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Wheat Sprout Grain Drying in Vacuum Drying Plants

Secado de grano de trigo germinado en plantas de secado al vacío

Natalya BUROVA 1; Nadezhda KISLITSINA 2; Faina GRYAZINA 3; Galina PASHKOVA 4; Vadim SMOLENTSEV 5; Margarita EVDOKIMOVA 6

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Content

ABSTRACT:

The technology of getting the sprout grain is known and popular enough in the whole world. The main disadvantage of using damp sprout grain for food is the possibility of their increased load with pathogenic microorganisms and impossibility to be transported to the long distances. The technology of vacuum drying of wheat sprout grain using the partial load modes allows getting a ready product with high process qualities and nutrition value. Sprouting is carried out in the vacuum drying plant at temperature of not more than 40 °C and atmosphere pressure. There are 3 drying modes in the chamber of vacuum drying plant with pressure of 15kPa, while heaters' temperature does not exceed 60 °C. Important points: 1. Sprouting of grain inside a drying plant with controlled parameters. 2. Drying occurs in three stages, the pressure is constant, the temperature of the heaters varies. 3. The drying temperature of the germinated grains does not exceed +50 °C, which preserves the high antioxidant activity of the finished product.
Keywords: wheat, sprout grain, vacuum drying, technology.

RESUMEN:

La tecnología para obtener el grano de brotes es conocida y popular en todo el mundo. La principal desventaja del uso de granos de brotes húmedos para la alimentación es la posibilidad de que aumente su carga con microorganismos patógenos e imposibilidad de ser transportado a largas distancias. La tecnología de secado al vacío del grano de trigo germinado utilizando los modos de carga parcial permite obtener un producto listo con altas calidades de proceso y valor nutricional. El brote se lleva a cabo en la planta de secado al vacío a una temperatura no superior a 40 °C y presión atmosférica. Hay 3 modos de secado en la cámara de la planta de secado al vacío con una presión de 15 kPa, mientras que la temperatura de los calentadores no supera los 60 °C. Puntos importantes: 1. Brotación de grano dentro de una planta de secado con parámetros controlados. 2. El secado se produce en tres etapas, la presión es constante, la temperatura de los calentadores varía. 3. La temperatura de secado de los granos germinados no excede los +50 °C, lo que preserva la alta actividad antioxidante del producto terminado.
Palabras clave: trigo, grano germinado, secado al vacío, tecnología.

1. Introduction

The provision of population with food products balanced in nutritional and vitamin composition is one of the main tasks. The technology of getting the sprout grain of different croppers is popular and known all around the world. The sprouting technology takes long enough time very often, thus, there is a great probability of developing pathogenic flora in the sprouted grain. Any cropper may be subjected to sprouting. The review of scientific researches of scientists of different countries has shown the usage of the sprouting technology and the subsequent vacuum drying for different croppers: brown rice, wheat for brewing, cereals, and bean cultures. Patricio J. Cáceresa, Elena Peñasb, Cristina Martinez-Villaluengab, Lourdes Amigoc, Juana Friasstudied brown rice sprouting and its subsequent sun drying. Sprouting raised GABA and terephthaloyl chloride content, as well as antioxidative activity. The research showed that sun-dried sprouted brown rice may be used for food after dehydration or included into bakery products to control noncontagious diseases.[1]

The scientists Mohammed Hefnia, Cornelia M. Witthöftb studied the influence of sprouting and drying on folate content in different grades of wheat and rye. They proved that folate content in rye is 25% higher than in wheat. Sprouting of both types of grains let to 4-6-fold increase in folate content depending on the grade and the duration of sprouting. Maximum folate content in both types of grains was discovered after 96 hours of sprouting. Wheat sprouting during 48 and 72 hours at 50 °C influenced folate content. That is why the sprouted grain may be recommended as an ingredient for bakery products with the increased folate content [2]. British scientists studied macroelement redistribution in the sprouting grain. They found out that magnesium, calcium, and potassium were redistributed from the aleuronic tissue into the green sprouts during grain sprouting.[3]

The scientists Thatchapol Chungcharoena, Somkiat Prachayawarakornb, Patcharee Tungtrakulc, Somchart Soponronnarita studied the influence of sprouting and drying on brown rice quality. The work mentioned that sprouting time and drying temperature were very important parameters influencing the quality of sprouted grain as amyloidal corpuscle microstructure was modified during sprouting. Experimental studies showed that sprouting time from 60 to 68 hours provided more densely packed amyloidal corpuscles. Longer sprouting led to deterioration of organoleptical properties of the product.[4]

Therefore, we may conclude that sprouting is a prospective technology for grains, and the subsequent drying will allow saving substances being received during sprouting unchanged.

2. Experiments and Methods

The laboratory of the Mari State University and the production spaces of Intech, LLC in Yoshkar-Ola (Mari El Republic, Russia) performed research concerning sprouting and the subsequent drying of sprouted wheat grain in the vacuum drying plant with infrared heating.

The research used the wheat grain of Kazanskaya 560 grade sprouted in the Mari El Republic which corresponds to the requirements of the State Standards of the Russian Federation. The research was carried out using the conventional and standard analysis methods. The scientists determined moisture content, sensory parameters, gluten quantity and quality, foreign impurities and foreign grain content in the original grain. The sprouted grain was used for defining total antioxidant capacity using the method developed by Research and Manufacturing Association “Chimavtomatika” on the instrument Tzvet-Yauza-01-AA, mass fractions of proteins, oils, and carbohydrates. Before trial establishment the grain was subjected to preprocessing. It was cleared of mineral and organic impurities by washing in running water. Metallomagnetic impurities were removed with the help of the magnet. Main controlled factor of damp sprouted grain was the existence of embryo root of not more than 5mm for 90% of grain. A series of trials for getting dry sprouted wheat grain was carried out in the vacuum drying plant with infrared heating VDSU-2M. The suitable parameters of drying the sprouted wheat grain were selected within the heaters' temperature range of 40-100 °C and the pressure of 15kPa inside the drying plant. Infrared heaters' temperature and the layer of sprouted wheat were controlled using copper resistive temperature transducer with cable selection DTS 014-50M.V.3.20/3 established on heaters and inside the grain layer. As for specifications, temperature measuring range was from -50°C to +150°C, error in measurement was ±0.25°C. The main reason of conservation method of sprouted grain involves the influence of different environmental factors, as well as pathogenic microorganisms' activity. One of the ways to remove the factors mentioned is sprouting and the subsequent drying inside the drying plant. There are some positive aspects in this moment:

Maximum possibility of avoiding the influence of external factors

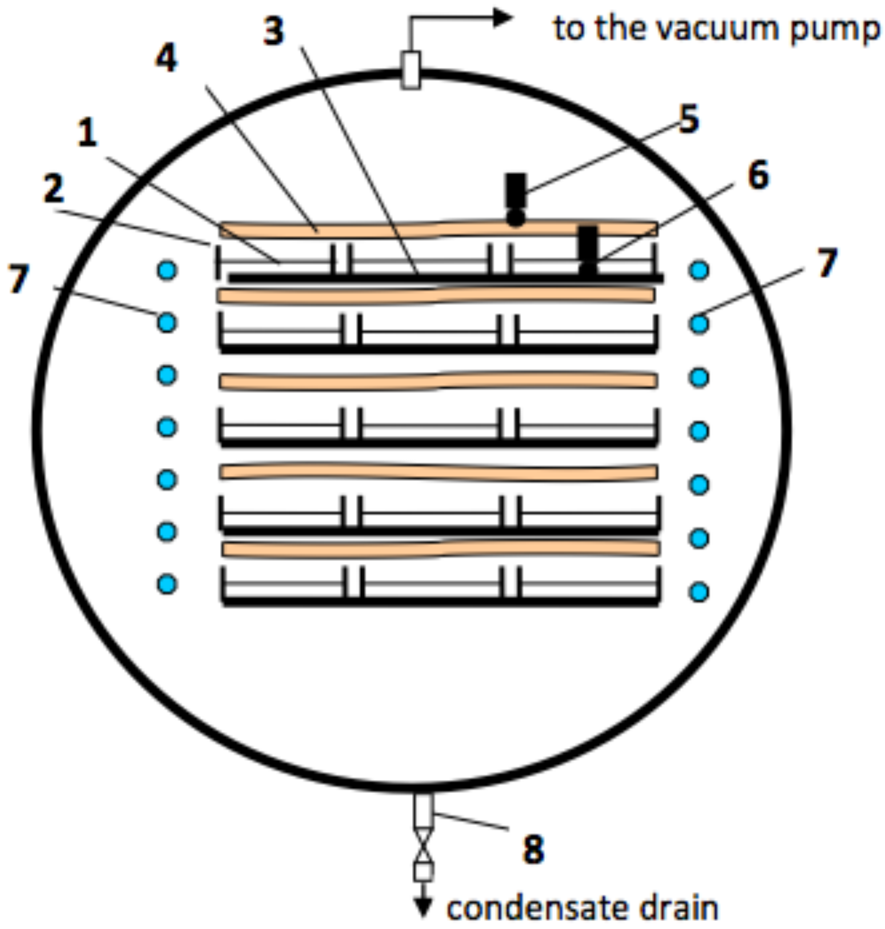
Avoiding microorganisms ingress from environment

Decrease of expenses for transportation by means of excluding one operation from the technical process.

Sprouting was carried out inside the drying chamber at the temperature of +40 °C and atmosphere pressure favourable for the vital processes in grain. 2cm layers of grain were located on the pans inside the drying chamber which was conditioned by the peculiarities of the drying plant. Then the grain was dowsed with pure drinking water and left for 24 hours. A series of trials for sprouting included 9 experiments. The controlled parameter was the existence of 3-5mm embryo root for 95% of grain. 24-hour period for sprouting was selected by using this method, at the same time temperature inside the grain layer did not exceeded 25-26°C. Then the grain was dried. When drying grain in the fixed layer the temperature of drying agent should not exceed the definite value. Basing on the data received by other scientists the researchers chose the parameters maintaining the temperature of grain mass of not more than +50°C, the pressure inside the drying chamber was 15kPa [5]. The use of the drying method consisted of 3 periods: period of material heatup, period of constant drying rate, and period of falling drying rate. When moving from period to period, grain mass moisture factors were changing, thus, grain sensibility to heating was increasing from period to period. In this technology zero degree limits of protein denaturation were basic ones, as dried sprouted grain should continue its growth during the subsequent sprouting, hence, it should stay 'sleeping' after drying.

The drying plant presented in Figure 1 was used for sprouting and drying.

Figure 1
The diagram of vacuum drying plant
with infrared transmitters VDSU-2M



Specifications of the drying plant VDSU -2M:

number of shelves – 14 pcs

number of pans loaded at the same time– 112 pcs

overall dimensions of pans – 35x440x540 mm

total loading of the drying chamber during grain drying – 150 kg

temperature of infrared heaters – from 30 to 120 ºC

pressure inside the drying chamber – from 15 to 20 kPa

total capacity – 15 kW.

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3. Discussion and Results

The process of wheat grain sprouting and drying was carried out in the vacuum drying plant VDSU -2M in the following way. Preliminary selected and washed wheat grain 1 was located on the shelves 3 inside the drying plant. The thickness of wheat grain layer was 2 cm. Then the grain was dowsed with pure drinking water; grain should have been totally covered with water. After 24 hours, when 90% of grain had the embryo root of not more than 5mm, the grain was dried. The next step was to establish 15kPa pressure inside the drying chamber. Sensors 5 and 6 were fixed on the heater 4 and inside the grain layer 1. Then the heating elements were switched on. During drying, water evaporating from the product was condensed on the condenser tubes 7 and poured by gravity into the lower sleeve 8, the leakproof closed drum. The studied process was divided into 3 stages: initial, main, and final.

At the initial stage the temperature inside the grain layer did not exceed 34 °C. By the final stage the temperature inside the grain layer had increased up to +40,7°C. Thus, the following process modes were received:

1st 3-hour stage, heaters' temperature of 80 °C

2nd 5-hour stage, heaters' temperature of 70°C

3rd 15- hour stage, heaters' temperature of 60°C

Total drying time did not exceed 24 hours. The executed organoleptic estimate of dry sprouted wheat grain has shown high quality of the proposed products. The index of total antioxidant capacity (TAC) was 37.0mg/100g in comparison with 17mg/100g in wheat grain before sprouting. Gluten in the sprouted grain did not come out, while mass fraction of crude gluten before sprouting was 20%. The fall decreased from 284 seconds down to 60 seconds after sprouting.

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4. Conclusions

The proposed technology of producing the dried sprouted wheat grain is unique due to its high consumer-oriented qualities of end product. The offered process parameters of sprouting and drying allow getting the qualitative food products with 2.1 times higher TOC in comparison with source raw material, as well as high organoleptic characteristics. Dried sprouted grain could be later soaked and used as a ready food product, or chapped and added into bakery and other types of products of food industry.

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1. Mari State University, Yoshkar-Ola, Russian Federation; E-mail: natsta@mail.ru

2. Mari State University, Yoshkar-Ola, Russian Federation

3. Mari State University, Yoshkar-Ola, Russian Federation

4. Mari State University, Yoshkar-Ola, Russian Federation

5. Mari State University, Yoshkar-Ola, Russian Federation

6. Mari State University, Yoshkar-Ola, Russian Federation
