# Efficiency of the modes of hydrothermal processing of buckwheat grains in the production of cereals

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**Summary.** The article presents the results of experimental studies of the effectiveness of the hydrothermal processing (HTP) of buckwheat grains in the process of making cereals, carried out according to the developed method with the help of a constructed and manufactured laboratory-scale plant.

In the course of research, the general yield of cereal products was determined experimentally after peeling the buckwheat grains and sorting the resulting mixture, depending on the hydrothermal processing mode.

As a result of experiments on grains of buckwheat, varieties Antalya, Oranta, Krupynka and Ukrainka, it was established that the optimum duration of hydrothermal processing of raw materials is 9 ... 10 min., at a water vapor pressure in the HTP apparatus P = 2.0 MPa. The application of a justified optimal mode of hydrothermal processing of buckwheat grains allows increasing the total yield of buckwheat, on average, by 4.1 ... 5.1% compared to the existing technology.

**Key words**: buckwheat grains, hydrothermal grain processing, grain peeling, general yield of cereals.

#### FORMULATION OF THE PROBLEM

In flour-milling and cereal production, hydrothermal processing (HTP) is an important means of improving the technological properties of the grain in the process of its preparation for grinding or peeling. Its essence is the simultaneous action on the grain of water, water vapor and heat for a purposeful change in the technological properties of its shells and core.

In the process of obtaining cereals, the goal of the HTP of raw materials is to increase the strength and elasticity of the core, and reduce these indices in the shells, as well as improve the consumer quality of cereals, while maintaining the values of its biological and consumer values.

In the process of making cereals during peeling of grain after HTP, its shells are more easily destroyed, the core is less crumbled, which leads to an increase in the yield of whole cereals (peeled buckwheat), and, thus, to increasing the efficiency of the technological process and improving the quality of the finished product. The structure of cereal products, more precisely, the specific gravity of whole cereals, as well as the overall yield of cereal products, largely depends on the parameters of the HTP of grain mode in the processes of making cereals. Therefore, the justification of optimal parameters of the HTP mode of grain of different varieties in the technological processes of making cereals is an important engineering task that requires experimental research.

## ANALYSIS OF RECENT STUDIES AND PUBLICATIONS

A number of studies have been devoted to the description of technological processes for the production of cereals, technologies for their production, as well as the disclosure of the device and the operating principle of technological equipment, which are widely represented in the scientific and educational literature [1-6].

A large number of scientific papers contain the results of researches and analysis of the efficiency of technological processes in food production, as well as the operation of equipment [7-10].

New methods of grain peeling and processing equipment for this operation are disclosed in patented developments [11-15].

In patents [16, 17] new methods of hydrothermal processing of grain in the processes of obtaining cereals are presented. The influence of moisture on the processes of briquetting and cutting agricultural crops has been studied by many scientists, for example [18, 19].

In [20], the influence of relative humidity on the geometric parameters of wheat and rye grains was investigated. However, the influence of the parameters of the HTP mode of buckwheat grains of different varieties on the overall yield of cereals and cereal products is, in our opinion, in need of an additional scientific study.

## FORMULATION OF THE PROBLEM

The article posed an engineering problem - to investigate the influence of the mode of hydrothermal processing of buckwheat grains on the overall yield of cereals and cereal products. According to the existing technology of obtaining buckwheat, which is used on the production technological line (PTL) of the Chair of Mechanical Engineering of Lviv NAU, the total yield of cereal products, according to the manufacturer of this PTL, is 65%. The recommended duration of the HTP of grain in the apparatus of this PTL is 7 ... 8 min. The pressure of water vapor in the apparatus of the HTP when

processing the buckwheat grain before peeling is  $2 \dots 3$  MPa [4, 5].

## THE MAIN MATERIAL PRESENTATION

We have proposed a design and manufactured a laboratory facility for studying the HTP modes of buckwheat grains before peeling (Figure 1).



**Fig. 1.** Scheme of a laboratory-scale installation for studying the mode of hydrothermal grain processing: 1 - the steel cylinder; 2 - thermometer; 3 - tap for steam release; 4 - safety valve; 5 - manometer; 6 - cover; 7 - stopwatch; 8 - basket for grain; 9 - electric heating element; 10 - thermal insulation of the cylinder.

The installation works as follows. Unscrew the cover 6 and inside the cylinder 1 pour 2 liters of drinking water. The cover 6 is turned on and the electric heating element 9 is turned on. When the valve 3 is open, the temperature inside the cylinder is monitored by means of a thermometer 2. After the evaporation starts (97 ... 98 °C), do not turn off the electric heater from the 220 V mains, turn off the cover 6 again , take out a basket for grain 8. It is covered with 350 g of buckwheat grains and inserted inside the cylinder. After that, the cover 6 is hermetically tightened with a key and the tap is closed. The vapor pressure inside the cylinder is monitored by the pressure gauge 5, and adjusted to the required limits by means of a tap 3, which acts as a manual throttle. The temperature inside the cylinder is fixed by means of a thermometer 2,

and the duration of the HTP of grain is measured with a stopwatch 7. With the help of the above-described laboratory-scale installation (Figure 1), we conducted a HTP of grains lasting 5, 7, 10, 14 and 19 min. Immediately after the HTP, the grain was peeled on a BRIG-10 roll-core machine, and the grain before and after the HTP, as well as cereal products after peeling and sorting, were weighed on the Zelmer electron scales.

Thus, we carried out experimental studies of the influence of the parameters of the mode of hydrothermal buckwheat grains of varieties Antalya, Oranta, Krupynka and Ukrainka on the effectiveness of the peeling process. The modes of hydrothermal processing of buckwheat grains are shown in Table. 1.

				Grain weight after the HTP, g			
Experience option	Vapor pressure, MPa	Duration of HTP, min.	Grain weight before the HTP, g	Antalya	Oranta	Krupynka	Ukrainka
Ι	2,0	5	350	361	360	362	361
II	2,0	7	350	368	367	369	368
III	2,0	10	350	380	379	377	379
IV	2,0	14	350	381	384	386	385
V	2,0	19	350	384	389	391	390

Table 1. The modes of hydrothermal processing of buckwheat grains



Fig. 2. Dependence of the yield of cereal products after peeling of buckwheat grains of buckwheat Antalya on the mode of HTP at P = 0.2 MPa.

An indicator of the effectiveness of the HTP process of buckwheat grains was the general yield of cereal products after peeling of the grain after the HTP. The results of an experimental study of the influence of the HTP modes on the yield of cereal products from buckwheat grains of different varieties are presented in Figs. 2-5. From the graphs in Fig. 2, we can conclude that for the buckwheat grains of the buckwheat "Antalya" the optimal duration of the HTP is 10 minutes at a pressure P = 0.2 MPa. Under this HTP the output of cereals was 70.1%, namely: 233 g of cereal-kernel and 13 grams of cereals.

Let's analyze the output of cereals from the buckwheat brand Oranta after the HTP on different modes (Figure 3).



**Fig. 3.** Dependence of the yield of cereal products after peeling of buckwheat grains of buckwheat Oranta on the mode of HTP at P = 0.2 MPa

As can be seen from the figures in Fig. 3 graphical dependencies, at the pressure P = 0.2 MPa, the optimal duration of the HTP for the sort of buckwheat Oranta is

also 10 minutes, since of 350 g of raw materials were obtained: 229 g of the core and 15 g of cereals, which is 69.7% of general output of cereals.



**Fig. 4.** Dependence of the yield of cereal products after peeling of buckwheat grains of buckwheat Krupynka on the mode of HTP at P = 0.2 MPa

From the presented graphical dependencies we conclude that, at a pressure of P = 0.2 MPa, the optimum duration of the HTP for the buckwheat grains of the buckwheat sort Krupynka is within 9-10 minutes, as

evidenced by the yield of the cereal-core in 227 g and cereals of 16 g (from 350 g of grain), which is 69.4% of the total yield of cereals.



Fig. 5. Dependence of the yield of cereal products after peeling of buckwheat grains of buckwheat Krupynka on the mode of HTP at P = 0.2 MPa

The ones shown in Fig. 5 graphics show that the best mode of HTP for peeling buckwheat grains buckwheat varieties Ukrainka is also equal to 10 minutes at a pressure P = 0.2 MPa. The conclusion is based on the mass of the resulting kernel in 229 grams, and 15 grams of cereals from 350 g of raw materials, which is 69.1% of the total yield of cereals.

#### CONCLUSIONS

We carried out experimental studies of the effect of the parameters of the HTP modes of buckwheat grains of varieties: Antalya, Oranta, Krupynka and Ukrainka on the total yield of cereals. As a result, it was established that the optimum duration of the HTP for the buckwheat grains tested is 9 ... 10 min., at a water vapor pressure in the HTP apparatus equal to P = 2.0 MPa.

Optimization of the HTP mode allows to increase the overall yield of buckwheat, on average, by 4.1 ... 5.1% compared to the existing technology.

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## ЭФФЕКТИВНОСТЬ РЕЖИМОВ ГИДРОТЕРМИЧЕСКОЙ ПЕРЕРАБОТКИ ЗЕРНА ГРЕЧИХИ ПРИ ПРОИЗВОДСТВЕ ЗЕРНОВЫХ

### Игорь Флис, Марян Макар, Владимир Янкив, Василий Томьюк

Аннотация. В статье представлены результаты экспериментальных исследований эффективности гидротермальной обработки (ГТО) зерен гречихи в процессе производства зерновых культур, выполненных по разработанному методу с использованием построенного и изготовленного лабораторного оборудования.

В ходе исследований общий выход зерновых продуктов определяли экспериментально после отслаивания зерен гречихи и сортировки полученной смеси в зависимости от режима гидротермической обработки.

В результате экспериментов на зернах гречихи, сортах Анталии, Оранты, Крупинки и Украинки было установлено, что оптимальная продолжительность гидротермической переработки сырья составляет 9 ... 10 мин при давлении водяного пара в аппарате ГТО P = 2,0 МПа. Применение обоснованного оптимального режима гидротермической переработки зерна гречихи позволяет увеличить общий урожай гречихи в среднем на 4.1 ... 5.1% по сравнению с существующей технологией.

Ключевые слова: зерно гречихи, гидротермальная переработка зерна, шелушение зерна, общий урожай зерновых.