Ministry of Education and Science of Ukraine

ODESSA NATIONAL ACADEMY OF FOOD TECHNOLOGIES

International Competition of
Student Scientific Works

BLACK SEA SCIENCE 2018

PROCEEDINGS

April, 4, 2018

ODESSA, ONAFT 2018

Ministry of Education and Science of Ukraine

Odessa National Academy of Food Technologies

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Proceedings

April 4, 2018

Odessa, ONAFT 2018

Міністерство освіти і науки України

Одеська національна академія харчових технологій

Міжнародний конкурс студентських наукових робіт

BLACK SEA SCIENCE 2018

Матеріали

4 квітня 2018 року

Одеса, ОНАХТ 2018

UDC 001(262.5):378.4.091.27(08)
BBC 421D221
B64

Black Sea Science 2018: Proceedings of the International Competition of Student Scientific Works, April 4, 2018, Odessa / Odessa National Academy of Food Technologies; B. Yegorov, M. Mardar (editors-in-chief.) [*et al.*]. – Odessa: ONAFT, 2018. – 827 p.

Proceedings of International Competition of Student Scientific Works «Black Sea Science 2018» contain the works of winners of the competition.

The author of the work is responsible for the accuracy of the information.

ISBN 978-966-289-181-2 Odessa National Academy of Food Technologies

УДК 001(262.5):378.4.091.27(08)
ББК 421D221
В64

Black Sea Science 2018: Матеріали Міжнародного конкурсу студентських наукових робіт, 4 квітня 2018 р., Одеса / Одеська національна академія харчових технологій; Б. В. Єгоров, М. Р. Мардар (відп. ред.) [та ін.]. – Одеса: ОНАХТ, 2018. – 827 с.

Збірник включає матеріали робіт переможців Міжнародного конкурсу студентських наукових робіт «Black Sea Science 2018**».**

За достовірність інформації відповідає автор публікації.

ISBN 978-966-289-181-2 Одеська національна академія харчових технологій

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TECHNOLOGICAL PROPERTIES AND QUALITY INDICATORS OF HULLED WHEAT

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Among the many types of wheat, the most common today is the modern cultivated wheat T.aestivum L., which is known as common wheat or bread wheat, but exist ancient types of wheat: diploid – T. monococcum L. (AA); tetraploid – emmer (AABB), as well as hexaploid – spelt (AABBDD).

In this research work, the currently used species of wheat, this is part of the group of hulled species – spelt and emmer wheat. Hulled wheat considered being a crop with high nutritional value, which determines its relevance and using in Ukraine. Hulled wheat in comparison with common wheat contains practically all the nutrients that are necessary to the human body.

The purpose of the research is to substantiate the directions of further processing of spelt and emmer on the basis of comparison of their physico-technological and chemical composition with ordinary hard wheat.

In this work was done following tasks:

1. Chemical composition of macronutrients of investigated samples of wheat;

2. Physico-technological properties of the studied samples;

3. Flour and cereal indices of investigated samples of wheat;

4. Physico-chemical properties of investigated wheat samples.

The results of the research showed the difference in the physical and mechanical properties of the spelta and emmer compared to the common wheat (Kuyalnik).

The work consists of 6 sections, outlined on 18 pages, includes 6 tables, the list of references includes 18 titles.

Introduction

In Ukraine, the leading place in the dietoccupied by bread, flour and cereal disheslong time ago. The composition of grain products for their production is diverse. Everywhere are grown oats, buckwheat and millet. Various types of wheat, rye, barley are widespread. Today, almost all nutritionists recommend using grain as a central part of our diet, due to

their naturally high content of biologically active substances and low fat content. Consumed daily in constant and sufficiently high quantities of bread and cereal crops, which are optimal for enrichment with vitamins, minerals and other biologically active substances.

Wheat is the most important agricultural crop that grows in more than 120 countries. According to WHO / FAO, world wheat production is more than 730 million tons, of which 24-26 million tons grown in Ukraine. The wheat belongs to the family Roasaye, the Triticum L. genus, which has more than 30 kinds, well visible for morphological and biological characteristics. More than 95% of cultivated wheat falls on soft and hard wheat, the remaining 5% are emmer, spelt and other kinds of wheat.

Creation of healthy food products based on grain crops with the assessment of their biological and consumer properties on a modern diet, taking into account the requirements of nutrition to the chemical composition and biological value of food.

Recently, work has been intensified to attract little-studied species of cereal crops to use, in particular, wheat, which is included in the group of hulled wheat– spelt. This kind of wheat was previously quite common and used-all in nutrition in many countries, but is currently cultivated in non-significant volumes [1].

As the researchers note, spelt is a high-protein culture, which virtually without the introduction of mineral fertilizers forms the protein content in grain not lower than 16.3% [2].

High adaptability and tolerance of the varieties of spelt to diseases and pests makes it one of the main candidates for cultivation without the use of pesticides to produce high quality, environmentally friendly organic grains [3].

1. Analytical review

1.1. General characteristics of hulled wheat

Spelt – is a kind of hulled wheat. On the forehead (Triticumdicoccum) or spelt, double grains, emmer, – the ancestor of all modern varieties of wheat. The interest in speltincreases as an environmentally friendly culture that exceeds wheat by the content of proteins, unsaturated fatty acids, fiber, and vitamins [4].

Itwas known to humanity in the Stone Age. In the middle of the 20th century, the Poltava was the main culture ethnographically associated with the descendants of the peoples, raised it even in ancient times. Micro districts of this cereal have survived in the mountainous regions of Swit-

zerland, Austria, Germany (Alps), Spain, North Caucasus, Georgia, India, Ethiopia, Morocco, Poultry, Tatarstan, Bashkortostan, Chuvashia. Field of origin (presumably) – Mediterranean zone. Introduced in culture over 5000 years BC. They cultivated it in Ancient Egypt, Babylonia and others places [5, 6].

The most interesting thing is that the completelyspelt was a dash for many years ago. This is the same plant. Just this kind of wheat for 150-200 years was a bit "refined" by Western breeders, and today, purely outward, spelt and emmer differ from each other.

Based on the ancient emmer, all modern varieties of wheat derived. Emmer is a semi-hard wheat variety, more precisely, a group of wheat species with a lame-eyed colossus and plumage grain. It has many useful and viral therapeutic properties.

As the merits of crops, it is stated:

- Insensitivity to soil-climatic conditions;
- High (even in the case of hard-wheat) protein content;
- Different from modern wheat, through the structure of the protein.

However, the speltare not without disadvantages, which partially overcome in the process of breeding, in particular:

- Low yields;
- Difficulty in threshing and initial processing of hulled varieties.

Emmer and spelt contains virtually all nutrients that a person needs in a harmonious and balanced combination – and not only in the shell of the grain, but evenly throughout the grain. This means that it maintains its nutritional value even at the finest ground [7].

1.2. Selection various types of wheat by using hulled wheat

About some of the first varieties of wheat obtained by the method of interspecific hybridization with the participation of T. dicoccum, points out N.I. Vavilov (1964): "... in the United States, McFadden managed to get varieties such as Hope by crossing the Yaroslavl fast-paced emmer with hard wheat." Although these varieties were not widely distributed, but combining the immunity to the sodas and rust (transmitted from the hulled wheat), they became the stage for the creation of immune forms of hard wheat. P. M. Zhukovsky (1964) points out that in Canada, the Lee variety, obtained from the crossing of the Hope (ancestor of the Yaroslavl Emmer) breed with the Timopheevi breed, is sown on hundreds of thousands of hectares and is characterized by resistance to most races and a stem -low rust.

Using the emmerfrom India as a donor to stem rust resistance, and the creation on its basis of new varieties of spring wheat Langdon and Yuma, actually saved the culture of hard wheat in the United States.Golik V.S., Golik O.V. (2008) also note that the variety of spring wheat Kharkiv 46, obtained from crossbreeding with the pillow, in the second half of the twentieth century occupied a leading position in the USSR in the areas of sowing [8]. Therefore, in 1969 the Kharkivska 46 variety occupied an area of 4.6 million hectares. In the future, the Kharkiv variety 46 became the ancestor of most varieties of spring wheat in the USSR. With the participation of the emmer, the following varieties of soft wheat such as Tulun 197, Cesium 94, Ottawa, as well as sorghum of hard wheat were also obtained.

1.3. Consumer values and technological properties of hulled wheat

The long-term lack of interest of the spelt was due to the mass production of common wheat, which yielded a larger harvest. In the period of industrialization, due to the introduction of fertilizers and the use of other technological means, priority given to crop yields, not quality. Due to the consequences of mass production, qualitative properties of wheat have significantly decreased, and only in the late 20th century in the countries of Western Europe, there was a necessity in grain of high quality. These requirements corresponds to the hulled wheat, which has better biological value than common wheat.

Studies carried out by Western European scientists argued that protein content in winter and spring forms of spelt was higher in 1.3-1.5 times compared with common wheat and averaged 13-17%. In addition, emmer`s and spelt`sprotein is characterized by a high degree of nutrition and excellent biological quality. Overfilling of protein exceeds 80%. The quality of gluten in the flour is half a bar higher than in common wheat. Bread from spelt characterized by a pronounced bread odor, good taste and a long period of non-drawing. Spelt is a very valuable grain because of the high concentration of nutrients. In addition, it characterizes the high value of fat, unlike ordinary wheat. Particularly important, for example, for the heart, is the content of unsaturated fatty acid, which is twice as large in spelt than in normal wheat. In fat, half a pound-on-many more phytosterols, so that the colon reduces the level of cholesterol-well in the blood. The research has identified that in the grains of speltmore than 20 such connections.Found sub-high content in the grain of the half-full of all amino acids (except arginine) compared with common wheat in the range of 20-60% (Table 1, 2).

Spelt contains more vitamins A, E, D compared to common wheat. The activity of vitamin E in half a third is higher than the activity of vitamin E of common wheat. In addition, speltcontains more vitamins B1, B2, B3 [9].

An important feature in assessing the quality of speltis the mineral composition. More often emphasize the high value of phosphorus, iron, zinc, copper, manganese and cobalt. Spelt has a beneficial effect on the process of etching and therefore used in hospital diets. It contains a significant amount of silicon, which plant takes from minerals. Silicon oxide is important for the skin, hair, nails, and also improves brain activity [10].

According to some reports, the first in Ukraine was used for baking bread, making porridge and blueberries of the monastery from Kremenets of the Ternopil region. They argue that the bread and porridge from emmer (spelt) are much more delicious than from ordinary wheat.

Table 1 – The content of amino acids in hulled and common wheat

Amino acids	Hulled wheat	Common wheat
Endogenous amino acids		
Asparagine	0,74	0,55
Serine	0,87	0,56
Glutamine	5,83	3,63
Proline	2,59	1,64
Glycine	0,59	0,45
Alanine	0,52	0,36
Cysteine	0,33	0,27
Tyrosine	0,49	0,31
Exogenous amino acids		
Lysine	0,54	0,42
Methionine	0,26	0,19
Threonine	0,44	0,31
Phenylalanine	0,89	0,62
Leucine	1,27	0,83
Valine	0,86	0,67
Histidine	0,39	0,26
Arginine	0,51	0,54
Isoleucine	0,61	0,40

As already mentioned, emmer (spelt) contains all the nutrients necessary for the human body. It significantly exceeds the wheat content of

protein, unsaturated fatty acids, fiber, and vitamin B groups. Experts believe that eating this kind of wheat is useful for improving the immunity of the body and normalizing the cardiovascular system, beneficial for the nervous [6].

Table 2 – The content of vitamins in hulled and common wheat,mg/100g

Vitamin	Hulled wheat	Common wheat
Thiamine (B_1)	0,64	0,48
Riboflavin (B_2)	0,22	0,14
Niacin (PP)	0,60	0,42
Pantothenic acid	0,08	0,09

3. Object and subject of research, materials and methods

Purpose of the research: To substantiate the directions of further processing of spelt and emmer on the basis of comparison of their physico-technological, and chemical composition with ordinary hard wheat.

Objectives: The object of research work are samples of wheat grown in different regions of Ukraine in 2016. For researches of wheat were selected:

1. Common wheat –Kyualnik;
2. Spelt «Zorya of Ukraine»;
3. Spelt of German origin;
4. Emmer.

Materials and methods. The subject of research was selected 4 samples of wheat grown in 2016: the 1st sample – common wheat hard red of Kuyalnik variety, grown in the Odessa region; 2nd – spelt German origin, grown in the Odessa region; 3rd – spelt of Zorya of Ukraine variety, grown in the Zhytomir region; 4th – Emmer that was grown in the Chernihiv region.

Standard materials were used to study the chemical composition (content of protein, fat, ash) and technological characteristics (content of hulk, bulk weight, weight of 1000 grains, vitreousness, falling number, quantity and quality of gluten). Sedimentation was determined by the Pumpyansky method [11] in the acetic acid, hardness by Brabender method: by grinding 6 g grain at the Brabender Automatic Micro Hardness Tester, according to [12], hardness (PSI) by the AACC 55-30.01 method.

Tasks:

1.Chemical composition of macronutrients of investigated samples of wheat.

2.Physico-technological properties of the studied samples.

3.Flour and cereal indices of investigated samples of wheat.

4. Physico-chemical properties of investigated wheat samples.

4. Results

Wheat grain, as well as other cereals, contains macronutrients: carbohydrates, proteins, fats, minerals, and micronutrients: vitamins, pigments, enzymes and other substances [13]. Its chemical composition varies depending on the species, the variety, the external conditions of cultivation, the soil.

Carbohydrates in the diet that provide up to 40-75% of total energy is the main energy component of nutrition. Usually they are classified depending on the degree of polymerization on sugars, oligosaccharides and polysaccharides. As for normal wheat, and for hulled wheat, carbohydrates are the main component (59-71%) of wheat grain [14], although their ratio is somewhat different [15, 16, 17]. The main "spare" carbohydrate – it is starch (61-68%), while the mass fraction of sugars is 2-3%, and food fibers – 9-12%. In the investigatedsamples of wheat spelt and emmer (Table 3), the content of carbohydrates was 78.32-81.73 and 81.3% respectively, which is 2.96-6.37% lower than that of a standard wheat variety of Kuyalnik.

Proteins by their content in grains occupy the second place among macronutrients. In the diet, they are a source of energy and essential amino acids, while playing a major role in the process of pastoral care, defining the structure of baking products. In ordinary and hulled wheat, they are represented by different fractions: albumins and globulins (more fully valuable from a biological point of view), as well as gliadins and glutenins, which inhibit gluten, defining high baking properties, but unfortunately reduce digestion of proteins in the gastrointestinal tract.

In order to ensure satisfactory baking properties, the mass fraction of protein should be at least 11.5-12.0%, which is confirmed by the control sample of bread wheat of the Kuyalnik variety (11.89%). In the grain of spelt and emmer (Table 3), the mass fraction of protein is 14.22-17.82% and 15.10% respectively, which is significantly higher than that of hard wheat – 2.33-5.93% and 3.21% in accordance. The largest mass fraction of

protein is in the range of German origin, which has been grown in the Odessa region on the fields of the breeding and genetic institute.

Table 3 – Chemical composition of macronutrients of investigated samples of wheat, % on dry weight

Sample	Kind of wheat	Carbohydrates and food fibers	Protein content	Fat content	Ash content
1	Common wheat Kyualnik	84.69	11.89	1.92	1.50
2	Spelt «Zorya of Ukraine»	78.32	17.82	2.27	1.59
3	Spelt of German origin	81.73	14.22	2.54	1.51
4	Emmer	81.30	15.10	2.00	1.60

Fats are the smallest in number of macronutrients of grain; they are contained in a quantity of 2-3%. In general, 70% non-polar lipids, 20% glycolipids and 10% phospholipids [18], represent them. In the spelt samples under study(Table 3) the mass fraction of fats is 2.27-2.54%, emmer– 2.00%, bread wheat – 1.92%.

About the mass fraction of mineral substances are judged by the indicator of ash, which is quite low in all samples of investigated wheat – 1.50-1.60%, which is explained, firstly, by the depletion of agricultural lands, and secondly, by intensive methods cultivation and high crop yields for baking wheat, and for hulled wheat – an organic way of farming in their cultivation.

Thus, the chemical composition of the spelt and emmer from the point of view of "healthy nutrition" exceeds the grain of common wheat, above all, with a higher percentage of protein and lower energy value.

In commodity production, to determine the market price of raw materials (wheat), its technological properties play an important role. For hulled crops (for example, for barley), which are mainly processed for cereal products, the main technological indicator is the husk content. The amount of films depends on the bulk weight of the grain (Table 4), the content of "useful for processing" grains, is output of finished products and husk. Among the samples studied, the smallest husk content (22%) was in a hard spelt of Germanic origin, which makes it more promising for processing, the largest (26%) in the semi-hard spelt of the Zorya of Ukraine variety.

Table 4 – Physico-technological properties of the studied samples of wheat

Sample	Kind of wheat	Content of husk, %	Bulk weight with husks, kg/hl	Bulk weight without husks, kg/hl	Weight of 1000 grains without husks, g
1	Common wheat Kyualnik	–	–	0.799	41
2	Spelt «Zorya of Ukraine»	22	0.426	0.778	46
3	Spelt of German origin	26	0.422	0.784	48
4	Emmer	23	0.430	0.775	47

In terms of bulk weight, grain without husksin 1.7-1.8 times fell to non-threshing grain – 0.422-0.430 against 0.775-0.784 kg/hl, that is, storage and transportation of such grain requires more capacity of bunkers and transport. Therefore, it is considered reasonable to develop a technological (s) means of breaking down during post-harvest processing of hulled wheat, but it should be borne in mind that these wheat have a lower thickness of the pericarp and can be traumatized during drying, transporting and more subjected to microbiological contamination. Despite the bulk weight, hulled wheat had a mass of about 5-7 g of weight of 1000 grains, which conditioned by their more wrinkled surface.

Hardness is an important indicator for the processing of grain into flour, the choice of the modes of water-heat treatment, debranning, peeling and grinding. Among the samples studied (Table 5), only the specie of Zorya of Ukraine (sample 3) can be attributed to semi-hard wheat, such a grain should be used for the production of flakes or for the production of wholemeal flour. Other samples, including emmer and spelt of German origin, are hard varieties, which means that they receive a larger amount of cereal-based products when processed, they are more difficult to debrann and grinding, and therefore they are expedient to be used for the production of flour, as well as for the production of whole or crushed cereals.

According to the physical and chemical indices, different types and varieties of wheat were investigated according to the most important parameters that characterize the bakerygrain quality. From the given data (Table 6) it is evident that the grain of spelt and emmer has high gluten (35-39%), but this gluten related to the poor quality – the index of IGD

(index of gluten deformation) is more than 95 units. The rate of sedimentation in acetic acid does not exceed 20 ml, which is characteristic for a weak wheat baking power.

Table 5 – Flour and cereal indices of investigated samples of wheat

Sample	Kind of wheat	Moisture, %	Vitreousness, %	Hardness by Brabender, s	Hardness by PSI, %
1	Common wheat Kyualnik	12,8	54	23	13,0
2	Spelt «Zorya of Ukraine»	13,0	58	22	10,9
3	Spelt of German origin	13,0	42	103	17,2
4	Emmer	13,2	62	20	7,2

Table 6 – Physico-chemical parameters of investigated wheat samples

Sample	Kind of wheat	Falling number, c	Amount of gluten, %	Quality of gluten, IGD	Sedimentation, ml
1	Common wheat Kyualnik	246	24	65 (I)	33
2	Spelt «Zorya of Ukraine»	120	39	97 (II)	19
3	Spelt of German origin	63	36	95 (II)	16
4	Emmer	64	35	95 (II)	16

Otherwise, baking of bread from such grain will have a low volume (the dough will be diluted). This is due to the fractional composition of proteins and the higher ratio of less molecular gliadins to higher molecular weight glutenins. But in modern conditions whenever baking wheat varieties grown in Ukraine have too elastic gluten (the index of gluten defor-

mationis less than 60 units), spelt or emmer can be used in the mixture in the milling batch, and at a certain ratio it will improve both the baking properties of the flour , and its chemical composition.

5. Conclusions and recommendations

1. Based on the analysis conducted, it should be noted that the range of grain products existing in Ukraine is in need of expansion, which should be carried out in the direction of improving the nutritional value. The solution to this problem is possible due to the use of new (ancient) varieties of wheat and special breeding varieties with high levels of substances important for the human body.

2. The results of the research showed the difference in the physical and mechanical properties of the spelta and emmer compared to the common wheat (Kuyalnik). The bulk weight of the hulled wheat is lower than in the wheat.

3. By gluten strength, flour from spelt and emmer is characterized as "weak", which allows the recommendation of emmer`sand spelt`sflour to be used in the production of flour confectionery products, in particular, cookies.

4. The trashing grain of hulled wheat has the best composition of chemical substances. In the investigated samples of cereal spelt and emmer, the mass fraction of protein is 14.22-17.82% and 15.10%, respectively, which exceeds the hard wheat – this by 2,3-5.9% and 3.2% respectively; the carbohydrate content is 78.75-81.73% and 81.3%, respectively, which is 3-6% less than the sample of common wheat of the Kuyalnik variety.

5. According to the chemical composition, the samples hard spelt of German origin, the potential cereal properties (husk content, vitreousness and hardness) are dominated by other investigated samples, their husk content is 20-22%, vitreousness – 61-71%, hardness by Brabendermethod – 27-40 s.

6. Grain of spelt and emmer can be used to stabilize the baking properties of grain of hard wheat to increase the content of protein.

7. When further exploring the grain of spelt and emmer as the object of post-harvest processing and storage should take into account the smaller thickness of coated tissues grains, use a milder mode of drying and transporting.

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BLACK SEA SCIENCE 2018

Матеріали

Верстка – Н.М. Ковальчук

Формат 60х84/16. Гарнітура Times New Roman.
Умовно-друк. арк. 48,07. Тираж 300. Замовлення № 0518-105.

Видавництво і друкарня – Видавничий дім «Гельветика»
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Свідоцтво суб'єкта видавничої справи
ДК № 4392 від 20.08.2012 р.