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1. FOOD SCIENCE AND TECHNOLOGIES

NEW OPORTUNITIES FOR THE USE OF HEMP PRODUCTS IN BREADMAKING

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Abstract. *An important factor of increasing the competitiveness of the enterprise and intensification of processing is innovation. That is why solving issues related to the development and implementation of new technologies is an important task. The work is aimed to study the possibility of using various hemp products in the technology of low moisture bakery products, such as bread sticks. The results of the work have showed the rationality of using 10% of hemp seeds, flour and bran in recipe of breadsticks to increase the nutritional and biological value with a minor change in quality of finished products. In addition, it was noted that the use of hemp seeds to a lesser extent affects the physical and chemical indexes of the quality of both dough and breadsticks.*

Keywords: *breadmaking, hemp products, wheat dough, technological properties*

I. INTRODUCTION

In the modern world, there is a significant acceleration in the pace of scientific and technological development, leading to an increase in the rate of renewal of the range and technologies. Innovation is an important factor in increasing the competitiveness of an enterprise, its products and intensification of production. That is why, solving issues related to the development and implementation of new technologies is an important task.

The number of traditional bakery products is decreasing, and part of the products of the "health" group is increasing due to the growing demand for it, in addition, in Ukraine, the share of production and consumption of bakery products with low moisture content, such as breadsticks, crackers, etc., in the category «healthy food».

Local non-traditional raw materials and products that are by-products of the food industry are widely used in the production of bakery products. These can be legumes, oilseeds, and various types of alternatieve types of flour from seeds, roots and other plant parts.

Since bakery products have been around for thousands of years and are still a central component of population's diet, enriching them with a variety of nutrients, protective and functional compounds is considered an effective strategy for their renewal. Modern consumers want to see bakery products with a low glycemic index and fat content, without sugar in the recipe, the protein component must be balanced, with a high content of dietary fiber, vitamins, minerals and plant biologically active components. Such a traditional culture for Ukraine as hemp can be an effective means to solve most of these problems.

The ultimate goal of bakery production is the preparation of high-quality products with good consumer properties, physical and chemical characteristics, balanced composition in terms of nutritional value, good digestibility and be

appropriate to medical and biological requirements. Achieving this goal is based on the develompent of optimal parameters during each technological stage; regulation of a complex of processes that the structural components of raw materials and semi-finished products going through; ensuring the vital activity of the microflora of semi-finished products and dough. The breadmaking technology is based on the vital processes of the microflora of flour and semi-finished products: baker's yeast, lactic acid bacteria, as well as other types of microorganisms that provide loosening of the dough due to the release of carbon dioxide, saturation of the liquid phase of the dough with dissolved carbonic acid, an increase in the total and active acidity of semi-finished products, accumulation of in the dough of specific substances that form the taste and aroma of finished bread.

II. LITERATURE ANALYSIS

Industrial hemp is a non-psychotropic strain of the plant species Cannabis sativa, which is grown specifically for the industrial use of its derivatives. Technical hemp is now grown in at least 47 countries. China processes 70% of world production and is the world's leading producer of hemp. Today, Europe is estimated to produce about a quarter of the world's cannabis harvest, but historically the continent has been a world leader. At the present stage of development of hemp cultivation in Ukraine is undergoing processes of transformation to market conditions and is undergoing a period of formation, which is associated with an increase in the area under industrial hemp cultivation. Most industrial hemp is grown for fiber and seeds. Over the past six years, the number of cannabis plants in Ukraine has increased tenfold. This trend gives reason to count on the necessary raw material base in the case of technical hemp and products of their processing in the food industry.

Hemp processing products are a source of a number of nutrients: protein and essential amino acids, unsaturated fatty acids, vitamins, mineral compounds, natural food sorbents [1-4]

Fig. 1. Unhullted hemp seed

Currently, it is difficult to obtain data on the actual number of hemp producers, as in some country’s issues of legality or public perception prevent the availability of such information, however, at least 26 countries allow commercial cultivation of cannabis. And the commercial interest in the production of this crop is expressed in the current potential of industrial production of hemp, but so far this trend is most active in Europe.

Nevertheless, the market of technical hemp and its processed products in Ukraine is at a low level of development. Despite the prospects of this direction, its development is hindered by such factors as the lack of processing plants, established sales markets, consumer culture, as well as legal restrictions.

Ukrainian producers of technical hemp at the moment can only work with seeds and trusts (hemp straw), with the most expensive raw materials of technical hemp - leaves and inflorescences - they cannot work because of the prohibition.

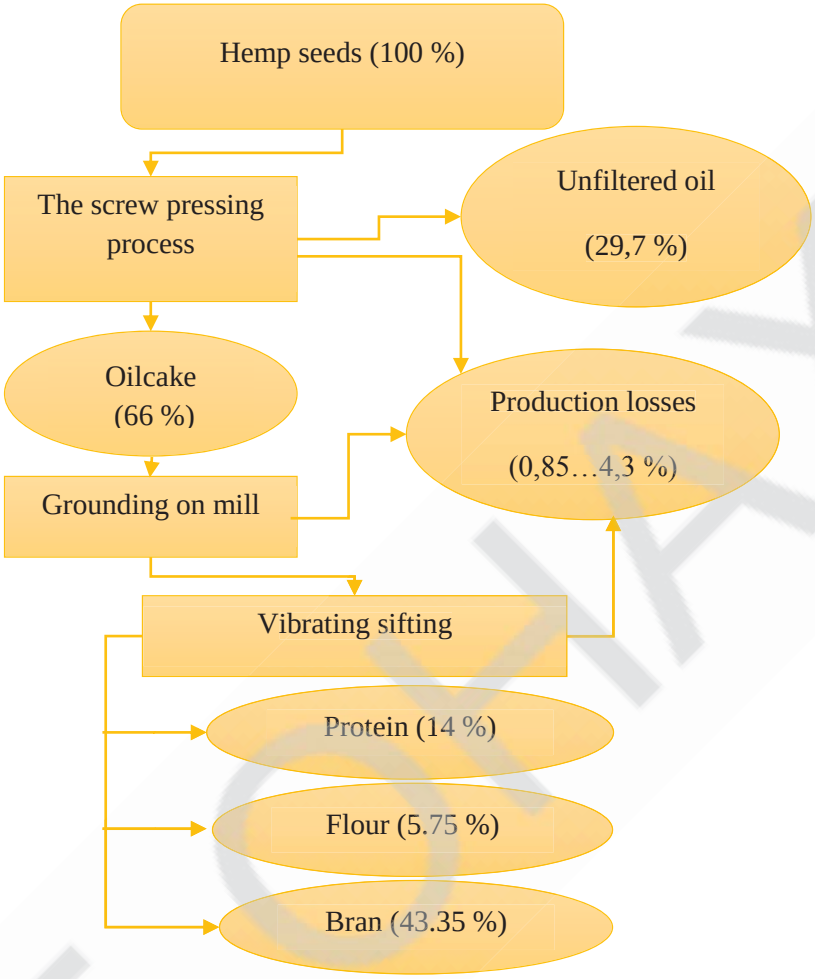

Fig. 2. Scheme of hemp seeds processing

In recent years, more and more attention is paid to the use of different hemp products such as hemp oil, which is a source of biologically active components, namely, essential amino acids, dietary fiber, antioxidants and proteins [5,6]. After squeezing the oil from the hemp seeds, a cake remains, from which loose hemp products, flour, "protein" and bran are obtained [7]. The percentage of protein absorption in hemp flour is 90.8 - 97.5% [8-9]. The high content of dietary fiber (10.4%) in hemp flour helps to remove heavy metals and radionuclides from the human body, lower cholesterol levels; improving intestinal motility; reducing the risk of diabetes, atherosclerosis and coronary heart disease. Also, hemp flour is rich in B vitamins (B1, B2, B3 and B6), E and minerals (Phosphorus, Calcium, Magnesium, etc.). The fat content in hemp flour is 7.9-10.2%.

According to the data [3], hemp seeds have a unique protein composition. It is known that essential amino acids include: valine, isoleucine, leucine, lysine, methionine, threonine, tryptophan, phenylalanine, all of which are present in the seeds and products of hemp processing [1-4].

Hemp seed meal is rich in protein and energy [10]. Hemp seed protein contains a

large number of sulfur-containing amino acids and very high levels of arginine and glutamic acid. In its digestibility, hemp flour is equivalent to heat treatment of canola flour. Some examples of animal cannabis feeds have been reported [11].

Speaking of chemical composition, we would like to consider in more detail polyunsaturated fatty acids (PUFAs), which hemp products contains. In the composition of hemp products are present in the optimal ratio (1:3) polyunsaturated fatty acids Omega-3 and Omega-6, which have a positive effect on the functional state of the nervous, cardiovascular, digestive, endocrine and reproductive systems [12].

So, all in all, despite the significant content of the obtained results, the potential use of hemp raw materials with bioactive compounds is insufficiently disclosed in the case of its use in the production of long-term bakery products. Due to their long shelf life, this group of goods can be considered as imported and promote Ukrainian products in both European and world food markets.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

Hemp flour, seeds and bran were made by «Richoil» company and certificated of standard for organic production and processing equivalent to Council Regulations (EU).

The intensity of gas formation in the dough was measured by AG-1M. This method is based on determining the amount of carbon dioxide formed during the dough fermentation by the volumetric method [13]. To Measure total titratable acidity the sample was grated and mixed with lukewarm (40°C) water and filtered. The filtrate is titrated against 0.1M NaOH with phenolphthalein as the indicator according to DSTU 7045:2009 and express in ml NaOH.

The model breadsticks samples were made following the recipe in table 1.

Table 1. Recipe of breadsticks

Ingredients	**Control sample**	**10% of hemp flour**	**10% of hemp seeds**	**10% of hemp bran**
Wheat flour, g	100.0	90.0	90.0	90.0
Hemp flour, g	-	10.0	-	-
Hemp seeds, g	-	-	10.0	-
Hemp bran, g	-	-	-	10
Baking yeast, g	5.0	5.0	5.0	5.0
Margarine, g	2.0	2.0	2.0	2.0
Olive oil, g	5.5	5.5	5.5	5.5
Salt, g	2.0	2.0	2.0	2.0
Water, g	according to water absorption of blend			

The dough was kneaded in the kneading machines with periodic action from wheat flour with addition of hemp flour, seeds and bran 10 % and other igredients, that are shown in Table 1 during 10 min. Temperature after the kneading was 26-28°C, moisture content - 32±1 %, dough fermentation – 60 min at 32±1°C. Formation of breadstick before proofing included the following operations: rolling the dough into strips 12 mm wide; cutting the dough strip lengthwise with the simultaneous formation

of 200 mm test bundles. Proofing parameters were: temperature - 40°C, relative humidity – 85%, duration - 15 minutes. The breadsticks have been baked on the sheets in the oven at 220°C for 13 minutes.

Determination of porosity is carried out as follows: a piece (slice) of semi-finished product with a width of at least 7-8 cm is cut from the middle of the product sample. It have been investigated according to DCTU 7045:2009.

Sensory characteristics were evaluated by 20 persons (both males and females), who had experience in sensory evaluation, there were 6 parameters all panelists assess them by 10-point scale. The water absorption capacity of breadsticks was determined by measuring the water absorption when it submerged in water at a temperature of 60°C for a set amount of time. Determination of moisture content in the breadsticks was made according to ISO 712:2009 «Cereals and cereal products - Determination of moisture content».

Mathematical processing of the experimental data was performed using the program MATSTAT.

IV. RESULTS

The gas-forming ability of flour is of great importance in the manufacture of bread products that do not contain sugar. Indicators predict the intensity of dough fermentation, increase in volume, the course of aging, porosity, color of the crust. Due to this, you can set the optimal parameters of the technological process of manufacturing products: the fermentation temperature of the dough, the shelf life, the baking temperature. The obtained data of intensity of alcoholic fermentation is shown on fig.3

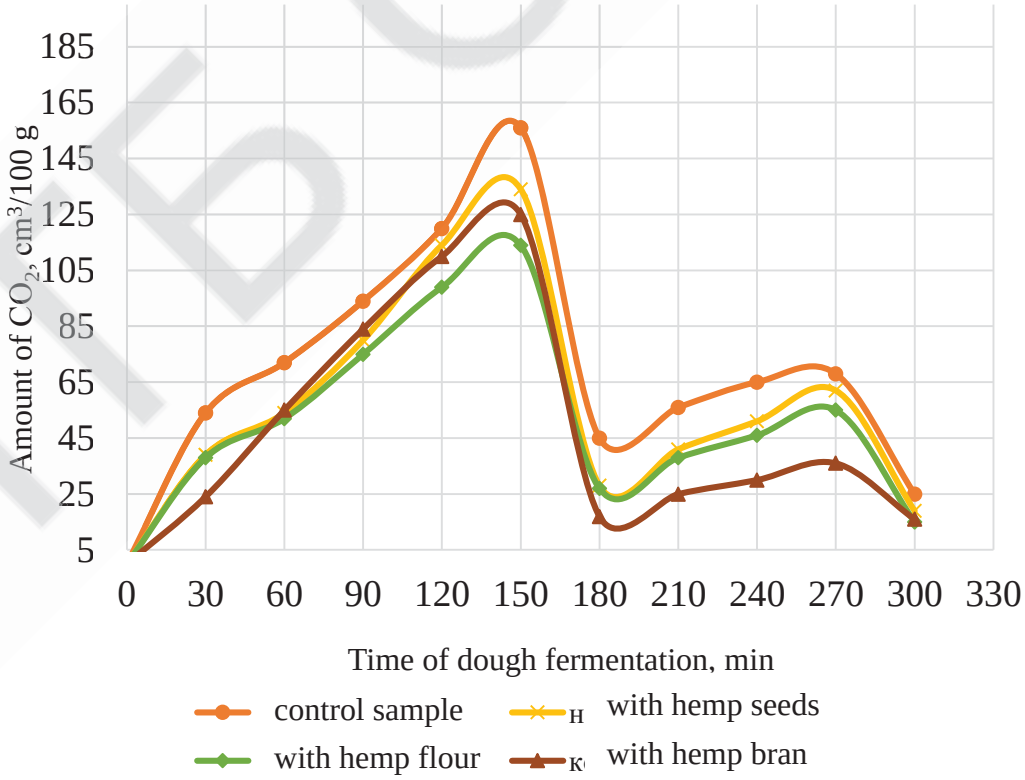

Fig. 3. Carbon dioxide producing during fermentation

Macronutrients (potassium, sodium, phosphorus, magnesium, calcium) play an important role in the nutrition of yeast. It is established that the increase of sodium ions in the nutrient mixture leads to the activation of the processes of synthesis of intracellular substances and stimulation of yeast growth, and sodium is a regulator of the osmotic pressure of the cell. Magnesium stimulates the action of almost all important enzymes in the cell. Lack of magnesium in the environment leads to a decrease in the buoyancy of the yeast. The main energy component of yeast biosynthesis is phosphorus. Its presence in the nutrient mixture in sufficient quantities is a prerequisite for the active functioning of cells. Potassium stimulates the penetration of inorganic phosphorus into the cell. That is, an increase in minerals in the fashion environment leads to an increase in the total amount of carbon dioxide formed.

The rational course of the technological process depends on the initial quality of yeast, their ability to adapt to anaerobic living conditions in flour semi-finished products, the activity of not only zymase complex, but also maltase. Therefore, it was advisable to investigate the effect of the state of the carbohydrate-amylase complex of flour on the intensity of fermentation in the semi-finished product. It is known that the conditions of yeast cultivation in yeast plants contribute to the formation in yeast of the active enzyme zymase complex, as well as the enzyme β-fructofuranosidase. There are no conditions for the accumulation of the enzyme α-glucosidase, which is activated in the presence of maltose in the environment.

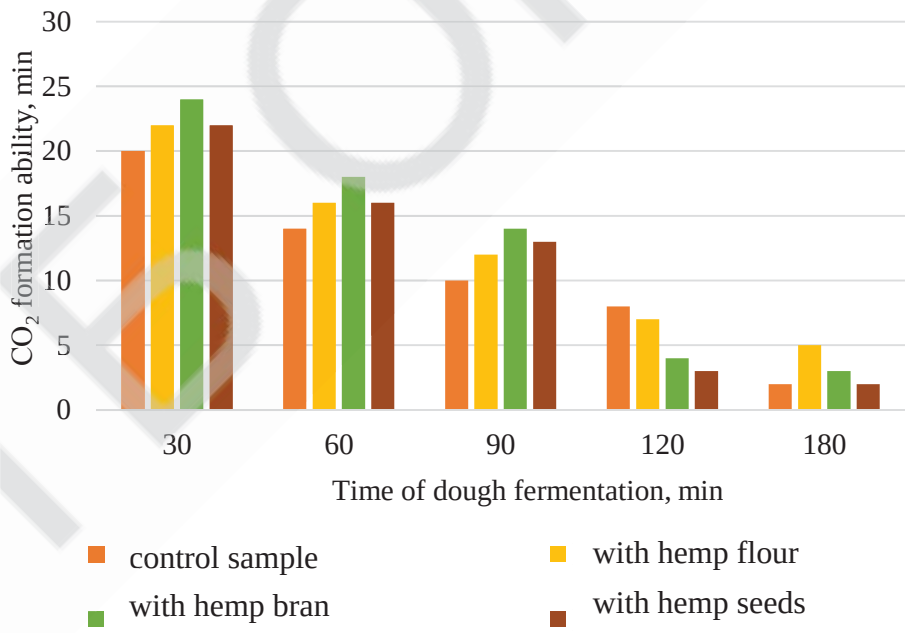

Fig. 4. CO_2 formation ability

Thus, the results of the analysis of the lifting force of compressed yeast allowed us to conclude that they affect the activity of yeast cells, slowing down the fermentation process with increasing duration. During the maturation of the dough, in addition to alcoholic fermentation, lactic acid and other types of fermentation take place in parallel and accumulation of flavoring and aromatic substances. The rate of increase in acidity

is influenced not only by temperature, but also directly by the composition of prescription ingredients. The change of acidity is very important for the process of dough formation, because with its growth the processes of swelling and peptization of protein substances of the dough accelerate. The taste and aroma of bread are also due to the accumulation in the dough of acids and products of their interaction and other constituent substances.

Along with alcoholic fermentation in semi-finished products of bakery production, other types of fermentation are carried out to varying degrees, the causative agents of which are microorganisms present in flour or additional raw materials

Lactic acid bacteria are more demanding of nutrients than yeast, for their growth requires almost all amino acids, purines, pyrimidines, vitamins. As a carbohydrate diet, they can use mono- and disaccharides, organic acids [14]. The increase in the intensity of acid accumulation in the experimental samples, apparently, is due to the content in hop extracts of biogenic and oligobiogenic elements, which largely meet the needs of lactic acid bacteria.

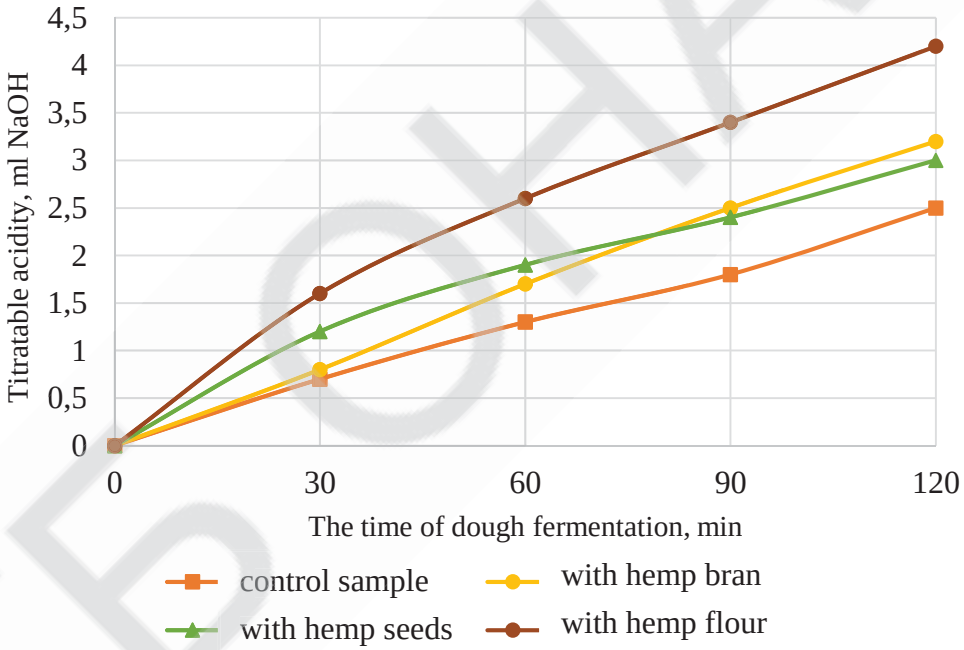

Fig. 5. Titratable acidity of dough

The consumer primarily pays attention to sensory characteristics such as appearance, taste and aroma. Thus, the second stage of the work was to determine the influence of the hemp products on the organoleptic and physicochemical indicators of breadsticks. The results of baking found that using hemp products reduced the baked goods score. Breadsticks were very fragile, with a less loosened structure, characterized by insipid, insufficiently expressed taste, odor and organoleptic parameters were assessed at 10 points scale. A graphic representation of the results of the analysis is shown as profillograms of breadsticks in Fig. 6.

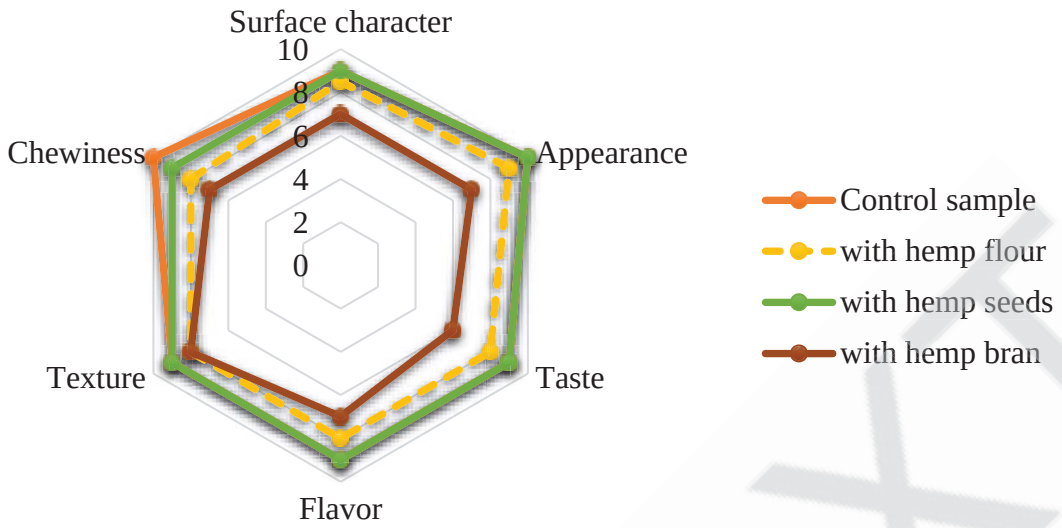

Fig. 6. Profillograms of breadsticks

According to the results of the analysis of profillograms, it was revealed that the sample with hemp seeds was characterized by an assessment of "excellent". Breadsticks with hemp bran were defined as "satisfactory". Samples with the hemp flour were rated as “good”.

Table 2. The chemical and physical properties of semi-finished product and breadsticks

Index	Control sample	Sample with hemp flour	Sample with hemp seeds	Sample with hemp bran
Semi-finished product for breadsticks				
Porosity, %	68.00	63.00	65.00	62.0
Ability to hold shape, H/D	3.25	2.95	2.57	2.8
Titratable acidity, °H	3.0	4.5	3.5	3.5
Quantity of crumbs, %	9.80	9.20	8.50	9.5
Breadsticks				
Moisture content, %	13.0	13.5	14.5	13.0
Titratable acidity, °H	2.5	4.3	3.0	3.2
Ability to water absorbtion, min	2.00	3.50	2.50	4.0
Hardness, units	9.00	9.00	9.00	9.00

Nutritional value - a concept that reflects the full range of useful properties of a food product, including the degree of provision of human physiological needs for essential nutrients, energy and organoleptic properties [15]. It is characterized by the chemical composition of the food product, taking into account its consumption in the conventional amount

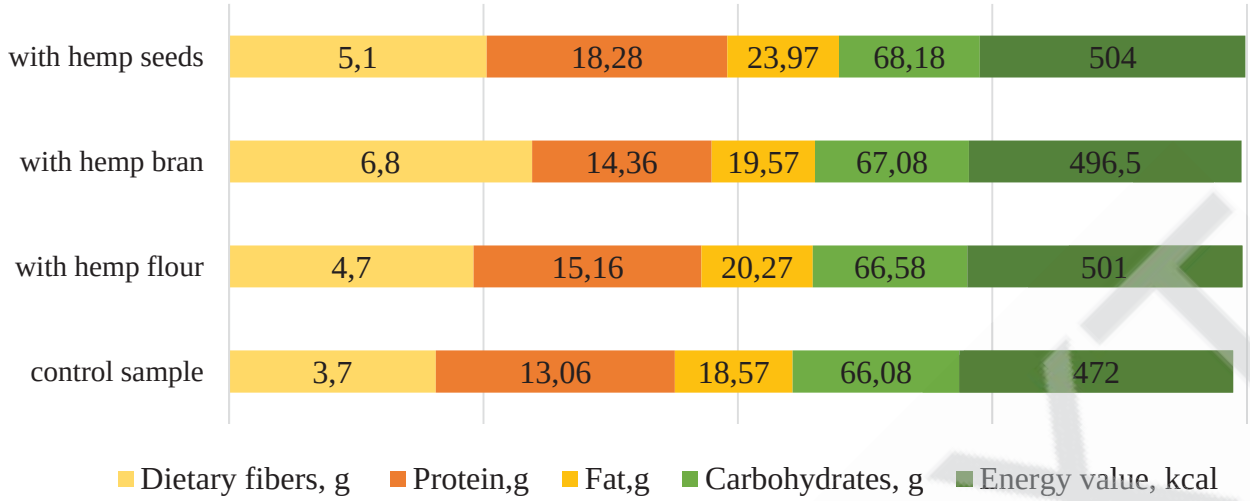

Fig. 7. Calculated nutritional value of breadsticks

Dietary fiber is important for human health: it normalizes intestinal motor function, regulates carbohydrate metabolism, adsorbs cholesterol and toxins. The norm of consumption of dietary fiber for an adult is 20-30 g per day. So eating of 100 g breadsticks with 10 % of hemp products can cover up to 34 % recomendet daily intake.

V. CONCLUSIONS

It was found that the addition of hemp products to the recipe of wheat bakery products with low moisture content has a positive effect on the bulk fermentation of the dough and acid fermentation. At the same time, the intensity of alcoholic fermentation decreases slightly, as evidenced by the decrease in the amount of carbon dioxide forming during the dough period. This result has shown that the chemical and species composition of different hemp products had a multidirectional effect on the number of physical and chemical processes. The decrease in the activity of baker's yeast was associated with an increasing dosage of fat component, from hemp products, in the dough and low content of simple sugars in hemp flour and bran.

Summarizing the above, it is proposed that the technological the rheological properties of the dough with hemp products should be improved to get better quality of the low-moisture bakery products with hemp flour; in addition, given the established patterns, further research should consider the use of sourdough and rye flour in the recipe for breadsticks.

VI. REFERENCES

1. Kiralan, M., Gül, V., & Kara, S. M. (2010). Fatty acid composition of hempseed oils from different locatins in Turkey. *Spanish journal of agricultural research*, (2), 385-390.

2. Nissen, L., Zatta, A., Stefanini, I., Grandi, S., Sgorbati, B., Biavati, B., & Monti, A. (2010). Characterization and antimicrobial activity of essential oils of industrial hemp varieties (Cannabis sativa L.). *Fitoterapia*, *81*(5), 413-419.

3. Wang, X. S., Tang, C. H., Yang, X. Q., & Gao, W. R. (2008). Characterization, amino acid composition and in vitro digestibility of hemp (Cannabis sativa L.) proteins. *Food Chemistry*, *107*(1), 11-18.

4. Anwar, F., Latif, S., & Ashraf, M. (2006). Analytical characterization of hemp (Cannabis sativa) seed oil from different agro- ecological zones of Pakistan. *Journal of the American Oil*

Chemists' Society, *83*(4), 323-329.

5. Hadnađev, M., Dizdar, M., Hadnađev-Dapčević, T., Jovanov, P., Mišan, A., & Sakač, M. (2018). Hydrolyzed hemp seed proteins as bioactive peptides. *Journal on Processing and Energy in Agriculture*, *22*(2), 90-94.

6. Pojić, M., Dapčević Hadnađev, T., Hadnađev, M., Rakita, S., & Brlek, T. (2015). Bread supplementation with hemp seed cake: A by- product of hemp oil processing. *Journal of food quality*, *38*(6), 431-440.

7. Sova, N. A., Lutsenko, M. V., Yenina, N. Yu., & Vasarab-Kozhushna, L. D. (2017). Nasinnia nenarkotychnykh konopel–perspektyvna biolohichno aktyvna syrovyna dlia kharchovoi promyslovosti. Khranenye y pererabotka zerna, (9), 217.

8. Švec, I., & Hrušková, M. (2015). The Mixolab parameters of composite wheat/hemp flour and their relation to quality features. *LWT-Food Science and Technology*, *60*(1), 623-629.

9. House, J. D., Neufeld, J., & Leson, G. (2010). Evaluating the quality of protein from hemp seed (Cannabis sativa L.) products through the use of the protein digestibility-corrected amino acid score method. *Journal of agricultural and food chemistry*, *58*(22), 11801-11807.

10. Deferne, J. L., & Pate, D. W. (1996). Hemp seed oil: A source of valuable essential fatty acids. *J Int Hemp Assoc*, *3*(1), 1-7.

11. Mustafa, A. F., McKinnon, J. J., & Christensen, D. A. (1999). The nutritive value of hemp meal for ruminants. *Canadian Journal of Animal Science*, *79*(1), 91-95.

12. Leizer, C., Ribnicky, D., Poulev, A., Dushenkov, S., & Raskin, I. (2000). The composition of hemp seed oil and its potential as an important source of nutrition. *Journal of Nutraceuticals, functional & medical foods*, *2*(4), 35-53.

13. Drobot V. (2006). Laboratornyi praktykum z tethnologii khlibopekarskogo ta makaronnogo vyrobnytstv:navch. Posib [Laboratory practicum on the technology of bakery and macaroni production]. K.:Tsentr navchalnoi literatury, 341 p.

14. Korus, J., Witczak, M., Ziobro, R., & Juszczak, L. (2017). Hemp (Cannabis sativa subsp. sativa) flour and protein preparation as natural nutrients and structure forming agents in starch based gluten-free bread. *LWT*, *84*, 143-150.

15. Dewettinck, K., Van Bockstaele, F., Kühne, B., Van de Walle, D., Courtens, T. M., & Gellynck, X. (2008). Nutritional value of bread: Influence of processing, food interaction and consumer perception. *Journal of Cereal Science*, *48*(2), 243-257.

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