

Peculiarities of the Chemical Composition of Kohlrabi Varieties Cultivated in Ukraine

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ABSTRACT

The paper presents the results of experimental research on the peculiarities of the chemical composition of kohlrabi varieties 'Azur', 'Videnska Synia', 'Videnska Bila' and 'Hihant' cultivated in field conditions in the Forest Steppe of Ukraine. The goal of the research was to track changes in the biochemical composition of kohlrabi under the effect of varietal factor. The experiment was carried out in the years 2018–2021. It was found that the vegetation period of the variety 'Hihant' is 145 days, while the vegetation period of varieties 'Azur', 'Videnska Synia' and 'Videnska Bila' ranges between 60 and 80 days. As a result of the longer vegetation period, 'Hihant' overcomes other varieties under study by the content of water (88.7%) and dietary fiber (2.1 g/kg). Kohlrabi variety 'Videnska Synia' is the most suitable for dietary nutrition, since it has a higher content of vitamins A, B₁, B₉, B₄, C, B₃, and essential amino acids, such as arginine, valine, histidine, isoleucine, leucine, lysine and phenylalanine, compared to other varieties. The content of linoleic, linolenic and palmitic acids is also the highest in 'Videnska Synia'. However, the content of vitamin B₆ is the highest in 'Hihant'.

Keywords: vitamins, macro and micronutrients, essential amino acids.

INTRODUCTION

Cabbage crops contain many biologically active compounds such as amino acids, anthocyanins, glucosinolates and polyphenols (Delgado-Vargas et al., 2000; Cartea et al., 2011). Amino acids play an important role in plant growth and development; they provide the ground for protein biosynthesis and play a key role in plant response to stress (Schäfer et al., 2016; Hildebrandt et al., 2015). The value of kohlrabi for the human body is that it contains nine essential amino acids, specifically valine, isoleucine, leucine, lysine, methionine, tryptophan, threonine and phenylalanine. Amino acids, acting as antioxidants, can effectively absorb free radicals and promote the synthesis of various metabolites and

neurotransmitters (Fernstrom, 1994), while glutamic and aspartic acid help reduce oxidative stress (Duan, et al., 2016). Cabbage crops are also rich in phytochemicals that have a preventive effect against cancer, atherosclerosis, nephritis and diabetes (Taveira, et al., 2009). Nowadays, amino acids and polyphenols are the most interesting antioxidants widely used in nutrition and medicine (Zhang, et al., 2012).

Other scientists reported that biochemical compounds can play an important role in plant resistance to stress (Kovalikova, et al., 2019) [24]. Many studies point out that the content of amino acids and polyphenols in plant tissues is a good indicator of the plant's resistance to stress (Pereira, 2016; Lattanzio, 2013). Some studies also note that changes in the amino acid,

flavonoid, polyphenolic and vitamin composition of plant tissues are associated with varietal characteristics and can be affected by many external factors. At the same time, resistance to abiotic stress strongly correlates with varietal factor (Zhu, et al., 2018). Therefore, taking into account the previous studies, this research aimed to establish the differences in the biochemical composition of different kohlrabi varieties.

MATERIALS AND METHODS

We studied kohlrabi varieties ‘Azur’, ‘Videnska Synia’, ‘Videnska Bila’ and ‘Hihant’. ‘Azur’ variety has a vegetation period of 50–60 days from germination to harvest. The variety is designed for spring and autumn cultivation. The bulb is flat-rounded and purple. It has sweet white dense flesh. The variety is highly resistant to bolting and drought. It has excellent taste and good commercial form. ‘Videnska Synia’ is a high-yielding variety with a vegetation period of 72–80 days from germination to harvest. The bulb is lilac-blue and has a round flat shape with an average weight of 160 g. The flesh is juicy and tender and contains a lot of sugars and vitamins. The variety is highly-resistant to adverse weather conditions.

‘Videnska Bila’ is a high-yielding variety with a vegetation period from germination to harvest of 70–80 days. The bulb is pale green, rounded or flat-rounded, with a weight of up to 300 g. The flesh is juicy, tasty and very tender. The variety can be grown in open ground or under film cover. ‘Hihant’ is a high-yielding variety with a vegetation period of 70–75 days from germination to harvest. The bulb is pale green, rounded, with a weight of up to 3000 g. The flesh is juicy, tasty and very tender. The variety can be grown in open ground. It is highly resistant to drought and is not demanding to the conditions of cultivation.

The research was carried out in the years 2018–2021 at the Uman National University of Horticulture and Institute of Bioenergy Crops and Sugar Beet NAAS. The cultivation of kohlrabi varieties was carried out in the research field of the Research and Production Department of the Uman National University of Horticulture. The accounting plot area was 12 m². The experiment was carried out with four replications. The scheme of planting was 70×25 cm, and plant density was 57.1 k plants per hectare. The soil of the experimental field was heavy loamy chernozem

with a humus content of 3.8% and pH of 5.7. The content of easily hydrolysable nitrogen (by the Kornfield method) was low (105 mg/kg) and mobile phosphorus and potassium (by the Chirikov method) were high (106 mg/kg and 132 mg/kg, respectively). Yield accounting in all experimental treatments was carried out by the weight method by dividing the crop into commodity and non-commodity parts.

The content of protein was determined by the Kjeldahl method; the content of carbohydrates was measured with the use of a sugar meter; the content of ash was measured by the method of burning in a muffle furnace; the content of fat was determined by the defatted residue method; the content of vitamin C was determined by the iodometric method, and other vitamins by the method of liquid chromatography using the Chromos-301 analyzer; the content of minerals was determined by the method of atomic absorption spectrometry. Statistical processing of the experimental data and determination of their reliability was performed with a package of standard programs (MS Office Excel).

RESEARCH RESULTS

Experimental results on the vegetation period show that in ‘Azur’, ‘Videnska Synia’ and ‘Videnska Bila’, this indicator corresponds to varietal characteristics; however, the vegetation period of ‘Hihant’ is much longer; therefore the yield of bulbs can be twice as high compared to other varieties (Table 1).

A longer vegetation period of the ‘Hihant’ variety affected the patterns of accumulation of biochemicals in the bulb (Table 2). Prolonged vegetation does not always provide conditions for the formation of high-quality kohlrabi crops, and in this variety, the content of proteins and carbohydrates was the smallest compared to other varieties. Instead, its bulbs had the highest content of water (88.7%) and dietary fiber (2.1 g/kg), which can potentially deteriorate its taste when eaten uncooked. ‘Videnska Synia’ was a leader by the content of vitamins such as A, B1, B9, B4, C and B3, while the content of vitamin B6 was the highest in the bulbs of ‘Hihant’.

Cabbage traditionally has a high content of biologically active compounds (Šamec et al., 2017) and can provide 72% of the recommended daily dose of vitamin K, 44% of vitamin C, 11%

Table 1. Duration of the vegetation period, yield and colour of kohlrabi bulbs grown in open ground

Variety	Vegetation period days	Yield kg/m ²	Colour
'Azur'	60	2.1	purple
'Videnska Synia'	80	1.5	purple
'Videnska Bila'	75	1.2	white
'Hihant'	145	4.0	white
LSD _{0.05}	10	0.2	-

Table 2. Biochemical indicators of kohlrabi bulbs grown in open ground

No	Biochemical indicator	Variety			
		'Azur'	'Videnska Synia'	'Videnska Bila'	'Hihant'
1	Proteins	2.8	3.2	2.7	1.8
2	Fat	0.2	0.2	0.2	0.1
3	Carbohydrates	7.9	7.4	7.5	5.9
4	Water	86.2	85.9	87.1	88.7
5	Dietary fiber	1.7	1.9	1.3	2.1
6	Ash, %	1.2	1.4	1.2	1.4
7	Mono and disaccharides, %	7.5	7.0	7.0	5.3
Vitamins					
1	A, µg/100 g	18	21	16	18
2	B1, mg/100 g	0.06	0.08	0.04	0.06
3	B2, mg/100 g	0.05	0.05	0.05	0.05
4	B9, µg/100 g	17	26	13	11
5	B4, mg/100 g	12.5	15	11	13
6	C, mg/100 g	50	57	48	50
7	B5, mg/100 g	0.1	0.1	0.1	0.1
8	B6, mg/100 g	0.18	0.21	0.16	0.24
9	E, mg/100 g	0.2	0.2	0.2	0.2
10	B3, mg/100 g	1.3	1.5	1.1	1.3
11	K, µg/100 g	0.1	0.1	0.1	0.1
Minerals					
1	K, mg/100 g	370	379	360	350
2	Ca, mg/100 g	45	45	45	45
3	Mg, mg/100 g	32	37	30	46
4	Fe, mg/100 g	0.7	0.7	0.5	0.5
5	Na, mg/100 g	11	15	9	11
6	Se, µg/100 g	0.6	0.6	0.6	0.6

of folic acid and 10% of vitamin B6 (Podsędek, 2007). Provitamins α -carotene and β -carotene are essential for healthy skin and bones, vitamin E regulates enzyme activity and gene expression, and vitamin C plays a role in strengthening the immune system (Combs, 2012). According to the data reported by other scientists, the content of β -carotene in kohlrabi ranges from 10 to 130 µg/100 g, vitamin C 5 to 51.1 mg/100 g and vitamin E 0.03 to 0.509 mg/100 g (Singh et al., 2007;

Peñas et al., 2011; Park et al., 2014). Therefore, our results are consistent with the data reported by other scientists.

Regarding the amino acid composition of the kohlrabi bulbs grown in open ground, 'Videnska Synia' has the highest content of essential amino acids, such as arginine, valine, histidine, isoleucine, leucine, lysine and phenylalanine. The content of linoleic, linolenic and palmitic acids in this variety was also higher (Table 3).

Table 3. Amino acid and acid composition of kohlrabi bulbs grown in open ground

No	Chemicals	Variety			
		'Azur'	'Videnska Synia'	'Videnska Bila'	'Hihant'
Essential amino acids, g/100 g					
1	Arginine	0.110	0.125	0.005	0.110
2	Valine	0.050	0.057	0.050	0.050
3	Histidine	0.020	0.026	0.020	0.023
4	Isoleucine	0,080	0.083	0.077	0,080
5	Leucine	0.071	0.075	0.066	0.062
6	Lysine	0.055	0.059	0.051	0.043
7	Methionine	0.015	0.015	0.015	0.015
8	Threonine	0.053	0,056	0.050	0.058
9	Tryptophan	0.010	0.010	0.010	0.010
10	Phenylalanine	0.040	0.046	0.043	0.040
11	Cystine	0.007	0.007	0.007	0.007
Acids, g/100 g					
1	Oleic	0.007	0.007	0.007	0.007
2	Linoleic	0.022	0.026	0.020	0.014
3	Linolenic	0,027	0.029	0.023	0.025
4	Palmitic	0.012	0.017	0.008	0.005
5	Stearic	0.001	0.001	0.001	0.001

In the 'Hihant' variety, we determined high content of the essential amino acid threonine and good values of the content of arginine, histidine, isoleucine and methionine.

Amino acids and polyphenols are considered important biomarkers, and their metabolic changes can reflect plant responses to biotic and abiotic stress (Riga et al., 2019; Sarker, Oba, 2019; Jorge, et al., 2016). Therefore, the patterns of changes in the amino acid composition of bulbs of different kohlrabi varieties should be further investigated.

CONCLUSIONS

It was found that the vegetation period of the kohlrabi variety 'Hihant' is 145 days, while the vegetation period of varieties 'Azur', 'Videnska Synia' and 'Videnska Bila' ranges between 60 and 80 days. As a result of the longer vegetation period, 'Hihant' overcomes the other studied varieties by the content of water (88.7%) and dietary fiber (2.1 g/kg). Kohlrabi variety 'Videnska Synia' demonstrates the highest content of vitamins A, B1, B9, B4, C, B3 and essential amino acids, such as arginine, valine, histidine, isoleucine, leucine, lysine and phenylalanine, compared to other varieties. The content of linoleic, linolenic and palmitic acids

is also higher in this variety. Therefore, 'Videnska Synia' can be recommended as a dietary product.

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