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COMPARATIVE CHARACTERISTICS OF TECHNOLOGICAL PROPERTIES OF FOUR-SPRCIES TRITICALE GRAIN COMPARATIVE TO CLASSIC TRITICALE AND COMMON WHEAT GRAIN

Прикладом ефективного схрещування зерна пшениці та жита є зерно класичного тритикале, яке нині набуває зростаючої популярності серед виробників хлібобулочних продуктів та круп'яних. У результаті подальшої гібридизації зерна класичного тритикале та пшениці м'якої, отримано високопродуктивні форми чотиривидового тритикале. Незважаючи на подібність до зерна пшениці, зерно чотиривидового тритикале має відмінності у технологічних властивостях, а тому вимагає додаткового вивчення. Одним із найбільш проблемних місць є виявлення достовірних відмінностей між властивостями чотиривидового тритикале та його батьківських форм. Тому важливим є комплексне дослідження та порівняння технологічних властивостей чотиривидового тритикале, класичного тритикале та пшениці м'якої, що дозволить обґрунтувати його цільове призначення. Отже, об'єктом досліджень обрано зерно чотиривидового тритикале сортів Алкід, Стратег, Тактик, лінія ЛП 195 (Україна).

В ході дослідження використовували чинні нині методики визначення технологічних властивостей зерна злакових культур, а отримані результати обробляли методами дисперсійного аналізу. Зерно чотиривидового тритикале має більшу масу 1000 зерен порівняно із зерном пшениці та класичного тритикале, що пов'язано із його більшою крупністю. Чотиривидове триткиале характеризується меншою сферичністю порівняно із пшеницею за рахунок більшої довжини, що має вплив на шпаруватість зернової маси та натуру зерна. Натура зерна чотиривидового тритикале істотно поступається (на 38–85 г/л) натурі зерна пшениці. Зерно чотиривидового тритикале склоподібне (98–99 %) та є подібним до зерна традиційного тритикале за цим показником. За вмістом клейковини (20–25 %) зерно чотиривидового тритикале істотно поступається пшениці, проте її якість задовільна.

Наведені у роботі результати дослідження демонструють високу склоподібність та низьку кількість клейковини. Це зумовлює можливість ефективного використання зерна чотиривидового тритикале для круп'яного виробництва, або у складі композиційних сумішей під час виробництва хлібобулочних продуктів.

Ключові слова: *тритикале, пшениця м'яка, технологічні властивості, маса 1000 зерен, натура зерна, склоподібність зерна.*

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1. Introduction

Bakery and cereal products of high biological value are gaining popularity, while the purchasing power of consumers is declining, so the search for promising ways to reduce the cost of finished products and at the same time improve their quality is a priority for the modern food industry. One of the ways to solve the corresponding problem is to expand the raw material base of grain due to new varieties and hybrids of high biological and economic value. One of the promising types of raw materials may be the grain of four species triticale.

Triticale grain appeared on the market relatively recently and is the first artificially created hybrid of wheat and rye [1]. However, due to the low quality of the first varieties of triticale, its use in the food industry was impractical. Therefore, traditionally triticale grain is positioned as raw material for feed production.

Despite the narrow scope of triticale grain, the work of breeders to improve its characteristics did not stop. This contributed to the development of new varieties, significantly superior in quality and safety to their predecessors [1]. As a result of crossing triticale grains with productive wheat (farro, spelt), varieties of four species triticale were obtained.

The varieties of four species triticale are able to form stable crops, have a low production cost and high protein content, balanced in amino acid composition, which determines the possibility of expanding its field of application.

Despite the external similarity of triticale and wheat grains, their technological properties differ, which makes the relevance of additional research and scientific justification of promising ways to use triticale grains in the food industry.

Triticale is the first artificially created hybrid of wheat and rye, which combines their best hereditary qualities [2]. Triticale grain is characterized by high protein content (10–25 %) [3].

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At present, hybrids of triticale and wheat (four species triticale) are known that can form high yields (up to 6.0–9.0 t/ha) [2]. They are resistant to diseases, pests and many adverse environmental factors, and in physical and technological properties approach wheat.

Despite the significantly higher protein content in triticale grain compared to wheat, triticale has the worst milling properties, which is associated with a significant proportion of water-soluble protein fractions [4]. Now triticale is considered as a promising diet food product [5]. In particular, a low amount of gliadins and glutenins can be a prerequisite for less irritating effect for consumers suffering from celiac disease [6].

It is known that the intended use of raw materials is due to indicators of the mass of 1000 grains, glassiness and nature. A mass of 1000 grains characterizes the supply of nutrients in the grains. Under equal conditions, a grain with an increased mass of 1000 grains has a more developed endosperm [7]. Triticale is characterized by a high mass of 1000 grains, which can vary from 36.0 g to 53 g [8–10]. However, the information on technological properties provided in the literature refers to the classical triticale grain. Highly productive hybrids of triticale (four species) differ in technological properties from the classical ones and require additional study.

So, *the object of research* was selected four species triticale varieties of varieties Alkyd, Strateg, Tactic, line LP 195 (Ukraine). Triticale grains were grown under controlled identical conditions. The quality of the studied samples of triticale grains was not lower than the second class according to DSTU 4762:2007. *And the aim of research* was to identify differences between the technological properties of four species triticale grains and classical triticale grains.

2. Methods of research

Glassiness was determined using the DSZ-3 diaphanoscope (Ukraine) (Fig. 1), and the falling number using the PCP-5 device (Ukraine) (Fig. 2).

The grain nature was established using liter bread scale (Ukraine) (Fig. 3). Gluten was washed by hand, and its quality was determined using an IDK-5M device (Ukraine) (Fig. 4).

The determination of indicators was carried out in accordance with the current at the time of the methodology [11].

Fig. 1. DSZ-3 diaphanoscope

Fig. 2. Falling number meter

Fig. 3. Bread scales

Fig. 4. Gluten strain meter

The studies were conducted in four repetitions, which were randomized over time. Samples of analytical repetitions that did not vary significantly (coefficient of variation less than 10) were considered qualitative and used for further statistical processing. In the course of the study, the programs Microsoft Excel 2010 and STATISTICA 10

were used. A comparative characterization of technological properties was carried out using the methods of analysis of variance.

For the experiment, triticale grains were used, which were stored under identical conditions. The moisture content of the grain was constant and amounted to 13.0±0.4 %. The mass of the sample for analysis – 2000 g.

3. Research results and discussion

The mass index of 1000 grains has a high direct correlation with the grain size, however, in the case when the grain is not sufficiently fulfilled, this regularity is absent. The triticale grains of the studied varieties were characterized by high weight grains of 1000 grains compared to the Khlibodar Kharkiv triticale grains and Podolianka wheat varieties, due to their high fineness (Fig. 5).

The Khlibodar Kharkiv variety had 4.5 g less weight of 1000 grains compared to wheat (45.5 g). The varieties of four species triticale had a mass of 1000 grains larger by 4.1–9.1 g compared to the classic triticale. The high grain size of the four species triticale is explained by their greater sphericity and geometric dimensions, and better filling.

The nature of triticale grains corresponded to the first and second classes (Fig. 6). It varied depending on the variety and ranged from 643 to 690 g/l, which is 38–85 g/l less compared to the nature of wheat grain (728 g/l). This is due to the greater duty cycle of triticale grains.

Glassiness is one of the important technological indicators of grain, which has a strong correlation with its hardness. Behind it, it is advisable to form crushing lots at flour mills, the target direction of raw materials. Grain with glassiness ≥ 90 % is recommended to be processed into cereal products. According to current requirements and norms, the glassiness index is determined for wheat and rice grains, however, given the similarity of triticale grains to wheat grains, it is advisable to determine its value for triticale grains.

It was found that triticale grains are viscoplastic (98–99 %) (Fig. 7). The Glassiness of the four species triticale grain did not change significantly depending on the variety. No differences were found between the four species triticale and the classic triticale in terms of glassiness, however, this indicator was significantly higher (by 9 %) compared to wheat.

According to the gluten content, the four species triticale grain corresponded to the first and second classes (19.6–25.3 %), while the Khlibodar Kharkiv triticale grain corresponded to the first class, since the gluten content was 24.0 % (Fig. 8).

The quality of gluten in terms of its deformation index varied from satisfactory weak to medium depending on the variety (Fig. 9).

Four species triticale grains of varieties Strateg, Alkid and Tactic had good gluten of the first group, since the deformation index of gluten of these varieties was 78 d. u., 77 d. u. and 69 d. u., respectively. The quality of wheat gluten and grain triticale varieties line LP 195 was satisfactory weak second group.

In terms of the falling number (280 s), the wheat grain corresponded to the first class (Fig. 10).

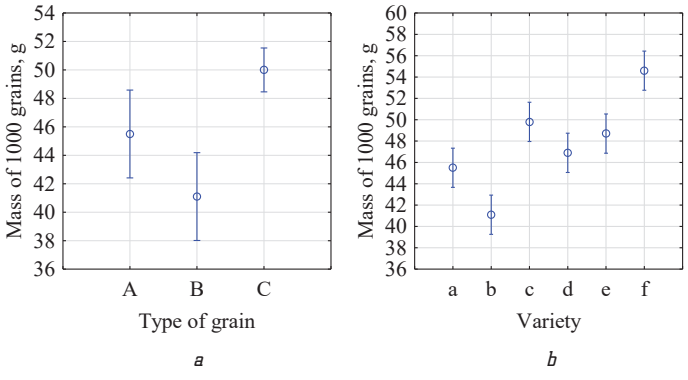

Fig. 5. The mass of 1000 grains of triticale and wheat:
a – a comparative characteristic of the grain of wheat and triticale;
b – comparative characteristics of various varieties of triticale;
A – wheat grain; *B* – grain of classic triticale; *C* – grain of four species triticale;
a – Podolianka wheat variety; *b* – Khlibodar Kharkiv triticale variety;
c – Alkyd four species triticale variety; *d* – Tactic four species triticale variety; *e* – Strateg four species triticale variety;
f – line LP 195 four species triticale variety

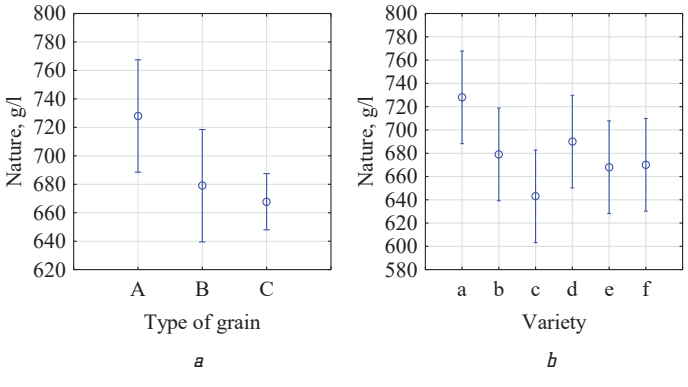

Fig. 6. The nature of the grain of triticale and wheat:
a – comparative characteristic of the grain of wheat and triticale;
b – comparative characteristics of various varieties of triticale;
A – wheat grain; *B* – grain of classic triticale; *C* – grain of four species triticale;
a – Podolianka wheat variety; *b* – Khlibodar Kharkiv triticale variety;
c – Alkyd four species triticale variety; *d* – Tactic four species triticale variety; *e* – Strateg four species triticale variety;
f – line LP 195 four species triticale variety

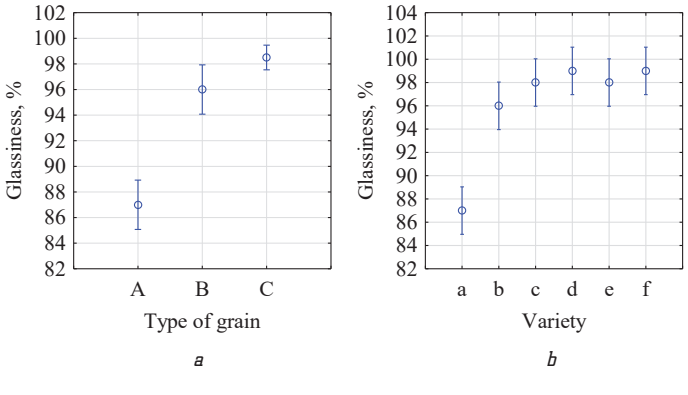

Fig. 7. Grain similarity of triticale and wheat glass:
a – comparative characteristic of the grain of wheat and triticale;
b – comparative characteristics of various varieties of triticale;
A – wheat grain; *B* – grain of classic triticale; *C* – grain of four species triticale;
a – Podolianka wheat variety; *b* – Khlibodar Kharkiv triticale variety;
c – Alkyd four species triticale variety; *d* – Tactic four species triticale variety; *e* – Strateg four species triticale variety;
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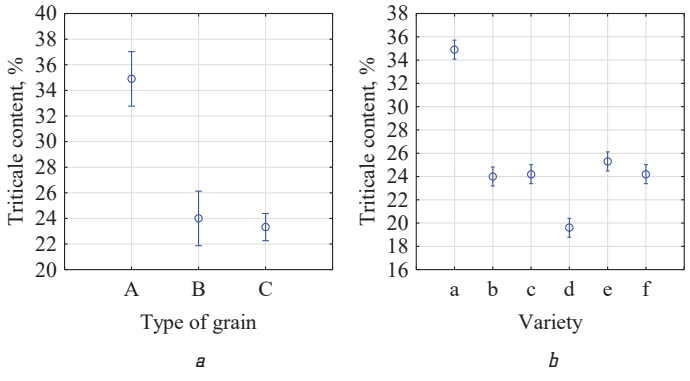

Fig. 8. Triticale content of triticale and wheat glass:
a – comparative characteristic of the grain of wheat and triticale;
b – comparative characteristics of various varieties of triticale;
A – wheat grain; *B* – grain of classic triticale; *C* – grain of four species triticale;
a – Podolianka wheat variety; *b* – Khlibodar Kharkiv triticale variety;
c – Alkyd four species triticale variety; *d* – Tactic four species triticale variety; *e* – Strateg four species triticale variety;
f – line LP 195 four species triticale variety

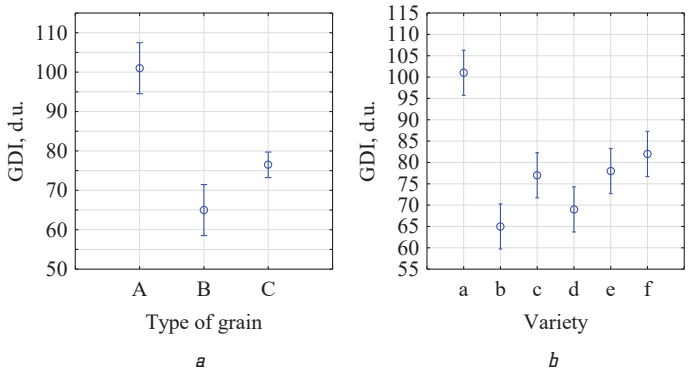

Fig. 9. Gluten deformation index of triticale and wheat glass:
a – comparative characteristic of the grain of wheat and triticale;
b – comparative characteristics of various varieties of triticale;
A – wheat grain; *B* – grain of classic triticale; *C* – grain of four species triticale;
a – Podolianka wheat variety; *b* – Khlibodar Kharkiv triticale variety;
c – Alkyd four species triticale variety; *d* – Tactic four species triticale variety; *e* – Strateg four species triticale variety;
f – line LP 195 four species triticale variety

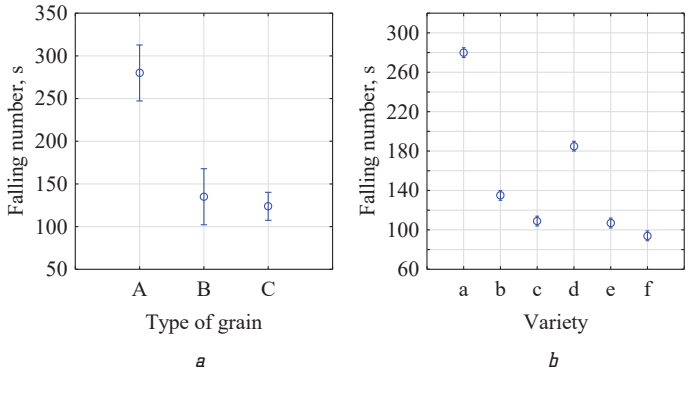

Fig. 10. Falling number of triticale and wheat glass:
a – comparative characteristic of the grain of wheat and triticale;
b – comparative characteristics of various varieties of triticale;
A – wheat grain; *B* – grain of classic triticale; *C* – grain of four species triticale;
a – Podolianka wheat variety; *b* – Khlibodar Kharkiv triticale variety;
c – Alkyd four species triticale variety; *d* – Tactic four species triticale variety; *e* – Strateg four species triticale variety;
f – line LP 195 four species triticale variety

The first class corresponded to triticale grains of Tactic variety, since the falling number was 185 s, however, the other varieties under study belonged to the second (107–135 s) and third classes (94 s) by this indicator.

The strength of the work is a comprehensive comparison of the important technological properties of the grain of four species triticale, wheat and traditional triticale.

Further study requires the chemical properties of the four species triticale. It is advisable to establish the possibility of developing dietary foods based on the four species triticale grain and to establish their culinary properties. Corresponding work is planned in further studies of the authors.

4. Conclusions

In the course of the study, it was shown that the technological properties of the grain of four species triticale, classical triticale and wheat are significantly different. Four species triticale has signs of raw materials for cereal production, which is due to the high glassiness (97–98 %) and grain size (weight of 1000 grains – 48–54 g). The amylolytic enzyme activity indices, the quantity and quality of gluten of four species triticale are worse compared to wheat, which indicates its low baking properties.

The research results presented in the work demonstrate the high cereal properties of the four species triticale and are useful for food manufacturers who seek to expand their assortment qualitatively.

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