[7] Seliutina, H. A. (2000). Vplyv deiakykh faktoriv na zberezhennia khlorofiliv pid chas pererobky. Part 1. Prohresyvni tekhnolohii ta udoskonalennia protsesiv kharchovykh vyrobnytstv, 244–248.
[8] Ermakov, V. A. (1986). Biokhimicheskie metody issledovaniya. Moscow: Nauka, 355.
[9] Pochinok, H. N. (1976). Methods of plants' biochemical analysis. Kyiv: Scientific Thought, 334.
[10] Dzhadd, D., Vyshetski, G. (1978). Svet v nauke i tekhnike. Moscow: Mir, 690.
[11] Reven' svezhiy: PCT URSR 299-89 [Vzamen RST USSR 299-80] (1989). Kyiv: Gosplan USSR, 6.

# RESEARCH INTO TECHNOLOGICAL INDICATORS OF A RYE-WHEAT DOUGH SEMI-FINISHED PRODUCT WITH THE ADDITION OF THE POLYFUNCTIONAL FOOD SUPPLEMENT "MAGNETOFOOD"

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**Abstract**

We studied influence of the polyfunctional food supplement "Magnetofood" on the technological parameters of rye-wheat dough semi-finished product and the finished product. A positive effect of the supplement "Magnetofood" on the technological parameters of dough and the bread baked using it, is shown. It was established that adding the food supplement “Magnetofood” in the amount of 0.15 % of the weight of flour reduces dough fermentation time by 13.0 on average %. The introduction of the food supplement “Magnetofood” also increases the yield of a dough semi-finished product by 2.9 % on average and improves the yield of the finished product by 3.45 % on average. It was revealed that the multifunctional food supplement “Magnetofood” enhances the quality of rye-wheat dough semi-finished product and the finished product due to its capacity of moisture retention and the inhibition of hydrolysis processes of the basic ingredients of dough.

The obtained experimental data could be used to develop a technology of rye-wheat bread, enriched with the polyfunctional food supplement “Magnetofood”.

**Keywords**: magnetofood, food supplement, technological indicators of rye-wheat dough semi-finished product.



**DOI: 10.21303/2504-5695.2017.00511**

## 1. Introduction

Bread baking technologies involve various technological techniques that are applied to create the required functional-technological properties of bread (increasing nutritional value and resistance to microbial spoilage; improving quality of the finished products; lengthening of the storage period, extending assortment, etc.) [1–5].

To enhance quality and improve the composition of rye-wheat bread, technologists in the baking industry widely employ various additives-improvers [6–10].

Information sources [1–13] reveal a lack of data about technologies of bread baking that utilize polyfunctional food supplements with a comprehensive effect, and, specifically, nanopowders, which improves technological indicators of dough semi-finished products and the products made from them.

The identified properties of the polyfunctional food supplement “Magnetofood” allow us to recommend it for the introduction to rye-wheat bread. The purpose of adding “Magnetofood” is the formation of new functional-technological properties of rye-wheat bread. “Magnetofood” is the nanopowder with a large specific and active surface [4–6].

## 2. Materials and Methods

### 2. 1. The examined materials and equipment used in the experiment

The object of present study is the technology of rye-wheat bread.

To study the effect of polyfunctional food supplement “Magnetofood” on rye-wheat bread, we used model systems. Hence follows the description of the experimental samples of rye-wheat dough and the bread made from it; as well as the equipment and techniques employed in the research.

**Fig. 1** shows experimental samples of the dough semi-finished products.

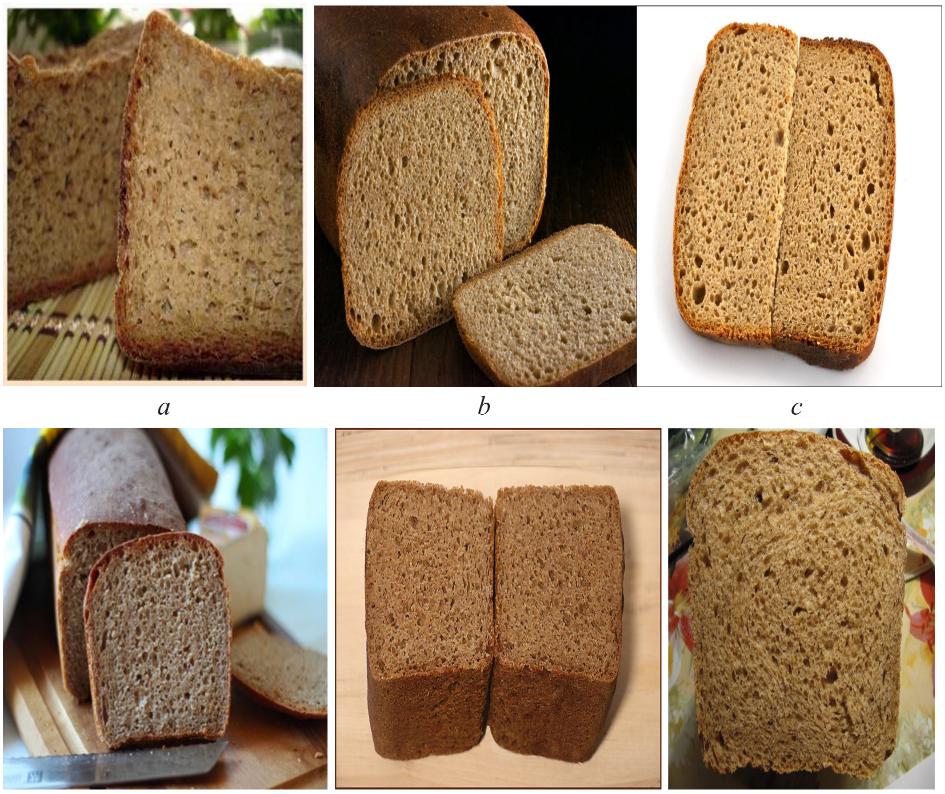
**Fig. 1, *a*** – sample 1, control, – rye-wheat dough semi-finished product, baked using flour of grade 1 and pressed yeast; **Fig. 1, *b*** – sample 2, rye-wheat dough semi-finished product, baked using flour of grade 1, pressed yeast, and the polyfunctional food supplement “Magnetofood” in the amount of 0.15 % by weight of flour, in the form of a powder; **Fig. 1, *c*** – sample 3, rye-wheat dough semi-finished product, baked using flour of grade 1, pressed yeast, and the polyfunctional food supplement “Magnetofood” in the form of oil-magnetofood suspension (OMS), in this case, OMS is introduced in the amount of 0.35 % by weight of flour; **Fig. 1, *d*** – sample 4, control, rye-wheat dough semi-finished product baked using flour of grade 2 (with short-tearing gluten), pressed yeast with reduced amylolytic activity; **Fig. 1, *e*** – sample 5, rye-wheat dough semi-finished product, baked using flour of grade 2 (with short-tearing gluten), pressed yeast with reduced amylolytic activity, and the polyfunctional food supplement “Magnetofood” in the amount of 0.15 % by weight of flour in the form of a powder; **Fig. 1, *f*** – sample 6, rye-wheat dough semi-finished product, baked using flour of grade 2 (with short-tearing gluten), pressed yeast with reduced amylolytic activity, and the polyfunctional food supplement “Magnetofood” in the form of an oil-magnetofood suspension (OMS), in this case, OMS is introduced in the amount of 0.35 % by mass of flour, **Fig. 1**.

*a* *b* *c*

*d* *e* *f*

**Fig. 1.** Experimental samples of wheat-rye dough: *a* –sample 1, control; *b* – sample 2; *c* – sample 3; *d* – sample 4, control; *e* – sample 5; *f* – sample 6

**Fig. 2** shows experimental samples of rye-wheat bread.



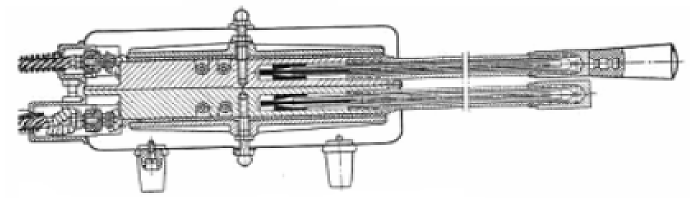
*a* *b* *c*

*d* *e* *f*

**Fig. 2.** Experimental samples of wheat-rye bread: *a* – sample 1, control; *b* – sample 2; *c* – sample 3; *d* – sample 4, control; *e* – sample 5; *f* – sample 6

**Fig. 3** shows instruments used in the study of dough and bread indicators.

*a* *b* *c* *d*



*e*

**Fig. 3.** Instruments used to study the indicators of dough and bread:
*a* – manual installation for titration; *b* – electronic analytical scale ANG;
*c* – thermal chamber UF55 Memmert; *d* – Zhuravlyov's device; *e* – device VNIIHP-VCh

The yield of dough and bread was determined using the electronic analytical scale of the series ANG (Ukraine); humidity of bread was determined in the thermal chamber UF55 Memmert (Germany), humidity of dough – using the device VNIIHP-VCh (Ukraine). Titrated acidity was determined using a manual installation for titration. Crumb porosity was determined using the Zhuravlyov's device.

**2. 2. Procedures for determining organoleptic, physical-chemical, structural-mechanical and technological indicators**

We employed standard research methods to conduct the experiment, which are described below [10–15].

The quality of rye-wheat bread was assessed by the organoleptic method [GOST 52961-2008, and DSTU-P 4583:2006]. Tasting board assessed it using a five-point scale, taking into consideration a significance factor for each indicator: physical appearance: shape, surface condition, color; condition of crumb: baking quality, mixture, porosity; taste; smell.

The tasting assessment was conducted using compiled tables in which each quality indicator is matched to its characteristic [10–12].

According to the requirements of normative and technical documents, the main physical-chemical quality indicators of bakery products are crumb humidity, acidity, porosity, bread yield determination [10].

We determined humidity by the standard accelerated method in line with GOST 21094-75. The essence of the method is the drying of the batch of shredded crumb at a certain temperature and humidity determination [10, 11]. We determined acidity of the bakery products by a titrimetric method in line with GOST 5670-96 [10, 11]. Porosity was determined by the standard method in accordance with GOST 5669-96 using the Zhuravlyov's device [10, 11].

The yield of bread (OFP, %) was determined as the difference in weight of the starting half-finished product and the finished product using a procedure developed by G. Yu. Botasheva [15].

One of the main stages in breadmaking is the kneading of dough. The kneading of dough is carried out in the dough mixing machines in order to obtain a formulation from the components that ensures the dough that is homogeneous in mass and structure.

Following the kneading, dough undergoes *fermentation*. Fermentation is performed to obtain dough with optimal organoleptic and rheological properties. Dough acquires these properties as a result of alcohol and lactic acid fermentation caused by yeast cells and lactic acid bacteria.

*Dough fermentation.* The kneaded dough is placed in a fermentation container, which is taken to the thermostat. The thermostat maintains a temperature of 35 °C while relative air humidity is 80‒85 %. If the fermentation proceeds without humidification of air, then the dough is covered with a wet cloth so that there is no crust formation. Duration of holding-fermentation of dough is approximately 30 minutes. *Handling the dough*. After a 30-minute holding-fermentation, a piece of dough is formed manually on the table, thereby giving it the shape. The dough piece is placed into a metallic mold greased with oil. The mold with the dough is taken to the thermostat (temperature 35 °C, $W_{rel.}$=80 %). The duration of holding depends on many factors and is not regulated. Thus, its duration is affected by the moisture content and temperature of dough; the weight of dough pieces; the presence of sugar and fat in the formulation, as well as improvers with oxidation effect; the grade of flour; the strength of flour; the temperature in the defreezer. The end of holding is determined by the organoleptic method – by the condition and physical appearance of dough pieces, not allowing them to fall. The mass and resulting acidity is determined; the losses during fermentation are derived from formula (1):

$$B_{fer} = (M_{t.\,b.\,before\,fer.} - M_{t.\,b.\,after\,fer.}) / M_{t.\,b.\,before\,fer} \quad (1)$$

where $B_{fer}$ are the losses during fermentation, arbitrary units; $M_{t.\,b.\,before\,fer}$ is the mass of a dough piece prior to fermentation, g; $M_{t.\,b.\,after\,fer}$ is the mass of a dough piece after fermentation, g.

Control over dough fermentation is carried out by the organoleptic parameters (flavor, structure, volume rise, taste), moisture content, and acidity. Quality of the prepared bread depends on the quality of dough [3, 13].

*Organoleptic assessment of the dough semi-finished product.*

To assess a semi-finished product for organoleptic indicators, its entire mass is examined. The quality of a liquid semi-finished product and dough is assessed by the organoleptic method for the following indicators:

– condition of the surface (convex, flat, settled, crusted, with a fine grid etc.);
– degree of rise and looseness; consistency (weak, strong, normal) and mixing;
– degree of “dryness” (wet, dry, smear, sticky, slimy);
– taste, color, flavor.

The readiness of thick dough is judged by its surface setting. Under normal fermentation, dough would have a convex surface, under abnormal ‒ flat.

Tangible, visible to the eye (in the form of small droplets) moisture content of dough testifies to its defects. Under normal course of fermentation dough should be well loosened and have a netted structure (observed when it is rolled out manually), smell of dough – strong alcohol.

We calculated the *yield of dough* from formula (2) [13]:

$$B_{dough} = (M_{dough} / M_{flour}) \cdot 100\ \%, \quad (2)$$

where $B_{dough}$ is the yield of dough, %; $M_{dough}$ is the weight of dough after kneading, g; $M_{flour}$ is the weight of flour, taken to knead the dough, g.

*Determination of dough moisture content.* Moisture content of dough $W_{dough}$ was determined immediately after the kneading by express method of drying at a temperature of 160 °C in the device VNIIHP-VCh using the following technique [3]: two batches of dough 5 g each are weighed on analytical scale to accuracy 0.001 g. These batches are dried in the device VNIIHP-VCh for 5 minutes and cooled in desiccator for 1–2 minutes. Next, they are weighed again on analytical scale to accuracy 0.001 g. $W_{dough}$ is calculated by a difference in the mass of dough before and after its drying (by dry residual) from formula (3):

$$W_{dough} = (M_1 - M_2)/M_1 \cdot 100\ \%, \quad (3)$$

where $W_{dough}$ is the dough moisture content, %; $M_1$ is the mass of the batch of dough prior to drying, g; $M_2$ is the mass of the batche of dough after drying, g.

*Determination of titrated acidity of dough.* Titrated acidity is an important indicator that characterizes dough quality. The rise in titrated acidity indicates the way the process occurred in a given phase (concerning temperature conditions and duration), which is important to establish dough readiness. Titrated acidity is the objective indicator of dough readiness to processing.

The magnitude of titrated acidity of the prepared dough indicates the acidity of bread baked from this dough (formula (4)):

$$K_{bread} = K_{dough} + (0,5 - 1) \quad (4)$$

*Procedure for determining titrated acidity* implies the following. 5 g of dough is weighed on a technical balance. The batch is placed in a porcelain mortar and ground with 50 ml of distilled water. First, by adding water by drops, the batch of dough is brought to the state of suspension, then the remaining water is added. Three-five drops of 1 % alcohol solution of phenolphthalein are added. The resulting nutrient mixture is titrated with 0.1 n solution of NaON until pale pink coloration that persists for a minute. The acidity is calculated from formula (5):

$$X_{dough} = 2\alpha K, \quad (5)$$

$X_{dough}$ – where α is the amount of NaOH solution consumed for titration, ml; K is the correction factor to alkali titer.

Upon completion of the procedure, the mold with dough is put into oven. The baking of rye-wheat bread was carried out at a temperature of 200–240 °C for 55–57 minutes [SOU 15.8-37-00032744-004:2005; 16].

Cooling and storing bread after baking was carried out under conditions of a bread-storer at a relative air humidity of 70–75 % [16–19].

**3. Results**

The methods of research considered in chapter 2 might have practical application when studying functional-technological characteristics of dough semi-finished products and the products made from them.

It was established that the introduction of the polyfunctional food supplement "Magnetofood" contributes to the reduction of time of rye-wheat dough fermentation by 13.0 % on average [20, 21]. This is related to the activating properties of the food supplement "Magnetofood", which leads to a reduction in the duration of dough fermentation, as well as decreases temperature and brings down losses during fermentation process.

The introduction of the polyfunctional food supplement "Magnetofood" contributes to an increase in the yield of rye-wheat dough semi-finished product and the finished product all experimental samples by 2.9 % and 3.45 % on average, respectively [21]. It is associated with the moisture-retaining capacity and complex-formation properties of the food supplement "Magnetofood", which contributes to maintaining the required humidity of dough.

The obtained experimental data could be used in the development of technology of rye-wheat bread, enriched with the food supplement "Magnetofood".

**4. Conclusions**

1. The techniques for studying dough semi-finished product and bread, reported in the present paper, could be used for examining the effect of different supplements, improvers, technologi-

cal methods, etc., on the functional-technological characteristics of the rye-wheat dough semi-finished product and the bread baked from it.

Applying the considered techniques, scientists in the future will be able to better explore the impact of various dietary supplements with a comprehensive effect on the yield of dough semi-finished and finished products; to examine in more detail the duration of fermentation of various dough semi-finished products.

The shortcoming of present work is that the action of the proposed techniques was considered only for one kind of a dough semi-finished product, the rye-wheat, with the effect of only one food supplement, the polyfunctional food supplement "Magnetofood" on a given semi-finished product. It also remains unknown in what way this supplement would affect technological indicators of dough semi-finished products with other formulation composition (from other kinds and varieties of flour).

The positive side is that the research methods proposed in the present study could be employed to investigate functional-technological characteristics of not only of the rye-wheat dough semi-finished and finished products, but rye, wheat, etc. as well.

Moreover, research results could be proposed for using in the technological process of rye-wheat bread baking with the addition of the polyfunctional food supplement "Magnetofood".

**References**

[1] Shijkina, Ye. (2007). Components for improvement of quality of bakery and flour confectionery products (Bargus). Khleboproducty, 12, 40–43.

[2] Nilova, L. P. (2013). Tovarovedenie i ekspertiza zernomuchnyh tovarov. Moscow: INFRA-M, 448.

[3] Lichko, N. M. (2000). Tehnologiia hlebopekarnogo proizvodstva. Moscow: Kolos, 552.

[4] Iliuha, N., Barsova, Z., Tsihanovskaia, I., Kovalenko, V. (2010). Tehnologiia proizvodstva i pokazateli kachestva pishchevoi dobavki na osnove magnetita. Eastern-European Journal of Enterprise Technologies, 6 (10 (48)), 32–35. Available at: http://journals.uran.ua/eejet/article/view/5847

[5] Koniushenko, I. S., Barsova, Z. V., Tsykhanovska, I. V. (2011). Syntez, fizyko-khimichni doslidzhennia i biolohichna diia mahnetytu na obiektakh in vivo. Zbirka tez dopovidei naukovo-praktychnoi konferentsii Vseukrainskyi konkurs studentskykh naukovykh robit za napriamkom «Khimichna tekhnolohiia ta inzheneriia». Donetsk: Donetsk National Technical University, 54–57.

[6] Tsykhanovska, I., Barsova, Z., Demidov, I., Pavlotskaya, L. (2015). Investigation of the oxidative and thermal transformations processes in the system «oil – lipids – magnetite suspension». Progressive engineering and technology of food production enterprises, catering business and trade, 1 (21), 353–362.

[7] Drobot, V. I. (2008). Ispolzovanie netraditsionnogo syria v hlebopekarnoi promyshlennosti. Kyiv: Urozhai, 152.

[8] Chugunova, O. V., Pastushkova, E. V. (2015). Modeling of organoleptic indicators of bread with plant supplements. Bulletin of the South Ural State University. Series Food and Biotechnology, 3 (4), 80–87. doi: 10.14529/food150411

[9] Tamazova, S. U., Lisovoy, V. V., Pershakova, T. V., Kasimirova, M. A. (2016). Food supplements based on vegetable raw materials in the production of baked goods and pastries. Polythematic Online Scientific Journal of Kuban State Agrarian University, 122 (08), 1–18. doi: 10.21515/1990-4665-122-076

[10] Roslyakov, Y. F., Vershinin, O. L., Gonchar, V. V. (2016). Scientific development for the baking and confectionery industry. Tehnologii pishchevoi i pererabatyvaiushchei promyshlennosti APK-produkty zdorovogo pitaniia, 6, 42–47.

[11] Translation from English: Wolszanski, I. et al.; In: Namestnikov, A. F. (1974). Metody analiza pishchevyh, sel'skohoziaistvennyh produktov i meditsinskih preparatov. Moscow: Pishchevaia promyshlennost, 743.

[12] Koriachkina, S. Ya., Berezina, N. A., Hmeleva, E. V. (2010). Metody issledovaniia kachestva hlebobulochnyh izdelii: uchebno-metodicheskoe posobie dlia vuzov. Orel: OrelSTU, 166.

[13] Kasymova, Ch. K. (2012). Laboratornyi praktikum po kursu «Tehnologiia hleba, konditerskih i makaronnyh izdelii». Bishkek: Kyrgyz State Technical University named after I. Razzakov, 48.

[14] Romanov, A. S., Davydenko, N. I., Shatniuk, L. N. et al. (2005). Ekspertiza hleba i hlebobulochnyh izdelii, kachestvo i bezopasnost. Novosibirsk: Siberian University Publishing House, 278.

[15] Botasheva, G. Yu. (2013). Tehnologiia proizvodstva hlebobulochnyh izdelii. Cherkessk: North Caucasian State Humanitarian and Technological Academy, 43.

[16] Ershov, P. S. (2004). Sbornik retseptur na hleb i hlebobulochnye izdeliia. St. Petersburg: Profi-inform, 190.

[17] Yevlash, V. V., Pohozhykh, M. I., Niemirich, O. V., Vinnikova, V. O. (10.10.2007). Method for production of spice-cakes «badiorist». Patent of Ukraine No. 26696 U, MPK7 A21D13/08. Appl. No. u200700379. Filed 15.01.2007. Bull. No. 16, 5.

[18] Yevlash, V. V., Niemirich, O. V., Vinnikova, V. O. (2008). Tekhnolohiia khliba zhytno-pshenychnoho, shcho zbahachenyi na hemove zalizo, ta otsinka yakosti (pochatok). Khlebopekarskoe i konditerskoe delo, 1, 48–51.

[19] Yevlash, V. V., Niemirich, O. V., Vinnikova, V. O. (2008). Tekhnolohiia khliba zhytno-pshenychnoho, shcho zbahachenyi na hemove zalizo, ta otsinka yakosti (zakinchennia). Khlebopekarskoe i konditerskoe delo, 2, 48–50.

[20] Tsykhanovska, I., Evlash, V., Alexandrov, A., Svidlo, K., Gontar, T. (2017). Influence of the polyfunctional food supplement «Magnetofood» on the quality of the wheat-rye bread «Kharkiv Rodnichok» in the storage process. Eastern-European Journal of Enterprise Technologies, 5 (11 (89)), 61–70. doi: 10.15587/1729-4061.2017.111522

[21] Tsykhanovska, I., Evlash, V., Alexandrov, A., Svidlo, K., Gontar, T. (2017). Research quality of the wheat-rye bread with addition of the polyfunctional food supplement «Magnetofood». EUREKA: Life Sciences, 5, 45–52. doi: 10.21303/2504-5695.2017.0043