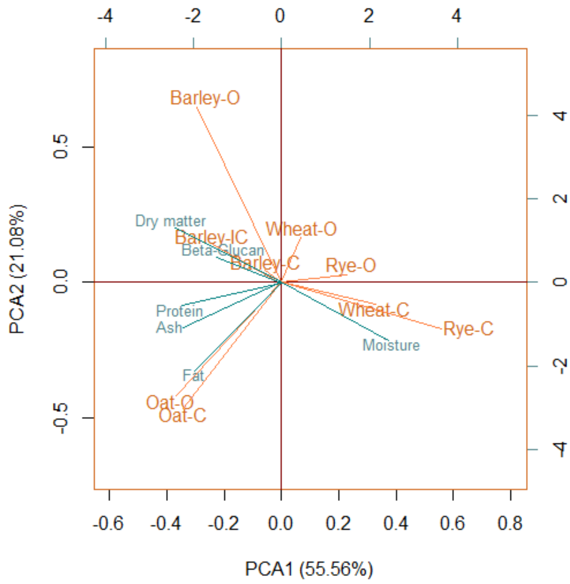

Figure 6. Cereal kind-farming method by chemical-technological trait bi-plot. (dry matter, protein, ash, fat, moisture, β-glucan)

Cereal kind-farming method by chemical-technological trait bi-plot (Figure 6) revealed existence of negative associations between: average dry matter content and average beta-glucan content and wheat and rye conventionally farmed; average fat content and wheat and rye organically farmed and to lesser extent for wheat and rye obtained from conventional farming method; average protein content and average ash content and wheat and rye produced with the conventional farming method; average moisture content and barley produced with the in conversion farming method and little weaker for barley obtained from conventional farming method.

Discussion

Our research has revealed that barley grown by either conventional or in conversion farming method proved to have the highest content of dry matter. Oat obtained from organic farming method exhibited the highest fat, protein and ash content. In comparison of the organic to conventional farming method, there was no change in the content of β-D-glucan value for barley which was grown either by organic or conventional farming.

Cereal kind-farming method by chemical-technological trait bi-plot explained high proportion of G + GE variance of 76.64% and revealed existence of positive associations between: average dry matter content and average beta-glucan content and barley produced from the in conversion farming method and also little weaker for barley produced with the conventional farming method; average fat content, average protein content and average ash content and oat produced with the organic farming method and also little weaker for oat produced with the conventional farming method; average moisture content and wheat and rye conventionally farmed.

A phenotype by trait bi-plot can help understand the associations among breeding objectives and identify traits that are positively or negatively correlated, traits that are redundantly measured, and traits that can be used in indirect selection for another trait (18). It also helps to visualize the trait profiles of phenotypes (19), what is of particular importance for selection programs, agronomic practice and food processing industry.

Conclusion

Based on the cereal kind-farming method by chemical-technological trait bi-plot the possibilities are derived that could be used for agronomic practice, breeding and food processing industry at improving the important properties-dry matter, protein, fat, ash, moisture and β-D-glucan in cereal crops.

As contents of protein, dry matter, β-D-glucan, fat and ash were positively associated the same-directional breeding for these traits would be possible, while due to negative association with moisture the co-breeding for moisture content in the same direction would not be possible.

Barley grown by either conventional or in conversion farming method proved to have the highest content of dry matter and β-D-glucan content when compared to other cereals investigated, whereas oat obtained from organic farming method exhibited the highest fat, protein and ash content.

Organic farming method proved to be effective for oat for the all examined chemical–technological traits except moisture and ash, and for barley for dry matter, beta-glucan, ash and protein contents. Average ash content and average moisture content were positively associated leading for the possibility of the same-directional breeding for these traits.

Acknowledgments: This research is a part of a scientific project which was supported by the integrative fond of the Ss.Cyril and Methodius University in Skopje, Macedonia.

Conflict of Interest: The authors declare that there are no conflicts of interes.

References

1. Discovering the Food System - A Primer on Community Food Systems: Linking Food, Nutrition and Agriculture http://foodsys.cce.cornell.edu/primer.html

2. Wisker E., Feldheim W., Pomeranz Y., Meuser F. Dietary fiber in cereals. In: Pomeranz Y., editor. Advanced cereal Science and Technology Vol. VII, Chapter 4. St. Paul, Minesota, USA: American Association of Cereal Chemists; 1985. p. 169.

3. Leeds R. A., Avenell A. Dietary fibre perspectives: Reviews and Bibliography 1, Leeds R. A., editor. London, England: John Libbey & Company Limited; 1985. p.358.

4. Obayashi T., Yoshida M., Mori T., Goto H., Yasuoka A., Iwasaki H., et al. Plasma (1-3)-beta-D-glucan measurement in diagnosis of invasive deep mycosis and fungal febrile episodes. Lancet. 1995; 345 (8941):17–20.

5. http://ec.europa.eu/agriculture/organic/eu-policy/ index_en.htm

6. Keogh G.F., Cooper G.J., Mulvey T.B., McArdle B.H., Coles G.D., Monro J.A., et al. Randomized controlled crossover study of the effect of a highly beta-glucan-enriched barley on cardiovascular disease risk factors in mildly hypercholesterolemic men. Am. J. Clin. Nutr. 2003; 78(4):711–718.

7. Odabasi Z., Mattiuzzi G., Estey E., Kantarjian H., Saeki F., Ridge R. J.et al. Beta-D-glucan as a diagnostic adjunct for invasive fungal infections: validation, cutoff development, and performance in patients with acute myelogenous leukemia and myelodysplastic syndrome. Clin. Infect. Dis. 2004; 39(2):199–205.

8. Ostrosky-Zeichner L., Alexander B.D., Kett D.H, Vasquez J., Pappas P.G., Saeki F.et al. Multicenter clinical evaluation of the (1→3)β-D-glucan assay as an aid to diagnosis of fungal infections in humans. Clin. Infect. Dis. 2005, 41(5), 654–659.

9. Vetvicka V., Dvorak B., Vetvickova J., Richter J., Krizan J., Sima P. et al. Orally administered marine (1-->3)-beta-D-glucan Phycarine stimulates both humoral and cellular immunity. International Journal of biological macromolecules 2007; 40(4):291–298.

10. European Commission. "Regulation 1160/2011". On the authorisation and refusal of authorisation of certain health claims made on foods and referring to the reduction of disease risk. Official Journal of the European Union.

11. Morgan, K and J. Murdoch. Organic vs. conventional agriculture: knowledge, power and innovation in the food chain. Geoforum. 2000; 31(2):159-173.

12. Renkin, A.M., K. Lyons and R.C.N. Laurence. Proceedings from the 14th IFOAM Organic World Congress; 2002 August; Victoria, BC; 2002.

13. Fact Pages: Organic Farming. European Commission Directorate General for Agriculture and Rural Development. (Europa Website, 2007).

14. Guidelines for the Production, Processing, Marketing and Labelling of Organically Produced Foods. The Codex Alimentarius Commission and the FAO/WHO Food Standards, Programme (1999).

15. Macedonian low of agricultural production, food products and food, Official paper 146/2009, with changes and supplements (14.4.2011).

16. McCleary B.V., Codd R. Journal of Food Science and Agriculture. 1991;55:303-312.

17. R Development Core Team R: A Language and environment for statistical computing: R foundation for statistical computing. 3rd ed. Vienna, Austria: R Foundation for Statistical Computing; 2013. 3551 p.

18. Lee, S.J., Yan, W., Ahn, J.K. & Chung, I.M. Effects of year, site, genotype, and their interactions on the concentration of various isoflavones in soybean. Field Crops Research. 2003;81:181–192.

19. Yan W, Kang MS. GGE bi-plot analysis: A graphical tool for breeders, geneticists, and agronomists. Boca Raton, FL: CRC Press; 2003.