

QUALITY FEATURES OF SOME OATS GENOTYPES CULTIVATED IN DIFFERENT SYSTEMS OF PRODUCTION

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Abstract

The aim of this investigation was to determine the differences in quality features of oats in the system of conventional and organic production. The tests were performed during 2005, 2006 and 2007 with five oats populations, of which four were domestic, one population was introduced from Bulgaria and three oats varieties were introduced from Serbia.

The quality of oats, especially the chemical composition of the grain in the tested genotypes, irrespective of years, varieties and climate conditions, and depending on the applied system of production was better when it was produced organically.

In organic production, the absolute protein content was higher by 0.18% and the relative protein content by 1.4% than the protein content in conventional production. The absolute cellulose content was smaller by 0.69% and the relative cellulose content by 5.8% than the cellulose content in conventional production. In organic production, the absolute and relative content of no nitrogen extractive substances (B.E.M.) were higher by 0.82% and 1.5% respectively than in conventional production.

For production expansion, the variety *Lovkjen* can be recommended as the most suitable variety, and the populations *Trebenishta* and *Bulgaria* in terms of quality for organic production. For conventional production the varieties *Lovkjen* and *Rajac* can be recommended in terms of quality.

The system of organic production - a good method for the production of oats intended for processing for human consumption.

Key words: Oats, organic production, conventional production, chemical composition, protein, B.E.M., cellulose.

1. Introduction

Oats (*Avena sativa* L.) is a crop which is mainly grown for grain and straw. It is believed that oats originates from two species: wild oats (*Avena fatua* L.) and the red wild oats (*Avena sterilis* L.) (Suttie [1]).

At full maturity, the oats grain contains 12-15% proteins, composed of amino acids lysine, arginine and tryptophan. According to the fat content in the grain (4-7%), oats falls only behind corn. Among wheat, oats is the richest source of minerals: Ca (57 mg/100 g fruit), P (520 mg/100 g fruit), K (384 mg/100 g fruit) and Fe. It contains vitamins B1, B2, B6, K1, E. (Cавова *u cop.* [2]).

The oats grain contains a polyglucan carbohydrate fraction, which is neither starch nor cellulose. These β -glucans are present in the cell walls of endosperm and function as soluble fibers (Nikolić *et al.* [3]). The content of β -glucan varies from 2,5-6,5% (Pržulj *et al.* [4]). The content of β -glucan in the oats grain reduces cholesterol in the blood, so that contemporary diets recommendations state that nutrition should be based on oats snowflakes (Mlinar [5]).

Because oats contain high concentration of well-balanced proteins, it can satisfy protein requirements, particularly for people whose diets are based on small amounts of protein from animal origin (Peterson [6]).

World tendency of producing healthy food has imposed the need for greater representation of organic production of cereals, as the main crops which comprise a large proportion of the food consumed by humans and domestic animals.

According to Zinta *et al.* [7], oats is a very suitable crop for organic farming. Considering that the oats grain has a high biological value and has been increasingly used in the diet of humans and the animals, we set a long-term goal, through field and laboratory comparative

methods of both systems of oats production, to establish the positive and negative sides of organic production, compared with the conventional production from agrotechnical aspect, and particularly to select the best varieties or populations for both systems of production.

2. Materials and Methods

The experiments were carried out in field and laboratory conditions. The field trials were set up on the experimental field of the Faculty of Agriculture in Strumica, at Goce Delchev University, Stip. Five oats populations and three oats varieties were analyzed. Four of the populations were domestic populations: *Krivogastani*, *Trebenishta*, *Radolishta* and *Kuceviste*, and one population were introduced from Bulgaria. The three oat varieties, *Rajac*, *Slavuj* and *Lovkjen*, were introduced from Serbia.

Two trials were set up, where all the above-mentioned genotypes of oats were represented, with the difference that in one experiment all varieties were cultivated in conditions of conventional production, and the other in conditions of organic production.

The experiments consisted of 8 variants in four repetitions, arranged according to the method of random block system with the dimension of basic parcel of 5 m². The distance between variants was 0.50 m, and between repetitions - 1.0 m.

The seed rate in both systems of production was 550 grains/per 1 m², or 5,5 million grains per 1 ha. Throughout the examinations, the soil was prepared in an identical manner. Thus, in autumn the area was ploughed at the depth of 30 to 35 cm, followed by separation of surface and fertilization. On the area provided for conventional method of cultivation of oats, artificial NPK granulated litter in combination 15:15:15 was applied in the amount of 300 kg/ha, while on the area provided for organic method of cultivation of oats, blown cow manure in quantities of 20 t/ha was applied. After the application of the proper fertilizer on the area, it was further processed by milling and the area was flattened.

Throughout the examination, sowing was carried out during the month of March, more precisely: in 2005 on 17 March, in 2006 on 28 March, and in 2007 on 6 March, that is, when there were optimal conditions. Sowing was performed by hand in rows at a depth of 5-6 cm.

During the field experiment two types of agrotechnics were used. In the conventional experiment, the standard agrotechnics for field production of oats was used, such as: protection against diseases, pests and

weeds, crop fertilizing with KAN 27% -150 kg / ha, in the stage tillering of oats.

In the organic experiment were used allowable and prescribed agrotechnics for field experiments and the necessary measures for crops care were implemented.

Before harvest, material from 1m² from each parcel was taken for laboratory analysis. The chemical properties of the grain were determined by the method of Kjeldahl, from average grain samples, in the laboratory for chemical analysis of grain at PSI Institute of Animal Husbandry in Skopje. The results were statistically analyzed using the variance analysis method, and the differences were tested according to the LSD-test.

3. Results and Discussion

The results related to the content of proteins in the grains in the conditions of organic production of oats are shown in Table 1.

They show that the genetic characteristics of varieties and populations have a major impact on the protein content in the grain.

For successful production of oats intended for human consumption, among other factors, it is necessary to make a correct choice of the variety.

Comparing the content of protein by years in both systems of production, irrespective of the varieties and populations, and depending on the applied agrotechnical measures, we can say that in the organic system of production the content of protein was higher than in the conventional system, in two years of examination. Thus, in the first (2005), the average absolute and relative protein content in the organic system of production of oats was greater by 0.79% and 7.0% respectively than the protein content of the grain in conventional production. In 2007 the absolute and relative protein content of the grain was higher by 1.13% and 7.7% respectively than the protein content in conventional production, and in 2006, the average absolute and relative protein content of the grain in the organic system of production of oats was lower by 1.34% and 9.4% respectively than the protein content of the grain in the conventional system of production.

Regardless of the year, soil, climatic conditions and system of production, the best genotype of the tested varieties and populations for obtaining a high percentage of raw protein in oats grain was the population *Trebenishta*, which in the organic system of production reached an average protein content of 13.74%, while in the conventional system of production it was 13.29%.

Table 1. Content of raw proteins in % in organic and conventional oats production

Variety/ Population	Organic production				Conventional production			
	Year			Average by variety/ population 2005/2007	Year			Average by variety/ population 2005/2007
	2005	2006	2007		2005	2006	2007	
Krivogash.	11.62	13.57	15.54	13.57	10.43	14.68	14.62	13.24
Trebenish.	13.25*	12.79	15.19	13.74	11.50	14.08	14.29	13.29
Radolish.	11.93	13.65	15.43	13.67	10.56	14.59	13.07	12.74
Bulgaria	10.50	13.05	15.51	13.02	10.00	14.85	12.09	12.31
Kucevish.	11.50	12.45	13.36	12.43	11.06	14.25	12.50	12.60
Rajac	11.50	13.22	14.63	13.11	11.93*	13.91	13.80	13.21
Slavuj	11.06	12.71	13.54	12.43	10.12	14.59	13.97	12.90
Lovkjen	11.06	12.81	14.08	12.65	10.50	14.08	13.97	12.85
Average by year	11.55	13.03	14.66	13.08 Common average	10.76	14.37	13.53	12.90 Common average
LSD 0.05 0.01	1.50 N.S.	N.S. N.S.	N.S. N.S.		1.0 N.S.	N.S. N.S.	N.S. N.S.	

The method of organic oats production showed a minimal increase in the content of protein. In organic production, the absolute and relative protein content was higher by 0.18% and 1.4% respectively than the protein content in conventional production. In the conventional oats production (Table 1), the highest average protein content, regardless of the year, was found in *Trebenishta* population (13.29%) and the lowest (12.31%) in the population *Bulgaria*, which is absolutely and relatively higher by 0.98% and 7.0% respectively.

The differences that occur among varieties and

populations under equal conditions of cultivation are due to the variety specificity, that is the specificity of the genetic characteristics of the examined populations and varieties.

Regardless of the year, genotypes, soil, climatic conditions and system of production i.e. the agrotehnics applied, the general average protein content in our tests was 12.99%.

The results of raw fiber (cellulose) of the grain in organic and conventional oats production are shown in Table 2.

Table 2. Percent of cellulose of grain in organic and conventional production

Variety/ Population	Organic production				Conventional production			
	Year			Average by variety/ population 2005/2007	Year			Average by variety/ population 2005/2007
	2005	2006	2007		2005	2006	2007	
Krivogash.	14.21	14.76	9.91	12.96	10.99	13.17	10.83	11.66
Trebenish.	11.10	11.57	10.14	10.93	13.18*	11.90	11.94	12.34
Radolish.	12.24	10.01	9.50	10.58	13.22*	13.78	11.90	12.96
Bulgaria	10.30	11.47	9.73	10.50	11.57	13.04	11.56	12.00
Kucevish.	10.77	11.26	9.92	10.65	11.02	12.15	12.01	11.72
Rajac	8.69	13.74	9.73	10.72	11.18	11.95	11.92	11.68
Slavuj	14.71	13.00	9.73	12.48	12.01*	12.65	10.68	11.78
Lovkjen	10.10	13.96	11.95	12.00	12.73*	12.00	11.84	12.19
Average by year	11.51	12.47	10.07	11.35 Common average	11.98	12.58	11.58	12.04 Common average
LSD 0.05 0.01	N.S. N.S.	N.S. N.S.			1.0 N.S.	N.S. N.S.	N.S. N.S.	

Comparing the content of cellulose per year in both systems of production, irrespective of varieties and populations, and depending on the applied agrotechnical measures, we can say that at organic production the percentage of cellulose was lower than in conventional production in the three years of trials. Thus, in the first (2005), the average absolute and relative content of cellulose in organic oats production was lower by 0.47% and 4.0% respectively than the cellulose content of the grain in conventional production. In 2006 the absolute and relative cellulose content was lower by 0.11% and 0.9% respectively than the cellulose content in conventional production, and in 2007, the average absolute and relative content of cellulose in organic grain production was lower by 1.51%, and 13.1% respectively than the content of cellulose in conventional production.

2007 proved to be the most favorable for the chemical composition of the grain because it features the highest percentage of protein and the lowest percentage of crude fiber (cellulose). The method of oats producing showed reduction of

the content of cellulose in organic production, the absolute and relative cellulose content was lower by 0.69% and 5.8% respectively than the content of cellulose in conventional production.

Regardless of the year, soil, climatic conditions and type of production, the best genotype of the tested varieties and populations for obtaining a lower percentage of cellulose in oats grain was *Kuceviste* population, which, in organic production, achieved an average cellulose content of 10.65% and 11.72% in conventional production. Also, the variety *Rajac* scored low percentage of cellulose in both systems of production – 10, 72% in organic production and 11.68% in conventional production.

Regardless of the year, genotypes, soil, climatic conditions and the type of production, the general average cellulose content in our tests was 11.69%.

The content of no nitrogen extractive substances in the grain in organic and conventional production of oats are shown in Table 3.

Table 3. No nitrogen extractive substances in the grain in organic and conventional production of oats (%)

Variety/ Population	Organic production				Conventional production			
	Year			Average by variety/ population 2005/2007	Year			Average by variety/ population 2005/2007
	2005	2006	2007		2005	2006	2007	
Krivogash.	56.48	53.77	52.98	54.41	58.34	52.49	55.73	55.52
Trebenish.	58.21*	58.45*	56.74**	57.80	56.65	55.88	54.73	55.75
Radolish.	60.38**	56.77*	57.07**	58.07	59.10	55.07	56.88	57.01
Bulgaria	62.04**	57.19*	57.80**	59.01	59.76	56.05	56.31	57.37
Kucevish.	57.31	57.70*	58.46**	57.82	56.61	56.21	56.06	56.29
Rajac	62.41**	54.56	56.23*	57.73	60.27	54.74	55.24	56.75
Slavuj	57.26	55.48	56.64**	56.46	59.43	52.98	57.10	56.50
Lovkjen	62.79**	53.45	54.22	56.82	60.27	53.61	55.35	56.41
Average by year	59.61	55.92	56.26	57.26 Common average	58.80	54.62	55.92	56.44 Common average
LSD 0.05 0.01	1.25 2.75	2.25 H.C.	2.50 3.35		1.5 H.C.	2.25 3.50	H.C. H.C.	

The method of oats production showed an increase of the content of no nitrogen extractive substances in organic production, which was higher absolutely by 0.82% and relatively by 1.5% compared with conventional production.

Regardless of the year, soil, climatic conditions and the system of production, the genotype for obtaining a higher percentage of no nitrogen extractive substances in no nitrogen garin oats was the Bulgaria population, which in organic production reached average of 59.01% and 53.37% in conventional production.

Regardless of the year, genotypes, soil, climatic conditions and type of production, the general average content of no nitrogen extractive substances in our tests was 56.85%.

4. Conclusions

Based on three years of research (2005-2007) on the quality features of oats genotypes depending on the system of production, the following conclusions could be made:

- The method of oats production showed a minimal increase in the content of protein. In organic production, protein content was higher absolutely by 0.18% and relatively by 1.4% than the protein content in conventional production.
- The method of oats production showed a reduction of the content of cellulose in organic production. The cellulose content was lower absolutely by 0.69% and relatively by 5.8% than the content of cellulose in conventional production. The population Kuceviste showed the lowest percentage of cellulose in both systems of production (10.65% and 11.72%). And the variety Rajac showed a low percentage of cellulose in both systems of production.
- The content of no nitrogen extractive substances in organic production was greater absolutely by 0.82% and relatively by 1.5% than the no nitrogen content of extractive substances in conventional production.

Based on the results obtained by analysis of quality features of some oats genotypes in different systems of production, the following conclusions could be made:

- The variety Lovkjen can be recommended as the most suitable variety and the populations Trebenishta and Bulgaria in terms of quality (protein, cellulose and N.N.S.) for organic production. For conventional production the varieties Lovkjen and Rajac and the population Bulgaria, in terms of quality, can be recommended for possible expansion in production.
- Organic production - a good way for the production of oats intended for processing for human consumption.

5. References

- [1] Suttie J. M. (2000). *Avena sativa* L. <http://www.fao.org/ag/AGP/AGPC/doc/Gbase/DATA/Pf000466.htm>.
- [2] Савова Т., Пенчев П., Котева В., Зарков Б., Станков С., Атанасова Д., Георгиева Т., Панаџтова Г. (2005). *Технология за отглеждане на овес*. Институт по земеделие - Карнобат.
- [3] Nikolić J.A., Hristić V., Krsmanović J. (1989). *Neke specifičnosti zrna ovsa i mogućnosti šire upotrebe u ishrani ljudi i domaćih životinja. Unapređenje proizvodnje pšenice i drugih strnih žita*. Institut za strnih žita, Kragujevac.
- [4] Pržulj N., Mladenov N., Momčilović Vojislava (1996). *Ječam i ovas kao sirovine za proizvodnju novel food i funkcionalne hrane*. Savremena poljoprivreda, Vol 50, (5-6), pp 5-10, Novi Sad.
- [5] Mlinar R. (1996). *Kupa - Nova sorta jare zobi*. Sjemenarstvo Vol 13, (1-2), pp 45-53, Zagreb.
- [6] Peterson M.D. (1989). *Oat quality and human nutrition*. Department of Agronomy, University of Wisconsin-Madison, Madison, Wisconsin U.S.A.
- [7] Zinta G., Bleidere M., Skrabule I., Vigovskis J. (2004). *The first steps in variety testing for organic agriculture in Latvia: oats and potatoes*. Proceedings of the First World Conference on Organic Seed. Challenges and Opportunities for Organic Agriculture and the Seed Industry, FAO Headquarters, Rome, pp 173-174, Italy.