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A comprehensive nutritional supplement made from germinated wheat to enrich drinks

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Abstract. The creation of new enriched and functional products contributes to the formation of a healthy type of nutrition in the population. The combination of processed wheat grain processing products into a complex nutritional supplement that can be used for enrichment will expand the range of functional products. As objects of study, a concentrate from germinated wheat grains and juice from green wheat sprouts were determined. Samples of complex nutritional supplements were prepared with different component ratios. Comparative results of organoleptic evaluation and physicochemical parameters of complex nutritional supplement samples are presented. The formulation of the complex nutritional supplement was optimized by the total quality factor, the most effective ratio of the concentrate from germinated wheat grains and juice from green wheat sprouts - 40:60. The study of the conditions and shelf life of the finished complex food additives, packaged in a vacuum bag, was carried out at a temperature of -18 ± 2 °C, air humidity of 75%. Quality control was carried out at 3 control points during 48 days of storage. The developed complex food additive, packed in a vacuum bag and frozen at a temperature of -18 ± 2 °C, air humidity of 75% has a shelf life of 40 days and can be widely used in the enrichment of drinks. The complex nutritional supplement from germinated wheat has the following indicators: dry matter content - 21.89%, vitamin C - 4.3 mg, vitamin B₁ - 0.13 mg, vitamin B₂ - 0.1 mg, vitamin B₆ - 0.17 mg, fiber - 0.72 g. The resulting complex nutritional supplement has increased nutritional value.

1. Introduction

The formation of a healthy type of nutrition for the population requires the production of new enriched, dietary and functional foods. One of the sources of enrichment of the diet is sprouted wheat, which is several times richer than vitamins, macro- and microelements 50 times richer than vitamin E, 10 times richer than vitamin B₆, 3-4 times richer than vitamins F and P 4-5 times richer in fatty acids, 2-3 times richer in amino acids, and also contains phosphorus, potassium, magnesium, manganese, calcium, zinc, iron, selenium, copper, vanadium, etc. It is established that the introduction of germinated grain in the diet improves metabolism and blood formation, boosts immunity, replenishes vitamin th and mineral deficiency, stabilizes the acid-base balance, aids in digestion and intensive cleansing the body of toxins. In addition, enzyme systems are activated in the germinated grain, which break down complex substances into simpler, easily absorbed by the human body [1-3].

Another source of enrichment, which contains a significant amount of nutrients, vitamins, macro- and microelements, enzymes, essential amino acids, is the juice from the green wheat sprouts. It contains chlorophyll, which inhibits the development of cancer, promotes tissue regeneration and stimulates the

production of hemoglobin and red blood cells in case of anemia. Chlorophyll derivatives have an antibacterial effect, have antioxidant activity and help cleanse the body of toxins [4-6].

To enhance the functional effect to the human body and expand the functional products, it is advisable to combine a concentrated product from germinated wheat grains and juice from green wheat sprouts into a complex nutritional supplement, which can later be used in the enrichment of various food products. As an optimal form of food product for enrichment, you can use thick drinks (smoothies) from crushed fruits, vegetables or berries of the same type with the addition of juice, mineral water, ice, etc.

The purpose of the work is the development of the technology and formulation of a comprehensive food supplement for the enrichment of drinks using the example of a smoothie with the definition of conditions and shelf life.

2. Materials and methods

The object of the study was selected concentrate from germinated wheat grains with the following indicators: solids content - $(45 \pm 0.04)\%$, protein - $(12.4 \pm 0.05)\%$, fats - $(1.93 \pm 0.003)\%$, starch - $(26.4 \pm 0.02)\%$, fiber - $(1.8 \pm 0.05)\%$, sugar - $(1.65 \pm 0.03)\%$, ash - $(1.03 \pm 0.03)\%$, consistency - homogeneous mass, with small inclusions, without coarse particles; color - beige, with small inclusions of brown; smell - characteristic of a healthy grain of this type; the taste is sweetish, characteristic of a healthy grain of this type [7]. Another object of study was juice from green wheat sprouts with the following indicators: moisture content - $(94 \pm 0.05)\%$, sugar - $(6.48 \pm 0.05)\%$, ash - $(0.09 \pm 0.03)\%$, vitamin C - $(5.1 \pm 0.02)\%$, consistency - a homogeneous opaque liquid; color - Homogeneous throughout the mass, saturated dark green; smell - appropriate, herbal; the taste is sweet [8].

To determine the optimal ratio of the concentrated product from germinated wheat grain and juice from green wheat sprouts, experimental preparation was carried out according to 4 variants of formulations. The ratio varied within 30:70; 40:60; 50:50; 60:40.

In the finished complex food supplement, organoleptic (on a 5-point scale) and physicochemical parameters (dry matter content, acidity, content of B vitamins and vitamin C) were determined in accordance with the requirements of the standards.

The optimization of the ratio of components in a complex food supplement was carried out according to the following criteria: Organoleptic evaluation (q_1), the content of physiologically functional ingredients (q_2, q_3, q_4), summarizing them into a total quality factor (U). The value of the quality factor (U) should be maximum:

$$U = q_1 + q_2 + q_3 + q_4 \quad (1)$$

where q_1 – the estimated coefficient of organoleptic evaluation; q_2 – estimated coefficient of solids content; q_3 – estimated coefficient of the content of vitamins of group B; q_4 – estimated coefficient of vitamin C.

The estimated coefficients were determined by the formula:

$$q_i = \frac{x_i}{\max x_i}, i = 1 \div 4 \quad (2)$$

where x_i – significant signs; $\max x_i$ – corresponding maximum values.

The study of the conditions and shelf life of a complex nutritional supplement from a mixture of concentrate from germinated wheat grains and juice from green wheat sprouts was carried out in accordance with TR TS 021/2011 and MUK 4.2. 1847-04 at a temperature of $(-18 \pm 2)^\circ \text{C}$. We used a vacuum packaging machine Profi Cook PC-VK 1015, an intensive cooling chamber PF 031AF CHILLY GN1. The complex nutritional supplement from germinated wheat was packaged in vacuum bags, frozen in an intensive cooling apparatus to -18°C inside the product and stored for 48 days. Organoleptic and microbiological indicators of a complex dietary supplement were determined at 3 control points.

Statistical processing of the results was carried out using the non-parametric Kolmogorov-Smirnov test in the programs “Statistica 6.1” and “Microsoft Excel”. The difference in the comparison of mean values was considered significant at $p < 0.05$.

3. Results and discussion

A complex nutritional supplement from germinated wheat was prepared by mixing a concentrate from germinated wheat grains and juice from green wheat sprouts in ratios 30:70; 40:60; 50:50; 60: 40, samples are shown in Figure 1.



Figure 1. Samples of a comprehensive nutritional supplement with a different ratio of concentrate from germinated wheat grains and juice from green wheat sprouts.

An organoleptic assessment of the quality of a complex nutritional supplement from germinated wheat is shown in Figure 2. According to experts, a high overall score (4.8-4.7) was noted in samples of a food supplement containing concentrate from germinated wheat grains and juice from green wheat sprouts in a ratio of 40 : 60 and 50:50.

The results of determining the mass fraction of solids are shown in Figure 3. From the data obtained, it can be seen that the solids content increases with a decrease in the juice of green wheat germ in the composition of the complex food supplement.

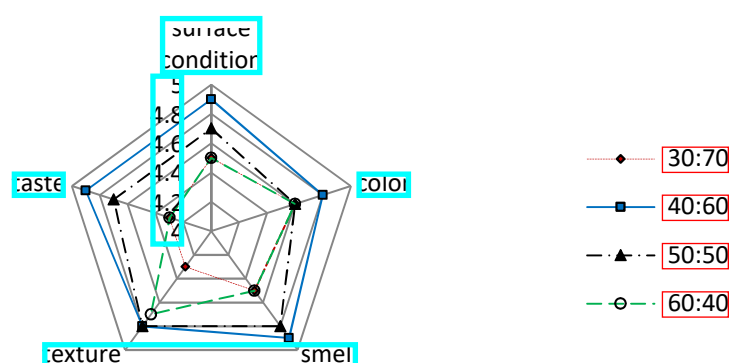


Figure 2. Organoleptic evaluation of a complex nutritional supplement with a different ratio of concentrate from germinated wheat grains of juice from green wheat sprouts ($M \pm m$) ($n=7$)

Acidity (pH) was determined in the finished samples of a complex food supplement with a different the ratio concentrate from germinated wheat grain and juice from green wheat germ. The results are presented in Figure 4.

Figures 5-6 show the results of the content of vitamins in the finished samples of a complex food supplement, from which it can be seen that with a change in the ratio of the components of a complex

food supplement, the vitamin composition changes depending on which component prevails in larger quantities. The juice from green wheat sprouts contains vitamin C, and the concentrate from germinated wheat grains contains B vitamins, therefore, with an increase in the concentrate from germinated wheat grains in the complex nutritional supplement, the content of vitamin C decreases, and the content of B vitamins, on the contrary, increases.

Organoleptic indicators, solids content, vitamin C and group B vitamins acted as criteria for optimizing the formulation of a complex nutritional supplement. The dependence of quality criteria on the mass fraction of components is presented in Figure 7.

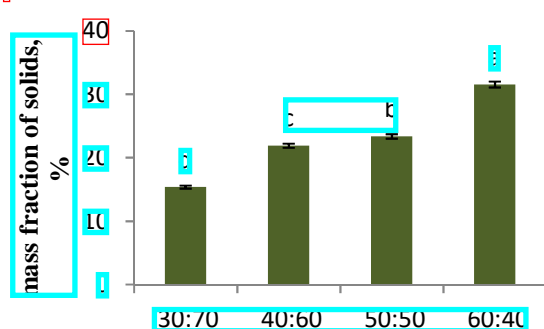


Figure 3. Mass fraction of solids in samples of a complex nutritional supplement from germinated wheat with a different ratio of incoming components ($M \pm m$) ($n = 7$) (intra-group differences are indicated by letters, multiple comparisons, LSD test, $p < 0.05$)

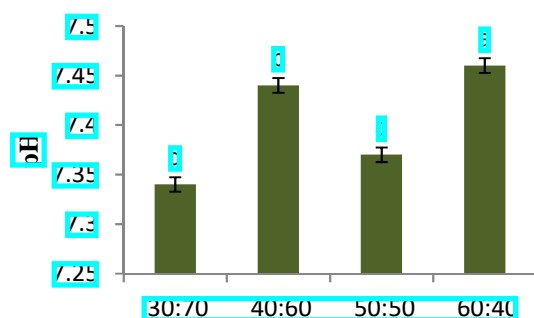


Figure 4. Acidity in samples of a complex nutritional supplement from germinated wheat with a different ratio of incoming components ($M \pm m$) ($n = 7$) (intra-group differences are indicated by letters, multiple comparisons, LSD test, $p < 0.05$)

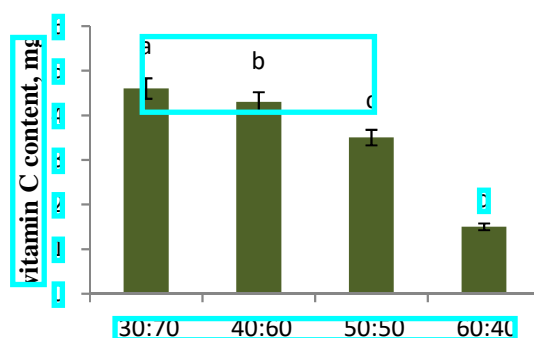


Figure 5. Vitamin C content in samples of a complex nutritional supplement from germinated wheat with a different ratio of incoming components ($M \pm m$) ($n = 7$) (intra-group differences are indicated by letters, multiple comparisons, LSD test, $p < 0.05$)

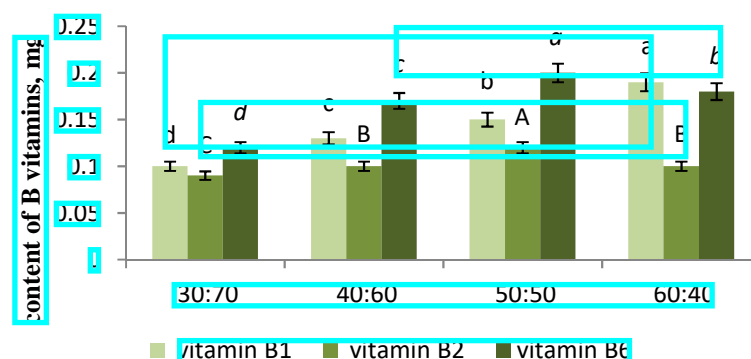


Figure 6. The content of B vitamins in samples of a complex nutritional supplement from germinated wheat with a different ratio of incoming components ($M \pm m$) ($n = 7$) (intra-group differences are indicated by letters, multiple comparisons, LSD test, $p < 0.05$)

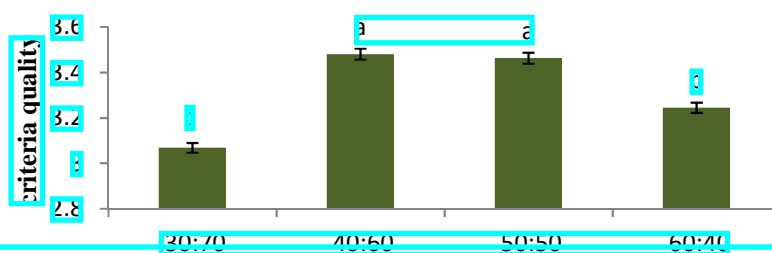


Figure 7. The total quality factor of a comprehensive nutritional supplement from germinated wheat with a different ratio of incoming components ($M \pm m$) ($n = 7$) (intra-group differences are indicated by letters, multiple comparisons, LSD test, $p < 0.05$)

Table 1. Organoleptic characteristics of a complex nutritional supplement from germinated wheat at control points, ($M \pm m$) ($n=7$)

Indicators	Characteristic	Total score (5 point system)
Packaging condition	Remained airtight	
Surface condition	Homogeneous mass, with small inclusions	4.9±0.02
Color	Green, with small inclusions of beige	4.8±0.01
Smell	Peculiar to this type, wheat grass	4.9±0.03
Taste	Sweetish, typical for this type, with a wheat flavor	4.8±0.01
Texture	Homogeneous, without coarse particles	4.9±0.02
	12 days	
	identically	
	30 days	
	identically	
	48 days	
	identically	

Based on the results obtained, it is seen that the best results are observed in samples of a complex food supplement with a concentrate from germinated wheat grains and juice from wheat germ in ratios 40:60 and 50:50. Since organoleptic indices and the safety of vitamin C are greater when the ratio of the concentrate of germinated wheat grains and juice from green wheat sprouts is 40:60, this ratio was chosen optimal for obtaining a comprehensive nutritional supplement from germinated wheat.

To prevent spoilage, a complex food supplement with a ratio of concentrate from germinated wheat and juice from green wheat germ - 40:60, was Packed in a polymer film using a vacuum packaging machine Profi Cook PC-VK 1015, then frozen in an intensive cooling chamber PF 031AF CHILLY GN1. Ready packaged and frozen complex food supplement was stored for 48 days at a temperature of $(-18 \pm 2) ^\circ\text{C}$. To control the quality of the complex nutritional supplement and establish the shelf life, three control points were established (12; 30 and 48 days), in which organoleptic and microbiological parameters were determined (Table 1 - 2).

Table 2. Microbiological indicators of a complex nutritional supplement from germinated wheat

Name of indicators	Test results after storage			Valid levels
	12 days	30 days	48 days	
QMAFAM, CFU / g	$<5 \cdot 10^4$	$<5 \cdot 10^4$	$<5 \cdot 10^4$	no more than $5 \cdot 10^4$
Escherichia coli bacteria in 0,1 g	not detected	not detected	not detected	not allowed
Pathogenic, including salmonella in 25 g	not detected	not detected	not detected	not allowed
Mold, CFU / g	< 50	< 50	< 50	no more than 50

After 48 days of storage at a temperature of $(-18 \pm 2) ^\circ\text{C}$, the organoleptic characteristics of the complex nutritional supplement from germinated wheat are high and meet the requirements of TR TS 021/2011. Microbiological indicators at the control points during storage and before vacuum packaging are identical, while the packaging has remained airtight.

Table 3. Evaluation of the nutritional value of a comprehensive nutritional supplement from germinated wheat (100 g)

Indicator	Value	Daily requirement, mg, g / day, MR 2.3.1.2432-08
Protein, g	4.96	74/89±0.50
% of daily requirement		6.3/5.57
Fiber, g	0.72	20±0.10
% of daily requirement		3.6
Vitamin C, mg	4.3	90±0.15
% of daily requirement		4.7
Vitamin B ₁ , mg	0.13	1.5±0.05
% of daily requirement		8.6
Vitamin B ₂ , mg	0.1	1.8±0.02
% of daily requirement		5.55
Vitamin B ₆ , mg	0.17	2±0.03
% of daily requirement		8.5
Iron, mg	1.5	18/10±0.09
% of daily requirement		8.3/15
Magnesium, mg	50.87	400±0.75
% of daily requirement		12.7
Potassium, mg	128.4	2500±0.80
% of daily requirement		5.1

Thus, taking into account $k = 1.2$ (MUK 4.2. 1847-04), the shelf life of the frozen complex nutritional supplement from germinated wheat packed in a vacuum bag was taken 40 days at a controlled temperature of -18 ± 2 °C, air humidity 75%.

Evaluation of the nutritional value of a comprehensive nutritional supplement from germinated wheat was carried out for men and women of the III group of physical activity and the age group of 30-39 years (MR 2.3.1.2432-08). Table 3 shows the level of satisfaction of the daily needs of the human body for basic nutrients due to 100 g of a complex nutritional supplement from germinated wheat.

The results of the study showed that a complex nutritional supplement from germinated wheat has a high nutritional value, is safe by microbiological indicators and can be used as an additive to various thick drinks (smoothies). An example of the use of the obtained complex nutritional supplement can be a formulation with the following ratio of ingredients (complex nutritional supplement: fresh apple: banana: ice or mineral water - 30: 30: 30: 10). The testing of beverage formulations using a complex nutritional supplement from germinated wheat was carried out at the company MAMA FLORA LLC under the direction of director T. B. Bronnikov. As a result, the product received high consumer reviews and can be used to produce drinks (smoothies) of high nutritional value.

4. Conclusions

As a result of the studies, the obtained complex nutritional supplement from germinated wheat has the following optimal ratio of concentrate from germinated wheat grain and juice from green wheat sprouts equal to 40:60. The complex nutritional supplement from germinated wheat has high organoleptic characteristics, is safe by microbiological indicators. The shelf life of a complex nutritional supplement of germinated wheat in a vacuum package frozen at an adjustable temperature of -18 ± 2 °C, air humidity of 75% is 40 days. The use of 100 g of a complex nutritional supplement from germinated wheat satisfies the daily need of the human body for protein by 6.3-5.57%, fiber - 3.6%, vitamin C - 4.7%, vitamin B₁ - 8.6%, B₂ - 5.55%, B₆ - 8.5%, in iron - 8.3-15%, magnesium - 12.7%, potassium - 5.1%, which indicates a high nutritional value of the product. This complex nutritional supplement can be used in the catering system in order to obtain drinks (smoothies) and other products of high nutritional value.

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