

# Analysis of the effect of hydrothermal processing on the technological properties of "Vakhshskaya-116" rye grown in a dry climate

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**Abstract.** This research paper presents the results of studying the effect of hydrothermal processing on the technological properties of autumn "Vakhshskaya-116" rye grown in a dry climate. The research was carried out using the general and modern chemical and physico-chemical methods specified in the "Rules for organization and management of technological processes in mills". Hydrothermal treatment of "Vakhshskaya-116" rye grain grown in dry climate showed 14.5-15% moisture, 64.77-64.80% flour yield after 6-8 hours of soaking, and 177-179 units of amylolytic activity (fall number). The results of this experiment confirmed the results presented in Table 1, entitled Effect of hydrothermal treatment on the amylolytic activity of "Vakhshskaya-116" rye grain. During the preparation of autumn "Vakhshskaya-116" variety rye grown in dry climatic conditions for flour weighing, its moisture content is 14.5-15%; 6-8 hours of soaking time has been found to be the most effective.

## 1 Introduction

Expanding the assortment of food products made from grain raw materials, increasing their nutritional and biological value, as well as creating a new generation of products that structurally meet the requirements of healthy nutrition are among the urgent problems of today. Because eating healthy products with biological value is one of the most important and reliable ways to prevent, improve health and treat chronic degenerative diseases. Hydrothermal treatment is a crucial step in grain preparation for grinding. In this case, the physical possibility of separating the anatomical parts of the grain into separate products is improved.

Cold conditioning method of hydrothermal treatment of grain is used in mills in the Republic of Uzbekistan. This method is simple to set up and operate, but more hopper volume is required for drying wet grain. Extensive research has been carried out on hydrothermal treatment of rye grain for flour milling, and the effect of cold conditioning on

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the structural-mechanical properties of grain, biochemical changes, yield and quality of flour, and the optimal regimes of the flour extraction process have been determined.

In rye grain, the husk, bract and aleurone layer are well developed compared to wheat, and the lower mass fraction of endosperm indicates that the optimal moisture range fluctuates in a large range of 14-16%. Also, rye grain contains 50...65% starch, which is less than wheat, sugars are 4...8%, i.e. more, and its distinctive feature is the large amount of mucilage, the main part of which consists of high-molecular carbohydrates (1.5 ...2.5%) requires a precise approach to hydrothermal treatment. It was determined that the optimal moisture content in cold conditioning of rye grain is in the range of 14.5 - 15.0%, and the optimal duration of moistening is 8 - 12 hours. In the hot conditioning method of hydrothermal processing, high efficiency is achieved in the mode of grain heating temperature of 50-60°C, humidity up to 15% and soaking time of 1-2 hours.

Despite the high acidity of rye grain, without losing the activity of  $\beta$ -amylase, the onset of  $\alpha$ -amylase activity at the most favorable temperature, the amount of active  $\alpha$ -amylase in unfermented rye grain, unlike wheat grain, and the activity of  $\alpha$ -amylase can increase several times as a result of hydrothermal treatment. It leads to a decrease in the quality of the product. During hydrothermal processing, the soaking time of soaked grain is also characterized by a certain optimal value. When the optimal value is reached, positive structural changes occur in the endosperm, shell and aleurone layer of the grain, which affects the strength of the grain structure, the separation of its anatomical parts into separate products during the grinding process, the yield of flour and quality indicators. Correct hydrothermal treatment of grain determines the efficiency of the process of turning it into high-quality flour. Research analysis shows that there are optimal hydrothermal regimes for each category of grain delivered for processing. They depend on the type and variety of grain, cultivation area, technological process conditions in the mill and other individual characteristics. Therefore, it is necessary to choose hydrothermal treatment methods and regimes for rye grain preparation based on its composition and properties. Based on the analysis of the above stages, it can be concluded that the "hot" method of hydrothermal treatment is useful. At the same time, the hydrothermal treatment method and its dependence on the type of flour have been studied.

Rye grain is a traditional crop, its growth conditions are simple, it is less demanding on agricultural technology. In recent years, "Southern Agriculture" (in Kashkadarya region), "Gallaorol Lalmikor" (in Jizzakh region), Agricultural Scientific Research Institute, "Andijan Agriculture and Agrotechnologies" and "Cereals and legumes" are widely studied by scientists of research institutes. Breeders are constantly conducting research on the creation of high-yielding, disease-resistant varieties of rye, their technological properties are regularly studied, and recommendations are made on the effective use of certain varieties. However, despite the high biological value and functional properties of rye grain, technologies for weighing target flour varieties for the production of bakery and flour confectionery products have not been developed. From the analysis of the above studies, it can be concluded that taking into account the properties of rye grain, it is necessary to analyze and develop the technological scheme of preparing flour for weighing and flour weighing. The purpose of the study analysis of the effect of hydrothermal processing on the technological properties of "Vakhshskaya-116" rye grown in a dry climate.

## 2 Methods

The general and modern chemical and physico-chemical methods mentioned in the "Rules for organization and management of technological processes in mills" were used in the research. Also, taking into account the fact that after cleaning the rye grain for production, it is necessary to choose the power of the hydrothermal treatment procedures, the amount of

water in the hydrothermal treatment is calculated using the following formula in this: G- the grain of the received grain sample; moisture content of w1-dactlabki wheat sample, %; w2 – increase of the grain sample to the required moisture content, %. Soaked grain is soaked in sealed canisters at the same time as the soaking time in production. The grain is moistened in the deep conditioning unit as stated in the "Rules for organization and management of the technological process in mills".

The flour content of the rye grain samples selected for the study was determined in laboratory conditions by the CD 1 MILL (Chopin technology, France) machine.

3 Results and Discussion

Hydrothermal processing of rye grain in the mill for preparing it for grinding graded flour is not only a quick separation of the anatomical parts of the grain into separate products and the grinding of high-quality flour, but also the control of the increase in the activity of amylolytic enzymes in the grain and flour, as well as the development of methods for managing technological processes, improving the baking properties of milled rye flour. an important technological process necessary for improvement is hindered.

The most objective description of the baking properties of rye grain is the carbohydrate-amylase complex, the location of this complex in the anatomical parts of the grain was studied. According to him, this is divided into three parts such as ¼ in the brawny part of the rye grain; ½ in the central part of the rye grain (endosperm); and ¼ rye grain in the hairs on the surface.

From the conducted research analysis, it can be seen that the preparation of rye grain for flour has a positive effect on the baking properties of the flour. In particular, hydrothermal treatment affects all the carbohydrate-amylase complex located in the anatomical parts of the grain through the amount of moisture and the duration of soaking. Based on this, small and light grain fractions with α-amylase activity in the "Vakhshskaya-116" rye grain sample selected for research were separated, and the effect of hydrothermal treatment on the amylolytic activity of the main fraction was experimentally studied. The results obtained from the experiments are presented in Tables 1.

**Table 1.** Effect of hydrothermal treatment on amylolytic activity of "Vakhshskaya-116" rye grain.

Samples	Moisture, %	Duration of dimming, hours	Falling number, s
No.1	14	6	196
No.2	14	8	191
No.3	14	10	186
No.4	14	12	179
No.5	14.5	6	190
No.6	14.5	8	183
No.7	14.5	10	176
No.8	14.5	12	169
No.9	15	6	186
No.10	15	8	179
No.11	15	10	171
No.12	15	12	165
No.13	15.5	6	162
No.14	15.5	8	151
No.15	15.5	10	138
No.16	15.5	12	121

The temperature of the furnace during hydrothermal treatment was  $23.2 \pm 1$  °C for all samples. The initial moisture content of the sample was 11.7%, its drop number was 219 units. Arithmetic average values of the drop number of hydrothermally treated grain were obtained.

From the analysis of the experimental results presented in Table 1, it can be seen that the initial values of humidity and humidity have no significant effect. At 14% humidity, the difference in numbers was 17 units, and at 15.5% humidity, it was 41 units. It can be concluded that increasing the humidity during hydrothermal treatment requires reducing the soaking time. In order to objectively evaluate the results of this experiment and the amylolytic activity of rye grain, it was shown that it is necessary to study the effect of hydrothermal treatment on the flouriness and baking properties of the flour.

The flour-making property of the grain is evaluated by the yield, quality, and the amount of electricity used for weighing the flour.

In order to develop a technological scheme for the preparation of domestic "Vakhshskaya-116" rye grain for flour milling, the dependence of the hydrothermal treatment procedure on its flour properties and amylolytic activity was experimentally studied. The experiments were carried out according to the AFNOR/CEN/ISO standard (ISO 27971:2015) in the CD1 MILL (Chopin technology, France) mill in laboratory conditions with a two-stage hydrothermal treatment according to the "Rules for the Organization and Conduct of Technological Processes in Mills". The results obtained from the experiments are presented in Table 2 below.

**Table 2.** Effect of hydrothermal treatment on the flour properties of "Vakhshskaya-116" rye grain.

Samples	Moisture, %	Duration of dimming, hours	Flour yield, %	Falling number, s
No.1	14	6	65.2	178
No.2	14	8	65.3	172
No.3	14	10	64.9	170
No.4	14	12	64.9	167
No.5	14.5	6	64.80	179
No.6	14.5	8	64.78	171
No.7	14.5	10	64.72	166
No.8	14.5	12	64.70	160
No.9	15	6	64.77	177
No.10	15	8	64.53	170
No.11	15	10	64.32	166
No.12	15	12	64.14	162
No.13	15.5	6	63.26	160
No.14	15.5	8	63.14	151
No.15	15.5	10	62.6	141
No.16	15.5	12	62.1	128

The obtained experimental results showed that hydrothermal treatment of domestic "Vakhshskaya-116" rye grain had 14.5-15% moisture content, 64.77-64.80% flour yield during 6-8 hours of soaking, and 177-179 units of amylolytic activity (falling number). showed. The results of this experiment confirm the results presented in "Table 1 Effect of hydrothermal treatment on the amylolytic activity of rye grain "Vakhshskaya-116". It can be concluded that the moisture content of autumn "Vakhshskaya-116" variety rye grown in a dry climate is 14.5-15%; It is advisable to set the duration of soaking for 6-8 hours. Also, the results obtained in this study can be used as a basis for the preparation of autumn rye grains grown in a dry climate for flour milling.

## 4 Conclusion

From the results obtained from the research, it was confirmed that the amylolytic activity of autumn rye grain grown in dry climate conditions and the amylolytic activity extracted from it does not have a significant effect on bread production. Also, for the first time, the effect of hydrothermal processing on the technological properties of rye grown in a dry climate was analyzed.

## References

1. I. Konopka, M. Tańska, M. Skrajda, *Przegląd Zbożowo-Młynarski*, **4** (2017)
2. K.A. Rosentrater, A.D. Evers, *Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture*. Woodhead Publishing (2018)
3. S. Stępniewska, E. Słowik, G. Cacak-Pietrzak, D. Romankiewicz, A. Szafrńska, D. Dzik, *European Food Research and Technology*, **244** (2018)
4. K. Vejražka, O. Faměra, Z. Kocourková, S. Hasenay, *Selected grain physical properties of different rye varieties (Secale cereale) and milling quality*. Proceedings of the 6th International Congress Flour-Bread'11. 8th Croatian Congress of Cereal Technologists, Opatija, Croatia (2011)
5. W. Małgorzata, *Journal of food science and technology*, **56** (2019)
6. M. Gómez, J. Pardo, B. Oliete, P. Caballero, *J Sci Food Agric*, **89** (2009)
7. J.M. Pihlava, J. Hellström, Kurtelius T, Mattila, *J Cereal Sci*, **79** (2018)
8. R.S. Saparovich, *Annals of the Romanian Society for Cell Biology*, **4091** (2021)
9. K. Vejražka, O. Faměra, Z. Kocourková, *Selected grain physical properties of different rye varieties (Secale cereale) and milling quality*. In: *Proceedings of the 6th international congress flour-bread '11. 8th Croatian Congress of Cereal Technologists*, Opatija, Croatia (2011)
10. Y.H. Jung, *BMC genomics*. **24**, 1 (2021)
11. H. Martin. *Economic diversification in GCC countries: Past record and future trends* (2013)