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Abstract. *Non-small cell lung cancer remains the leading cause of death among men in the world. New methods of treatment and improvement of existing ones are being sought. To date, there is conflicting information on the effectiveness of neoadjuvant chemotherapy and adjuvant radiation therapy in stage III a of non-small cell lung cancer. The work is devoted to the study of the impact of these techniques on survival in this pathology.*

Key words: *Non-small cell lung cancer, survival, chemotherapy, chemotherapy, complete morphological response.*

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COMPREHENSIVE EVALUATION QUALITY OF BIOFORTIFIED PUMPKIN VEGETABLES

КОМПЛЕКСНА ОЦІНКА ЯКОСТІ БІОФОРТИФІКОВАНИХ ГАРБУЗОВИХ ОВОЧІВ

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Abstract. *Today much attention in the world is focused on obtaining plant raw material with a high content of vital substances. One of the areas that is constantly evolving, is biofortification by using special fertilizer during cultivation. Objective: Conduction of comprehensive quality evaluation of biofortified pumpkin vegetables considering the content of important micro -and macronutrients and organoleptic characteristics. Methods: A comprehensive method for assessing quality. Results: Biofortified pumpkin vegetables differ with high contain macro- and micronutrients and excellent organoleptic properties. Conclusions: the comprehensive parameters of quality of the samples bofortified pumpkin vegetables were higher compared with the control sample.*

Keywords: *biofortification, pumpkin vegetables, Riverm, complex assessments, macronutrients, micronutrients*

Introduction.

The main task of the Food and Agriculture Organization (FAO), the Food and Agriculture Organization of the United Nations, is to fight hunger. In recent years, FAO, together with the concept of "hunger" uses the term "lack of food security" and identifies its forms - moderate and acute [1].

"Lack of food security" is a condition in which a person does not have regular access to a sufficient number of safe and complete foods for normal growth, development and ensuring an active and healthy lifestyle. This situation may be due to the unavailability of food and / or lack of resources to obtain it. Lack of food security can be characterized by varying degrees of severity.

FAO measures food insecurity using a food insecurity scale [2]. Acute food insecurity occurs when a person runs out of food and has not eaten for more than a day. That is, there is a high probability that she will go hungry. It is one of the extreme positions on the scale, but even a moderate lack of food security should be alarming.

After all, those who have faced a moderate lack of food security do not have guaranteed access to food. They have to sacrifice other basic needs just to eat. And when they get food, in most cases - it will be the most affordable and cheapest food, which is not always the most complete. Such foods may contain significant amounts of saturated fatty acids, sugars and salts; they will be cheaper than fresh fruits and vegetables. Their use will allow you to get the daily amount of calories, but will not be a source of intake necessary for the normal functioning of the body and maintaining the health of macro-and micronutrients [2].

Chronic deficiencies of essential vitamins and minerals have been found in 2 billion people worldwide [3–4]. Micronutrient malnutrition affects all age groups and has a cumulative effect. Diseases that occur in children and adolescents as a result of an unbalanced diet progress and become chronic over time, causing suffering and leading to premature death. Most often, the world's population suffers from insufficient amounts of iron, zinc, selenium, iodine, vitamin A [5-6].

The UN has declared the period from 2016 to 2025 a decade of concrete action to address nutrition. The Declaration on Nutrition, adopted by the UN Assembly in Rome, contains a comprehensive strategy - to overcome hunger; put an end to all forms of malnutrition, including micronutrient deficiencies in food; to solve the global problem of obesity. This strategy covers the entire food system and concerns the quality of grown plant raw materials, methods of processing and disposal of food waste [7].

The problem of micronutrient deficiency can be solved by crop products grown using a biofortification strategy. In particular, the direction that is based on the application of specially selected mineral fertilizers during the cultivation of vegetables, fruits and cereals. This direction is characterized by relative simplicity of implementation, insignificant cost of each individual intervention and fast effect [8]. It is increasingly used in many countries to produce biofortified crops with high levels of vital minerals and vitamins.

In recent years, scientists have studied changes in the macro- and microelement composition of bio-fortified plant raw materials and the effect of fertilizers on the organoleptic properties of grown vegetables.

Biofortification with iodides and iodates promotes the accumulation of iodine in grown lettuce samples [9]. The best results are obtained by applying fertilizer to the surface of the leaves. A pattern was also found - lettuce leaves accumulate more iodine when it is sprayed with iodide-based fertilizer during growth [10]. Application of fertilizers to the soil, which include iodine and selenium, has a positive effect on the content of these trace elements and sack properties of broccoli and carrots grown in greenhouses [11]; apples, pears, strawberries, potatoes, peas [5]; basil, cilantro, onions [12]; cauliflower [13], tomatoes [14].

Calcium biofortification of food crops is important. Varieties of biofortified lettuce were evaluated by sensory parameters and concluded that they do not differ in taste, smell, consistency from control samples [15]. For rice biofortification use a preparation containing iron and boron. The yield is not only high in iron, but also contains more of some amino acids - lysine, threonine, arginine, glutamic acid, etc. [16].

The use of fertilizers recommended in organic farming, contribute to the accumulation of iron and zinc in wheat, rice and corn [17]. The use of biofortified rice for cooking ethnic dishes does not affect their taste and aromatic properties [18]. Biofertilizers increase the iron content in lentils [19].

A promising way to bioenrich vegetables with useful trace elements in Ukraine is the use of environmentally friendly farming methods, including liquid, organic, environmentally friendly fertilizers "Riverm" [20-21]. Using Riverm, you can get bio-fortified plant products enriched with minerals and vitamins naturally [22-26]. However, crop production occurs without the use of harmful chemical compounds [21].

Due to the above facts, the aim of the article was to conduct a comprehensive assessment of the quality of biofortified pumpkins with organic fertilizer "Riverm". The objects of the research are biofortified and control samples of pumpkin vegetables: pumpkins of Oleshkivsky and Sviten varieties, melons of Fortuna and Olbia varieties, watermelons of Orpheus and Atlant varieties.

Materials and methods.

In order to better assess the biofortifiable pumpkin vegetables of different varieties, their comprehensive quality assessment was conducted. The following groups of indicators were used for calculations - group A: organoleptic (appearance, size, taste and smell, fruit maturity); group B: macronutrient composition (dry matter content, total sugar content, pectin content, protein content); group C: micronutrient composition (those micronutrients that are currently most important for overcoming "hidden hunger" - vitamins C, B1, B2, B9, carotenoids, iron, zinc, copper).

Results.

Absolute and baseline values were used to determine relative quality indicators. For the group of organoleptic indicators (group A) the estimation on a 5-point scale is given, thus the graph of function of desirability is used for translation of the received absolute values into relative sizes. For groups B and C, the values obtained by standard methods and translated into relative values to their baseline values were used. Calculations of relative quality indicators (q) for groups A, B and C were performed according to equation 1.

$$q = P_i / P_{bas}, \quad (1)$$

where: P_i – value of the indicator i;

P_{bas} – value of the indicator base.

The weighting factors of each quality indicator were also determined by groups in compliance with this requirement 2.

$$\sum_{i \; 1}^{n} V_i = 1, \quad (2)$$

where: V_i – the coefficient of weight of the indicator i;

n – the number of quality indicators in a particular group.

Group assessment of the quality of the studied vegetables was calculated for each group of properties and brought together using an additive model of integrated assessment.

The equation 3 was used for the group of properties A.

$$Ka = (Va_1 \times qa_1) + (Va_2 \times qa_2) + (Va_3 \times qa_3) + (Va_4 \times qa_4), \quad (3)$$

where: Ka – group assessment of vegetable quality (group A);
Va_1 – weighting factor for the appearance of vegetables;
qa_1 – relative quality indicator for appearance;
Va_2 – weighting factor for the size of vegetables;
qa_2 – relative quality indicator for the size of vegetables;
Va_3 - weighting factor for the taste and smell of vegetables;
qa_3 – relative quality indicator for the taste and smell of vegetables;
Va_4 – weighting factor for vegetable ripeness;
qa_4 – relative quality indicator for ripeness of vegetables.

The equation 4 was used for the group of properties B.

$$Kb = (Vb_1 \times qb_1) + (Vb_2 \times qb_2) + (Vb_3 \times qb_3), + (Vb_4 \times qb_4), \quad (4)$$

where: Kb – group assessment of vegetable quality (group B);
Vb_1 – weighting factor for dry matter content;
qb_1 – relative quality index for dry matter content;
Vb_2 – weighting factor for total sugar content;
qb_2 – relative quality index for total sugar content;
Vb_3 – weighting factor for the content of pectin substances;
qb_3 – relative quality index for pectin content;
Vb_4 – weighting factor for protein content;
qb_4 – relative quality index for protein content.

The equation 5 was used for the group of properties C.

$$Kc =(Vc_1 \times qc_1) + (Vc_2 \times qc_2) + (Vc_3 \times qc_3) + (Vc_4 \times qc_4) + (Vc_5 \times qc_5) + (Vc_6 \times qc_6) + (Vc_7 \times qc_7) + (Vc_8 \times qc_8), \quad (5)$$

where: Kc – group assessment of vegetable quality (group C);
Vc_1 – weighting factor for vitamin C content;
qc_1 – relative quality index for vitamin C content;
Vc_2 – weighting factor for the content of vitamin B_1;
qc_2 – relative quality index for vitamin B_1 content;
Vc_3 – weighting factor for vitamin B_2 content;
qc_3 – relative quality index for vitamin B_2 content;
Vc_4 – weighting factor for carotenoid content;
qc_4 – relative quality index for carotenoid content;
Vc_5 – weighting factor for vitamin B_9 content;
qc_5 – relative quality index for vitamin B_9 content;
Vc_6 – weighting factor for iron content;
qc_6 – relative quality index for iron content;
Vc_7 – weighting factor for copper content;
qc_7 – relative quality index for copper content;
Vc_8 – weighting factor for zinc content;
qc_8 – relative quality index for zinc content.

Therefore, the weights of quality indicators for individual groups of properties of biofortified vegetables amounted to:

– for group A properties– $Va_1 = 0,24$, $Va_2 = 0,23$, $Va_3 = 0,27$, $Va_4 = 0,26$.

– for group B properties – $Vb_1 = 0,27$, $Vb_2 = 0,26$, $Vb_3 = 0,24$, $Vb_4 = 0,23$.

– for group C properties – $Vc_1 = 0,13$, $Vc_2 = 0,12$, $Vc_3 = 0,12$, $Vc_4 = 0,12$, $Vc_5 = 0,13$, $Vc_6 = 0,14$, $Vc_7 = 0,12$, $Vc_8 = 0,12$.

A comprehensive assessment of the quality of biofortified (grown with the use of fertilizer "Riverm") and control samples of pumpkin vegetables: pumpkins, melons and watermelons. Pumpkins of varieties Oleshkivsky and Sviten, melons of varieties Fortuna and Olvia, watermelons of varieties Orpheus and Atlant were taken for research. At the first stage, the calculations of relative quality indicators for appearance, size, taste and smell, fruit maturity - indicators of group A. The results of the calculations are presented in table 1.

Table 1 - Relative quality indicators of pumpkin vegetables for group A

Name and variety of vegetables		Organoleptic indicators							
		appearance, point rating		size, point rating		taste and smell, point rating		fruit maturity, point rating	
		Pa_1	qa_1	Pa_2	qa_2	Pa_3	qa_3	Pa_4	qa_4
Pumpkins of the Oleshkivsky variety	experiment	4,4	0,88	4,8	0,96	4,0	0,80	4,6	0,92
	control	4,2	0,84	5,0	1,0	3,6	0,72	4,6	0,92
Pumpkins of the Sviten variety	experiment	5,0	1,0	4,6	0,92	4,2	0,84	4,6	0,92
	control	5,0	1,0	4,6	0,92	3,6	0,72	4,6	0,92
Melon of the Fortuna variety	experiment	4,4	0,88	4,8	0,96	5,0	1,0	4,6	0,92
	control	4,4	0,88	5,0	1,0	4,0	0,80	4,6	0,92
Melon of the Olvia variety	experiment	5,0	1,0	5,0	1,0	5,0	1,0	4,6	0,92
	control	4,8	0,96	4,6	0,92	4,0	0,80	4,6	0,92
Watermelons of the Orpheus variety	experiment	5,0	1,0	5,0	1,0	5,0	1,0	5,0	1,0
	control	5,0	1,0	4,8	0,96	4,6	0,92	5,0	1,0
Watermelons of the Atlant variety	experiment	5,0	1,0	4,8	0,96	4,6	0,92	5,0	1.0
	control	5,0	1,0	4,6	0,92	4,2	0,84	4,8	0,96

At the next stage, the relative quality indicators of the studied samples of pumpkins, melons and watermelons for group B were calculated and presented in table 2. The group of indicators of group B (macronutrient composition) we included the content of dry matter, total sugar, pectin, protein. Thus, for basic indicators for group B during calculations of relative indicators of quality of the investigated grades of pumpkins it was accepted: $Pb_{1\ bas} = 8,78$ %, $Pb_{2\ bas} = 2,22$ %, $Pb_{3\ bas} = 0,44$ %, $Pb_{4bas} = 1,13$ %; of the studied samples of melons of grades Fortuna and Olvia – $Pb_{1bas} = 11,68$ %, $Pb_{2\ bas} = 9,78$ %, $Pb_{3\ bas} = 0,85$ %, $Pb_{4\ bas} = 0,77$ %; studied samples of watermelons varieties Orpheus and Atlant – $Pb_{1\ bas} = 10,36$ %, $Pb_{2\ bas} = 8,24$ %, $Pb_{3bas} = 0,79$ %, $Pb_{4bas} = 0,79$ %.

The indicators of group C include the content of those micronutrients, the lack of which in the diet causes micronutrient starvation, to overcome which the world community uses a strategy of biofortification. These are vitamins C, B1, B2, B9, carotenoids, as well as iron, zinc, copper. To calculate the relative quality indicators of the studied pumpkin samples for group C (micronutrient composition) we used the following basic indicators: $Pc_{1\ bas}$ = 21,02 mg/100g, $Pc_{2\ bas}$ = 23,06 mg/100g, $Pc_{3\ bas}$ = 12,78 mg/100g, $Pc_{4\ bas}$ = 22,74 mg/100g, $Pc_{5\ bas}$ =30,5 µg/100g, $Pc_{6\ bas}$ =1,85 mg/kg, $Pc_{7\ bas}$ = 1,46 mg/kg, $Pc_{8\ баз}$ = 3,31 mg/kg. In determining the relative quality indicators of experimental samples of melons of varieties Fortuna and Olvia for group C (micronutrient composition) the following basic indicators were used: $Pc_{1\ bas}$ = 95,1 mg/100g, $Pc_{2\ bas}$ = 23,06 mg/100g, $Pc_{3\ bas}$ = 21,16 mg/100g, $Pc_{4\ bas}$ = 1,48 mg/100g, $Pc_{5\ bas}$ = 59,6 µg/100g, $Pc_{6\ bas}$ = 1,67 mg/kg, $Pc_{7\ bas}$ = 1,90 mg/kg, $Pc_{8\ bas}$ = 3,19 mg/kg. In order to determine the relative quality indicators of the studied samples of watermelons varieties Orpheus and Atlant for group C, used the basic indicators: $Pc_{1\ bas}$ = 24,13 mg/100g, $Pc_{2\ bas}$ = 29,2 mg/100g, $Pc_{3\ bas}$ = 50,24 mg/100g, $Pc_{4\ bas}$ = 0,54 mg/100g, $Pc_{5\ bas}$ = 53,5 µg/100g, $Pc_{6\ bas}$ = 1,6 mg/kg, $Pc_{7\ bas}$ = 2,57 mg/kg, $Pc_{8\ bas}$ = 3,61 mg/kg. The obtained data are shown in table 3.

Table 2 - Relative quality indicators of pumpkin vegetables for group B

Name and variety of vegetables		Macronutrient composition							
		dry matter, %		total sugar, %		pectin substances, %		albumen, %	
		Pb_1	qb_1	Pb_2	qb_2	Pb_3	qb_3	Pb_4	qb_4
Pumpkins of the Oleshkivsky variety	experiment	7,60	0,86	1,15	0,52	0,42	0,95	1,13	1,0
	control	7,26	0,83	1,05	0,47	0,33	0,75	1,08	0,96
Pumpkins of the Sviten variety	experiment	8,78	1,0	2,22	1,0	0,44	1,0	0,91	0,81
	control	8,36	0,95	2,09	0,94	0,35	0,80	0,77	0,68
Melon of the Fortuna variety	experiment	11,68	1,0	9,78	1,0	0,78	0,91	0,73	0,94
	control	11,36	0,97	7,76	0,79	0,72	0,85	0,61	0,79
Melon of the Olvia variety	experiment	9,95	0,85	7,15	0,73	0,85	1,0	0,77	1,0
	control	9,60	0,82	5,87	0,60	0,79	0,93	0,72	0,94
Watermelons of the Orpheus variety	experiment	10,36	1,0	8,24	1,0	0,68	0,86	0,79	1,0
	control	10,16	0,98	7,14	0,87	0,61	0,77	0,71	0,90
Watermelons of the Atlant variety	experiment	9,42	0,91	7,21	0,88	0,79	1,0	0,79	1,0
	control	9,17	0,89	6,45	0,78	0,70	0,89	0,72	0,91

Based on the obtained relative quality indicators of pumpkin vegetables for groups A, B and C, the group indicators were calculated, which are presented in table 4.

Using intergroup weights, in particular $Va_к$ = 0,33, $Vb_к$ = 0,32, $Vc_к$ = 0,35, a comprehensive assessment of the quality of pumpkin vegetables was calculated by the equation 6:

$$K_o = (Va_к \times Ka) + (Vb_к \times Kb) + (Vc_к \times Kc) \quad (6)$$

The results of a comprehensive assessment of the quality of the studied samples of vegetables are shown in Fig. 1, which shows that the complex quality indicator of biofortified pumpkins of the Oleshkivsky variety is 0.90 (control - 0.79), pumpkins of the Sviten variety - 0.94 (control - 0.81). In biofortified melons of the Fortuna variety, this indicator is at the level of 0.97 (control - 0.85), for Olvia melons - 0.93 (control - 0.82). Also, according to the obtained data, biofortified watermelons of varieties Orpheus and Atlant have a higher overall quality index compared to control samples. In particular, the biofortified watermelons of the Orpheus variety have a complex quality indicator - 0.94 (control - 0.86), the watermelons of the Atlant variety - 0.92 (control - 0.83).

Table 3 - Relative quality indicators of pumpkin vegetables for group C

Name and variety of vegetables		Micronutrient composition															
		vitamin C, mg/100g		vitamin B_1, mg/100g		vitamin B_2, mg/100g		carotenoid mg/100g		vitamin B_9, mg/100g		iron, mg/kg		copper, mg/kg		zinc, mg/kg	
		Pc_1	qc_1	Pc_2	qc_2	Pc_3	qc_3	Pc_4	qc_4	Pc_5	qc_5	Pc_6	qc_6	Pc_7	qc_7	Pc_8	qc_8
Pumpkins of the Oleshkivsky variety	E	21,02	1,0	23,06	1,0	12,78	1,0	22,74	1,0	26,2	0,86	1,85	1,0	1,46	1,0	3,31	1,0
	C	14,92	0,71	12,76	0,55	8,4	0,66	17,56	0,77	18,6	0,61	1,58	0,85	1,42	0,97	3,24	0,98
Pumpkins of the Sviten variety	E	19,31	0,92	20,11	0,87	10,56	0,83	20,12	0,88	30,5	1,0	1,81	0,98	1,44	0,99	3,28	0,99
	C	12,64	0,60	10,58	0,46	6,88	0,54	14,94	0,66	21,3	0,70	1,52	0,82	1,36	0,93	3,20	0,97
Melon of the Fortuna variety	E	95,1	1,0	23,06	1,0	21,16	1,0	1,48	1,0	59,6	1,0	1,67	1,0	1,90	1,0	3,19	1,0
	C	62,3	0,66	12,76	0,55	18,08	0,85	1,12	0,76	48,0	0,81	1,52	0,91	1,67	0,88	3,04	0,95
Melon of the Olvia variety	E	91,17	0,96	20,31	0,88	20,92	0,99	1,45	0,98	47,5	0,80	1,62	0,97	1,83	0,96	3,12	0,98
	C	58,37	0,61	12,54	0,54	17,88	0,84	1,10	0,74	35,3	0,59	1,48	0,89	1,62	0,85	2,98	0,93
Watermelons of the Orpheus variety	E	21,98	0,91	29,2	1,0	50,24	1,0	0,45	0,83	46,8	0,87	1,57	0,98	2,57	1,0	3,4	0,94
	C	16,06	0,67	20,7	0,71	32,50	0,65	0,38	0,70	40,0	0,75	1,38	0,86	2,57	1,0	3,21	0,89
Watermelons of the Atlant variety	E	24,13	1,0	20,42	0,70	34,21	0,68	0,54	1,0	53,5	1,0	1,6	1	2,38	0,93	3,61	1,0
	C	18,05	0,82	12,0	0,41	16,61	0,33	0,46	0,85	46,1	0,86	1,42	0,89	2,27	0,88	2,68	0,74

E – experiment, C – control

Table 4 - Group quality indicators of pumpkin vegetables

Name and variety of vegetables		Organoleptic indicators (Ka)	Macronutrient composition (Kb)	Micronutrient composition (Kc)
Pumpkins of the Oleshkivsky variety	E	0,89	0,83	0,98
	C	0,86	0,74	0,77
Pumpkins of the Sviten variety	E	0,92	0,96	0,94
	C	0,88	0,85	0,72
Melon of the Fortuna variety	E	0,94	0,97	1,0
	C	0,90	0,85	0,81
Melon of the Olvia variety	E	0,98	0,89	0,95
	C	0,90	0,82	0,74
Watermelons of the Orpheus variety	E	1,0	0,97	0,91
	C	0,97	0,88	0,79
Watermelons of the Atlant variety	E	0,97	0,95	0,91
	C	0,93	0,86	0,73

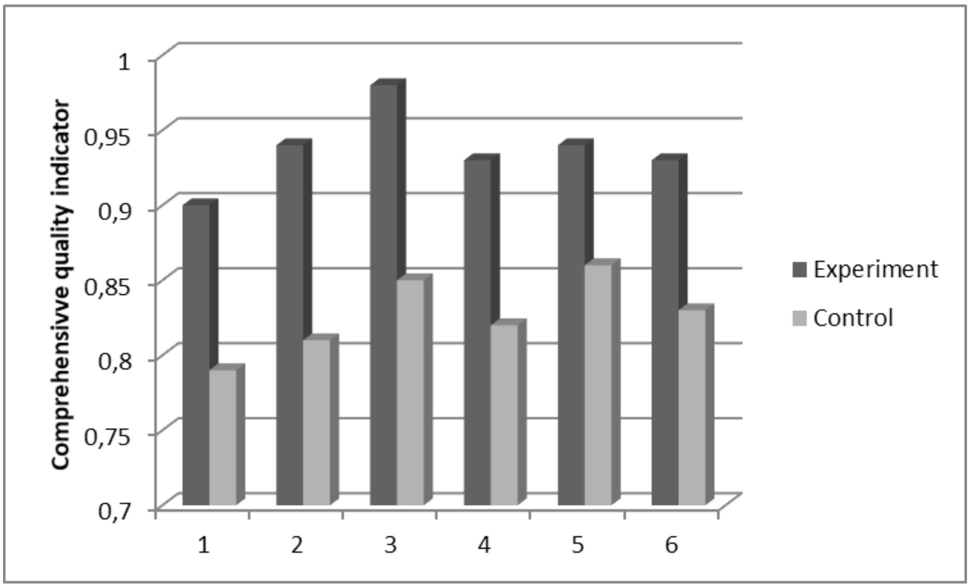

Fig. 1 - A comprehensive indicator of the quality of the studied pumpkin vegetables: *1– Pumpkins of the Oleshkivsky variety, 2– Pumpkins of the Sviten variety, 3– Melon of the Fortuna variety, 4 – Melon of the Olvia variety; 5 – Watermelons of the Orpheus variety, 6 – Watermelons of the Atlant variety*

Conclusions.

The complex quality index of bifortified vegetables in all cases exceeded the figure in the control samples (vegetables grown by standard technology).

Thus, pumpkin vegetables grown using organic, environmentally friendly fertilizer "Riverm" were more valuable in organoleptic (appearance, size, taste and smell, fruit ripeness), physicochemical (dry matter, total sugar, pectin, protein) indicators and content of important micronutrients (vitamins C, B1, B2, B9, carotenoids, iron, zinc, copper).

The use of biofortified pumpkin vegetables can reduce the deficiency of essential micronutrients in the diet.

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Анотація. *Нині значна увага у світі зосереджена на одержанні рослинної сировини з підвищеним вмістом життєважливих сполук. Одним із напрямків, який постійно розвивається, є біофортифікація шляхом застосування спеціальних добрив під час вирощування. Мета: Проведення комплексної оцінки якості біофортифікованих гарбузових овочів з урахуванням вмісту важливих мікро- і макронутрієнтів та органолептичних показників. Методи: комплексний метод оцінки рівня якості. Результати: Біофортифіковані гарбузові овочі відрізняються підвищеним вмістом макро- і мікроелементів і відмінними органолептичними властивостями. Висновки: комплексні показники якості всіх досліджених зразків біофортифікованих гарбузових овочів були вищими порівняно з контролем.*

Ключові слова: *біофортифікація, гарбузові овочі, «Ріверм», комплексна оцінка, макронутрієнти, мікронутрієнти*

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