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The potential of wheat barley (tritordeum) cultivation in Poland, its fodder value and the possibility of its use in poultry nutrition

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Cereals are among the most important plants crops, the grain of which is the basis for human nutrition and raw material for the production of animal feed. They are therefore of great economic importance. Currently, six main types of cereals are cultivated in Poland (wheat, maize, triticale, barley, oats and rye). Cereal breeding provides new varieties with high grain yield potential. Creative breeding of new varieties of the most important cereal species involves the production of new genotypes within the same species. Another variant of improvement is the creation of new cereal species through hybridization. Hybridization leads to introgression, i.e. the flow of genes from the gene pool of one species to the gene pool of another. As a result, triticale was obtained, which is currently the cereal species of the greatest importance for fodder in Poland. Wheat and barley, which has not yet been cultivated in Poland, are less known. It is a cereal obtained by hybridisation, the parent forms of which are durum wheat and wild barley. It is a plant whose parental forms and the resulting hybrid are best adapted to the warm and fairly dry climate of the Mediterranean basin. Due to the ongoing climatic changes, it can be assumed that also in Poland there is a potential possibility of growing wheat barley. The grain of this cereal also has a fairly good fodder value, hence its cultivation and use in animal nutrition, including biu may be of much greater importance in the future.

The aim of the work is to assess the possibility of introducing barley tritordeum as a new grain into cultivation in Poland, taking into account the possibility of its use in the feed industry and potential use in poultry nutrition, based on a review of scientific literature.

Possibility of growing wheat barley in the conditions of the Polish

climate So far, due to the occurrence of low temperatures in Poland and periods of severe frosts in winter, the cultivation of some types of cereals has been ineffective. Currently, the simulations of temperature increase and global warming in Poland have proven their worth. In the long-term period of 1971–2000, a decrease in the area with a moderately cool climate was found in Poland from 37 to 3%, with an increase in the area with a moderately warm climate from 62 to 75%, and the emergence of a region with warm weather conditions with an area of 22%, the area of which, according to forecasts, may increase up to 94% (Ziernicka-Wojtaszek, 2009). A positive effect of the increase in temperature is the extension of the growing season and the possibility of growing thermophilic plants (Kopeÿ, 2013). However, it is also associated with the potentially more frequent occurrence of drought periods, which negatively affects the yield of cereals, especially

spring tea (Wójcik et al., 2019). In this context, it may be beneficial to introduce new cereal species to cultivation in Poland. Increasing the diversity of cultivated cereal species should have a positive impact on the supply of grain on the market, while securing the needs of the food and feed sectors. In this situation, a poten- tially good solution seems to be the possibility of introducing barley into the cultivation of wheat.

So far, no scientific research has been conducted on the possibility of cultivating this cereal in the conditions of the Polish climate, nor is the potential of its yielding in our soil conditions known. One can rely on the results of research obtained in climatic conditions similar to those of Poland. Although barley wheat is considered a thermophilic plant and cultivated in spring, it can also be sown in autumn under favorable conditions. Martinek et al. (2003) found that after autumn sowing, the plants showed a good degree of winter hardiness and yielded much better than those sown in spring. This may have been due to a mild winter and favorable conditions for spring cultivation and water supply, which contributed to twice the grain yield. The yield of plants sown in spring was 1.4–2.44 t/ha-1 , while the yield of winter plants was 2.04–3.92 t/ha-1. This yield may be higher, as other research results have shown that it is obtained in the range of 4 to 5.5 t/ha (Vaquero et al., 2018).

Due to the results of the cited authors, it can be assumed that there is a possibility of growing wheat barley in Poland, especially in the conditions of the south-western and south-eastern parts of the country. According to the research results obtained by Stoyanov (2015), there is a large diversity of individual lines of tritor deum in terms of winter hardiness (40–100% of sowings). Therefore, there is a possibility of purposeful breeding work and selection of appropriate genotypes for cultivation in Polish climatic conditions, also taking into account their regional diversity. Currently, the largest acreage of cultivation and production of barley wheat grain occurs in Portugal and Spain, followed by in France and Turkey. Wheat barley yields a lower grain yield compared to wheat or triticale, but in drought conditions it yields comparable or even higher (Villegas et al., 2010). This is due to the fact that tritordeum is more efficient in using limited water resources than wheat (MartÍn et al., 1999). This is confirmed by the research of Küçük et al. (2018), who cultivated wheat in drought conditions and obtained a lower yield than in conditions of optimal rainfall. However, the yield of grain obtained during drought was higher than that of wheat. The authors also found that individual varieties and lines reacted with a different degree of yield reduction, which is associated with a decrease in the weight of a thousand grains. At the same time, according to the cited authors, drought causes an increase in the protein content in the grain.

Currently, there are no cultivated varieties of wheat barley entered in the register of the Central Research Center for Cultivar Testing, similarly to the Common Catalog of Varieties of Agricultural Plants (CCA). This is due to the fact that the exclusive rights to conduct breeding work on this species are held by Agrasys, which has two varieties registered in the Community Plant Variety Office (CPVO): ÿAUCAN – as the first stabilized and registered in 2010.

ÿBULEL – registered in 2015.

Another 12 genetic lines are candidates for the registration of varieties, they are currently in the phase of field tests (Sÿowik, 2018).

Due to legal restrictions on licensing and the difficulty in obtaining wheat seed, barley is currently unknown to growers in Poland. For this reason, farmers do not cultivate this cereal themselves, relying on the cultivation of previously known cereal species and extensive knowledge of their agricultural technology. Introducing new cereals into cultivation, especially on a larger scale, is

considered risky by them. Another limitation is the lack of national research on agricultural technology and fertilization and soil requirements for this cereal. Therefore, it is necessary to undertake such works and implement their results into agricultural practice through dissemination and implementation instructions, as well as training in the field of cultivation. The current limitation is also the lack of a market and the problem with managing the harvested grain. It cannot be used as a seed material, and currently there are no companies interested in buying it for baking and fodder purposes. The increase in market interest and demand for grain will probably increase along with the dissemination of knowledge about the fodder value of this species.

At present, at the Institute of Soil Science and Plant Cultivation, in the Department of Cereal Plant Cultivation, preliminary cultivation experiments of both wheat barley varieties in different conditions of soil complexes and sowing dates are conducted. The obtained results will contribute to the implementation of cultivation of this cereal in Poland.

Fodder value and the possibility of using barley wheat grain in poultry nutrition

In terms of protein content, barley wheat significantly exceeds wheat and barley. The protein content is 17–21% in grain, compared to 10.5–14% in wheat, 10–12% in barley and 12–16% in triticale. Cubero et al. (1986) showed that there may be up to 25% protein in barley wheat grain. Küçük et al. (2018), however, found a varied protein content in barley wheat grain in particular varieties and lines of this cereal, respectively: Aucan 19.5%, HT-444 18.1%, Bulel 16.8% and HT460 16.2%. As in the case of other cereal species, the protein content depends on many factors, mainly the genetic factor and agricultural technology (e.g. nitrogen fertilization). Martinek et al. (2003) showed, however, that the date of sowing (spring or autumn) affects the protein content. The same wheat varieties sown in autumn contained twice as much protein (17–21%) than those sown in spring (9.5–10.8%).

This protein additionally has a more favorable amino acid composition, as it contains slightly less lysine compared to wheat, but significantly more cysteine (Table 1).

In addition to macronutrients, barley wheat also contains a valuable ingredient, which is carotenoids, especially lutein, which is ten times more in the grain of this cereal than in wheat grain. Its total content in relation to total carotenoids is 86%; 7% is zeaxanthin. There are very small amounts of ÿ- and ÿ-carotene, respectively: 0.5% and 0.3% of total carotenoids (Paznocht et al., 2018). For this reason, the use of barley wheat as a feed component introduces this compound into the animal organism, and thus it is deposited in tissues and products such as eggs, thanks to which it increases their pro-health value for humans (Mattera et al., 2020).).

There are also phenolic compounds in cereal grains. They have a beneficial effect, because they have antioxidant properties, which consist in eliminating reactive oxygen species, blocking free radicals, inhibiting enzymes from the group of oxidases, as well as supporting enzymes with antioxidant properties and chelation of metal ions (Parus, 2013).
Introducing them to the diet of broiler chickens also shows beneficial effects. There is a reduction in the degree of lipid oxidation and cholesterol levels, while increasing the content of beneficial fatty acids (Starševiš et al., 2015). According to Eliášová and Paznocht (2017), barley wheat has a similar content of phenolic compounds and antioxidant activity as wheat grain.

However, the authors found that the breeding line HT 439 has a slightly higher value of these compounds.

Table 1. Comparison of yield and protein content depending on sowing date (Martinek et al., 2003)

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Characteristic *Characteristic*	Harvest year *harvest year*	*Sown in spring* wheat - *wheat* of			Winter sowing – *Sown in autumn*		
		tritordeum barley wheat	*spring varieties*		tritordeum barley wheat	wheat – *winter* varieties *wheat*	
			Sandra	Saxana		Astel	Brea
Yield (t/ha -1) *Yield*	2000 2001	1.48 2.44	6.25 6.89	6.41 7.02	2.04 3.92	9.27 8.26	7.45 6.74
Protein content (%) *protein content*	1999 2000 2001	17.6 21.2 17.7	13.4 15.7 13.2	13.8 14.6 13.0	– 19.8 18.6	9.5 10.8 9.7	12.5 12.0 11.8
Lysine content in grain dry matter (mg/g-1) *Lysine content in dry matter of grain*	1999 2000	5.4 5.7	6.0 4.0	6.2 3.9	– –	5.47 3.71	5.64 3.68
Cysteine content in grain dry matter (mg/g-1) *Cysteine content in dry matter of grain*	1999 2000	5.8 6.8	2.3 3.4	2.3 3.3	6.2 5.4	3.27 3.31	1.54 3.22

The fodder value of tritordeum grain can also be increased by appropriate fertilization. The use of selenium fertilization increases the content of this element in grain, which is then used in feed for laying hens, resulting in a higher concentration of this element in eggs (Tufarelli et al., 2016).

Currently, there are no results of research on the content of anti-nutritive components in wheat barley grain, which is of great importance in limiting the possibility of using this cereal and its share in compound feed for particular age and production groups and poultry species.

Also, the Polish Poultry Nutrition Standards do not contain information on restrictions on the use of this cereal. There is therefore a need to conduct national research in this area.

Summary

Barley as a new cereal is at the stage of testing and genetic stabilization of new varieties of this species. As the few conducted agrotechnical studies show, there is a potential for wider cultivation of this plant, both in Europe and in Poland. Due to restrictions on the marketing of barley wheat seed material, which results from legal provisions and licences, this cereal is not widely cultivated, and research results are scarce. However, the available literature shows that this cereal has great potential, and in the future it can be widely cultivated and used. Its fodder value and yielding potential may contribute to the dissemination of its cultivation. However, it is necessary to conduct research, especially national research on the possibility of cultivating individual varieties in the climatic conditions of our country, appropriate

agricultural technology and the use of its fodder value, especially in poultry nutrition.

Due to the fact that Poland is a significant producer of poultry in the European Union, the appropriate feed base is of great importance in ensuring the economics of production. As the research results have shown, wheat-barley has quite a long life cycle, stable yield in drought conditions and good fodder value.

The increased content of lutein in grains does not predispose it to be used in feeding poultry, especially laying hens, whose egg yolks may contain a greater amount of this pro-health compound.

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POTENTIAL FOR CULTIVATION OF TRITORDEUM IN POLAND, ITS FEED VALUE AND THE POSSIBILITY OF USING ITS KERNEL IN POULTRY NUTRITION

Summary

Tritordeum is a new cereal crop which is at the stage of testing and genetic stabilization of new varieties of this species. There is a potential for wider cultivation of these plants in Europe and Poland. Due to restrictions on the marketing of seeds of this plant, including legal restrictions and licenses, this cereal is not widely cultivated, and the results of research are few. However, the available literature shows that it has a great potential to be widely cultivated and used in animal nutrition. Its feed value and yielding potential may contribute to a higher interest in tritordeum cultivation. However, it is necessary to carry out research, especially a domestic research, on the possibilities of cultivation of particular cultivars in the climatic conditions of Poland, appropriate agrotechnology, and use of the fodder value of this cereal, especially in poultry nutrition. As Poland is a significant poultry producer in the European Union, an adequate feed base is of great importance in ensuring production economics. As the results of the research have shown, tritordeum has fairly stable yields under dry conditions and good forage value. Increased lutein content in the grain of this cereal makes it suitable for feeding poultry, especially hens, whose egg yolks have a higher content of this health-promoting compound. The review article assesses the possibilities of growing tritordeum in Poland based on the latest available scientific literature. The fodder value and the possibility of using this cereal grain in poultry nutrition were described.

Key words: tritordeum, fodder value, protein content, lutein, poultry feed

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