Evaluation of technological and cereal qualities of grains of zoned barley varieties grown in Subtaiga-taiga zone of the Irkutsk region

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Abstract: Among the varieties of barley (Hordeum sativum), barley nutans varieties have the best qualities for food processing according to state standards (GOST) 28672-90. The paper presents the results of cultivation and a comprehensive assessment of technological parameters of grain of zoned barley varieties: Acha, Abalak and Biome obtained in the conditions of the subtaiga-taiga zone of the Irkutsk region. Barley was grown according to the steam predecessor on gray forest soil with a high level of fertility according to the methodology of the state network for testing varieties in the Nizhneudinsky state site of variety testing. Grain quality assessment was carried out according to generally accepted methods in accredited laboratories. It is shown that grain quality is subject to dynamics due to changes in meteorological conditions during the cultivation of barley. In terms of nature, all varieties meet the requirements of GOST 28672-90. Grain Biome is characterized by a higher mass of 1000 grains (more than 50 g), which subsequently affects its cereal qualities. The quality of cereals in all varieties is rated as "excellent". In terms of uniformity, cereal yield and protein content in grain, the best among the studied varieties was Biome. Thus, the cereal quality of the grain obtained in the region meets the requirements of the processing industry and is determined by the variety.

1. Introduction
Barley is widely used for the production of cereals (pearl barley and barley), extracts, syrups of alcoholic and non-alcoholic drinks. Barley flour, added to wheat when baking special types of bread, is a source of dietary fiber and nutrients. The use of barley flour in the manufacture of pastes, soups, cereals, salads, puddings, noodles and barley tea is a promising area. Barley is grown in many countries of the world and is an important grain crop [1–4]. Lack of suitable malt barley varieties that exhibit high yielding, stable performance, and good malting quality is the major factor among several production constraints contributing to low productivity of malt barley [5]. Barley (Hordeum vulgare L.) is a nutritious cereal but very little (only about 2%) of this grain is used as human food. However, it has attracted the attention of researchers and food processors in the last 15 years for its potential health benefits. It is also recognized as a functional grain because it contains high levels of β-glucan and phytochemicals. Therefore, a number of barley processing research and animal/clinical trials have been performed over the last 15–20 years. Also, health claims have been approved by a number of government agencies including the Food and Drug Administration (FDA)
and the European Food Safety Authority (EFSA) about consumption of β-glucan, an important component of barley. Barley must undergo various processing steps before human consumption, which greatly affect their composition and physicochemical properties. These properties play an important role in the development of new products. Therefore, the present article reviews the literature on the effect of processing on the physicochemical and thermal properties of barley [6]. An agronomic improvement in grain yield and quality in winter wheat could be obtained through the application of strategies, such as application of foliar fungicides or fertilizers, that protect health of the last leaves and delay the senescence process during ripening. Only a few studies have reported the effect of these practices on barley, although these treatments could represent a new opportunity to specialize in feed and food barley markets and raise farmer profitability. Malting is the controlled germination of cereal grain which takes place in three stages steeping, germination and kilning. During germination the starchy endosperm undergoes modification, a key step in achieving good malt quality. Modification of the endosperm is a result of the activity of enzymes primarily produced within the aleurone layer [7]. Modification involves the breakdown of both cell walls by hydrolytic enzymes, and hordein proteins by proteolytic enzymes, into soluble peptides and associated amino acids. Modification is an essential part of malting, which makes starch stored within endosperm cells available for later gelatinisation during mashing, and also releasing nutrients which are metabolised by yeast. It is the result of grain quality traits which determine to what extent this modification occurs and therefore how successfully this malt is processed downstream. Diastase enzymes (α-amylase and β-amylase) are also produced during endosperm modification, these are later utilised in mashing to convert the dissolved starch into maltose and glucose. The power of these enzymes to breakdown starch is referred to as the diastatic power (DP), a malt quality parameter. However, how SW influences the malting process as whole or individual parts of it is unknown.

Recently in Russia much attention has been paid to increasing the production of cereal crops and the development of food products based on them. Groats is an old and beloved food product among the population, the value of which is high nutritional value, easy digestibility and good taste. Barley groats in national cuisines around the world are used to prepare a wide variety of first and second courses, and in the food industry for the production of canned food and food concentrates. Barley groats is a good source of dietary fiber, which have a positive effect on the physiological and microbiological processes of the gastrointestinal tract.

In the Irkutsk region, barley is cultivated on an area of about 100 thousand hectares, its gross harvest exceeds 180 thousand tonnes. However, over the years, sown area and gross harvests vary depending on market conditions and meteorological conditions. The main trend in the selection of spring barley is associated with an increase in the overall productivity potential. Varieties of spring barley over the years of testing have differently realized their productivity potential. High-quality barley should have the following indicators: nature 600-750 g / dm3; weight of 1000 grains - more than 40 g; descent from a sieve with a hole size of 2.5–20 mm (particle size) - at least 85%; sprouting ability - not less than 95%.

According to GOST 28672-90, the grain is divided into four groups, where the grain of the first class is intended for use for food purposes for the production of cereals, and the second for producing malt in the distillery, animal feed and feed purposes. In this regard, the quality of barley grain is standardized by different GOSTs, depending on the intended use: GOST 5060-86 Barley for brewing, GOST R 53900-2010 Feed barley. Analysis of GOST requirements, research by scientists show that double-row barley (Hordeum sativum distichum) has the most suitable grain for processing purposes. In Eastern Siberia, barley is grown for fodder, cereal and brewing purposes. The relatively low productivity of barley in the Irkutsk region (the average over the past 10 years was 1.87 t / ha) is due to the fact that it is traditionally placed as the second crop in the crop rotation after the steam field, and this reduces not only the crop, but also the quality of the grain. Placing this culture on a steam field allows you to get high-quality grain. Previous studies in the main agroclimatic zones of
the Irkutsk region showed that, to obtain cereals from Acha grains, it is best to place it in the subtaiga-taiga zone.

The cereal quality of barley largely depends on the grain size. In turn, grain size depends on the mass of 1000 grains and is largely determined by the conditions of barley cultivation (provision with moisture and mineral nutrition elements, variety, phytosanitary condition of sowing) and grain harvesting mode. Thickened, as well as overly sparse crops in the conditions of the Irkutsk region form grain with a low grain size. Varietal characteristics also determine the technological quality of grain. A multivariate analysis of variance and covariance analysis showed that in the Irkutsk region, grain quality is determined by variety and productivity by an agrofon of the soil-climatic zone. So multi-row barley form a grain with a particle size of 50-60%. In this regard, two-row barley is of great interest. As our studies have shown, in dry years in the Irkutsk Region, barley forms a larger and more even grain.

Currently, three varieties of varieties are grown in the region, however, the largest area (80-85%) is occupied by two-row barley of the Hordeum distichon variety, since, in addition to feed purposes, its grain can be effectively used for cereal and brewing purposes.

The purpose of the work is to conduct a comprehensive assessment of cereal and technological indicators of grain of zoned varieties of two-row barley: varieties Acha, Biom and Abalak grown in the subtaiga-taiga zone of the Irkutsk region in the Sayan region.

2. Materials and methods
Barley was grown according to the steam precursor according to the method of state variety testing of agricultural crops.

Variety Acha in the Irkutsk region at the state variety test is adopted as a standard. Bred at the Siberian Research Institute of Plant Breeding and Selection. Weight 1000 grains 34-56 g. A variety of nutans. Mid-season. The growing season is an average of 82 days. The protein content is from 10 to 13%. Highly resistant to lodging, medium resistant to drought. Zoned since 2001. Brewing valuable variety. Medium resistant to Helminthosporium gramineum and Puccinia graminis, highly susceptible to Ustilago nuda var.hordei.

Variety Biom. The bush is erect. The grain is very large. Weight 1000 grains 46-55 g. Resistance to lodging at or slightly higher than the standard. The protein content is 11.9-15.2%. Moderately resistant to Ustilago nuda var.hordei; highly susceptible to Helminthosporium gramineum and Fusarium.

Variety Abalak. Grain from large to very large. The weight of 1000 grains on average over the years of testing in the state section of variety testing (hereinafter GSU) reached 57 grams. Mid-season. The growing season averages from 67 to 84 days. Resistant to lodging, shedding, responds to drought, but more stable compared to the standard. Brewing valuable variety. The protein content in the grain is lower than that of the variety Acha by 1.0 -2.1%.

The grain obtained at the Nizhneudinsky GSU was analyzed in the laboratory of the Rosselkhoznadzor in the Irkutsk Interregional Veterinary Laboratory and in the West Siberian Interregional Center for a comprehensive assessment of the tested varieties (Table 1). Grain quality was determined according to generally accepted methods according to GOST 6378-84 “Barley for processing into groats”, etc. For 10 years, grain quality analysis was carried out according to general and special quality indicators.

3. Results and discussion
Fineness and uniformity have a significant effect on the yield and quality of cereals. Coarse grain has better technological properties, it is easier to peel off, and less crushed cereal is obtained from it.

Evenness contributes to lower core fragility, increased yield and improved cereal quality. Over the years, grain uniformity varies depending on the meteorological conditions prevailing during the formation of the crop and quality. So in wet years, due to an increase in the productive bushiness
of barley, the proportion of large grain decreases, which reduces its evenness. The best values according to these indicators were characterized by biom grain, the grain size of this variety was determined by the sum of descents from sieves 2.8–2.5. This is ensured by its varietal feature and, first of all, with a mass of 1000 grains. The long-term averaged data for the weight of a thousand grains for the Nizhneudinsky cultivar for Biom varieties amounted to 52.4 g for Acha 46.6 g and for Abalak 49.6 grams, respectively.

For a comprehensive and most complete assessment of the technological properties of cereal grain, cereals were produced. The yield of cereals, regardless of variety, is at the level of 50%, with a slight dynamics over the years.

| Table 1. | Technological and cereal qualities of barley grain (average for 2009-2018). |
|---------|--------------------------------------------------------------------------------|

| Variety | Acha | Biom | Abalak | Acha | Biom | Abalak | Acha | Biom | Biom |
|---------|------|------|--------|------|------|--------|------|------|------|
| Technological qualities | Fineness | % | Flatness, | % | Grain yield | % |
| | 2.5-2.8 | 82.9 | 88.2 | 81.1 | 49.8 | 49.7 | 49.1 |
| Organoleptic characteristics of barley groats | The color of porridge, score | 4.9 | 4.9 | 4.7 | 5.0 | 4.9 | 5.0 | 6.5 | 6.6 | 6.6 |
| | The taste of porridge, score | Digestibility, coefficient.. |

Consumer advantages of cereals complete the assessment of the technological properties of grain and are most important, since they characterize cereal grain and cereals produced from it according to the final result - the quality of the porridge (table 1.). Test cooking of porridge allows you to determine the taste and color of porridge, the time of its cooking until fully cooked according to organoleptic signs. The highest score in terms of color was assigned to porridge developed from Acha and Biom. Attention is also drawn to the relative stability of this indicator during the research period for the variety Acha. The digestibility coefficient was determined by volume and weight as the ratio of the volume of obtained porridge to the volume of cereals before cooking, as well as the ratio of the mass of porridge to the mass of cereals before cooking. The shorter cooking time of the porridge and the greater coefficient of digestibility of cereals produced from barley varieties Abalak and Biom testify to the best consumer advantages of cereals. In our experiment, cooked cereals had a friable consistency. A significant correlation between the consistency of porridge, variety and year of cultivation was not observed. These parameters characterize the grain size, which depends on varietal characteristics and on the soil and climatic conditions of cultivation and is an important indicator of the quality of barley as a raw material for the production of cereals. Large barley grains provide a greater yield of barley grits, because they contain more endosperm and fewer flower films. This grain is easier to peel, which helps to reduce energy consumption, when processing it gets less crushed core, the most fully used grain resources. Evaluation of the grain size of barley at the initial stage allows you to adjust the technological modes for processing grain into barley groats and eventually get high-quality products. The thin shell of the variety is a favorable factor in its processing into cereals and flour, due to the high efficiency of grain peeling.

Protein content is an essential indicator of the nutritional value of any food crop. The amount of protein in the grain of spring barley, depending on the conditions of the year, ranged from 9.4% to 15.6%. The highest protein accumulation over an average of 10 years was obtained in Biom grains (14.1%) and low in Abalak varieties (12.6%) since this variety is recommended as brewing, and to obtain high-quality malt, the protein content in the grain should not exceed 12.0-12.5%.. Over the years of research, the protein content in Acha barley grain was 13.8%. The harmonious combination of malting barley yield, quality and nitrogen (N) use efficiency under nitrogen (N) rates applications was greatly conducive to production. Appropriate combinations of seeding and N rates are needed to improve the yield and nutritional quality of feed crops in the cool climate ecosystems.
4. Conclusion
Barley is a cereal grown for animal feed, human consumption, and malting. Nutrient concentrations are important as they provide information regarding the dietary values of barley consumed by animals or human beings. The wide spread of this grain crop is associated with its various applications in various industries: for feed and food purposes, in the production of beer and beverages based on it. At the same time, the consumption of barley in Russia for food is not high enough – mainly in the form of pearl and barley cereals for making soups and porridges, or as flour for baby food, cereals for Breakfast cereals and some types of bakery products. In addition, grain nutrient removal may be useful for refining fertilizer recommendations. The studies conducted in this work indicate the possibility of growing spring barley with good cereal indicators in the Irkutsk region. Different requirements for cereal, fodder and malting barley require the development of differentiated cultivation technologies that provide established technological and biological parameters of grain.

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