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STUDY OF INDICATORS OF CHEMICAL COMPOSITION OF ZUCCHINI PRODUCTS (*CUCURBITA PEPO* VAR. *GIRAUMONTIA DUCH.*) IN THE CONDITIONS OF THE FOREST-STEPPE OF UKRAINE

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Анотація

За результатами проведених досліджень виявлено вплив сортових особливостей на врожайність, біометричні параметри продукції та їх хімічний склад. Серед досліджуваних сортів найвищу врожайність сформував Чаклун – 62,0 т/га, де приріст відносно контролю склав 8,7 т/га. Серед гібридів найбільшу врожайність забезпечив гібрид Искандер F₁ – 57,8 т/га, а це на 9,4 т/га більше від контролю. Найбільшу кількість плодів мали рослини сорту Чаклун – 18,0 шт./рослину та гібриду Искандер F₁ – 16,9 шт./рослину. Найбільший вміст цукру в плодах був у сорту Золотінка та гібриду Алія F₁ – 2,3 та 2,2 % відповідно. Найбільшим вмістом сухої речовини відзначився сорт Золотінка – 5,6 %, що на 0,1 % більше від контролю та гібрид Искандер F₁ – 5,6 %, що на 0,2 % більше в порівнянні з контрольним варіантом. Вміст каротину у всіх досліджуваних сортів і гібридів суттєво не відрізнявся і був на рівні 0,12–0,29 мг/кг. Найменшим вмістом нітратів серед сортів характеризувався контрольний варіант (сорт Грибовський 37) – 54,0 мг/кг.

Abstract

According to the results of the research, the influence of varietal characteristics on yield, biometric parameters of products and their chemical composition was revealed. Among the studied varieties, the highest yield was formed by the Chaklun – 62.0 t / ha, where the increase relative to control was 8.7t / ha. Among hybrids, the highest yield was provided by the Iskander F₁ hybrid – 57.8 t / ha, which is 9.4 t / ha more than the control. Plants of the Chaklun variety had the largest number of fruits – 18.0 pieces / plant and Iskander F₁ hybrid – 16.9 pieces / plant. The highest sugar content in the fruits was in the variety Zolotinka and hybrid Alia F₁ – 2.3 and 2.2 %, respectively. The highest dry matter content was the variety Zolotinka – 5.6 %, which is 0.1 % more than the control and the hybrid Iskander F₁ – 5.6 %, which is 0.2 % more compared to the control variant. The content of carotene in all studied varieties and hybrids did not differ significantly and was at the level of 0.12–0.29 mg / kg. The lowest content of nitrates among the varieties was characterized by the control variant (variety Hrybovsky 37) – 54.0 mg / kg.

Ключові слова: кабачок, сорт, гібрид, біометричні параметри, врожайність, хімічний склад.

Keywords: zucchini, variety, hybrid, biometric parameters, yield, chemical composition.

Formulation of the problem. The formation of a high level of yield and product quality is a prerequisite for growing vegetables, including zucchini. It is important to study the biological ability of varieties of Ukrainian and hybrids of foreign selection to form a high level of fruit yield of normalized quality [11, 15, 32]. Zucchini – a valuable, widespread vegetable plant, in recent years has attracted attention due to its precocity, high yield, diet and cold resistance. Growing zucchini does not require significant labor and energy costs, which allows you to expand the range, improve the supply of vegetables to the population in the early stages [2-4, 28]. Zucchini is a large fleshy, multi-seeded false berry with a rich chemical composition. Vegetables, including zucchini, occupy an important place in the human diet. Their value is in the content of carbohydrates, proteins, fats, vitamins, enzymes and other substances. Vegetables are a source of a variety

of vitamins without which the human body cannot develop and function. Thus, pumpkins, including zucchini, contain carotene (provitamin A) [1, 25, 31].

The advantage of zucchini over other vegetables is high yields and consumer value. The composition of fruits includes proteins, carbohydrates, fat, fiber, ash substances. In technical maturity, they contain vitamins, organic acids, carotene, enzymes and other useful substances for humans. The seeds contain a lot of fat [90]. Zucchini fruit contains less sugar than pumpkin, but is richer in mineral salts and vitamin C [8, 26, 30].

Zucchini is a nutritious product with minimal calories but maximum biological value. Fruits of technical maturity 25–30 cm long and 8–10 cm thick are used for food. Their greens are rich in carbohydrates, vitamins and mineral salts, and are a valuable source of copper, iron, and calcium [7- 10, 24].

Young fruit products have delicate fiber, which is quickly and well absorbed, which is not the case with the fiber of mature fruits. Upon reaching biological maturity, the fruits lose their juiciness and tenderness of the pulp, become hard, because the bark develops a layer of mechanical tissue – sclerenchyma. The smaller the fetus, the younger the ovary, the more nutrients there are [12-15].

The content of nitrates in zucchini products is important. Nitrates themselves are low-toxic. Their potential danger is due to the fact that excessive amounts in the body of nitrates are converted into nitrites, which cause disorders of the body. Nitrates impair immunity, absorption of vitamin A, disrupt the thyroid gland, heart, central nervous system [16-19, 29, 31].

Analysis of recent research and publications.

Today, the problem of reduced human immunity, caused by a significant deterioration of the environmental situation and unbalanced diet, is quite acute. To solve it, many countries around the world have adopted programs at the state level to create health foods, primarily mass consumption, enriched with essential for human health deficient vitamins, macro- and micronutrients and other biologically active compounds.

Zucchini consist of 95.4–91.2 % of water. The amount of sugars is 2.9–5.0 %, including 10–12 % sucrose, fiber – 0.5–0.7, organic acids – 0.05–0.1, crude protein – 0.5–1, 1 %. Zucchini fruits are rich in vitamins: ascorbic acid – 5.0–12.7, thiamine (B₁) – 0.03, riboflavin (B₂) – 0.03, pyridoxine (B₆) – 0.11, folic acid (BC) – 14.0, nicotinic acid (PP) – 0.60 mg / 100 g of crude substance [4]. The nutritional value of zucchini is noted by other authors - sugars, vitamins, organic acids, ash elements [30]. Of great value in the fruits of zucchini is carotene, which reduces the risk of cardiovascular disease and cancer [1, 2]. Zucchini fruits are easily and quickly absorbed by the body, they are used in dietary and medical nutrition [11, 15, 32].

Zucchini contains: 5–7 % dry matter, 0.6 % protein, 4.3 % carbohydrates, 4.9 % sugar, 0.6 % pectin, 0.3 % fiber and 0, 4 % ash. The content of vitamins, mg per 100 g of product: vitamin C – 14, provitamin A and vitamin B₁ and B₂ – 0.03, vitamin PP – 0.6. The energy value is 113 kJ per 100 g of product [15, 16, 22]. Young ovaries aged 7–12 days contain 7 % dry matter, 1 % protein, 0.1 % fat, vitamin C, many mineral salts of phosphorus, potassium, iron and copper [21-25]. When growing zucchini in Ukraine, Moldova and Belarus, the dry matter content in the fruit was in the range of 3.8–8.8 %, sugar 1.9–5.0 %, ascorbic acid 5.0 – 21.5 mg % [12-17].

Zucchini fruits are rich in mineral salts and organic acids, contain carbohydrates and vitamins. They have dietary and medicinal properties. The shape of the fruit of the zucchini – cylindrical (often coinciding with the stalk) white, cream, orange or dark green color. The pulp is white or light green, with a delicate taste [8, 14, 26].

Zucchini fruits consist of 93–94 % of water, their caloric content is 50.4–113.4 kJ per 100 g of product. They contain 0.6 % protein, 2.0–5.7 % carbohydrates, 0.3–1.3 % fiber, 0.1 % organic acids [27-30].

Fruit of zucchini by 95.4–91.2 % consists of water, 2.9–5.0 % sugar, 0.5–0.7 % fiber, 0.05–0.1 % of organic acids based on crude matter, 5.0–12.7 mg / 100 g of crude substance, 0.03 mg / 100 g of crude thiamine (B₁), 0.03 mg / 100 g of crude riboflavin (B₂), 14.0 mg / 100 g of crude folic acid (Sun), 0.60 mg / 100 g of crude nicotinic acid (PP) [1, 2, 4].

Zucchini fruits contain 6.0 – 6.6 % dry matter, 3–3.5 % sugar, 1–1.2 % pectic substances, vitamins A, C, B₁, B₂, PP and 0.2–0.5 % of fiber [14]. Modern hybrids of foreign selection (Kavili F₁, Iskander F₁) were characterized by increased early harvest and contained more dry matter, sugar and vitamin C compared to the fruits of the variety Hrybovsky 37 [14]. The Chaklun variety contains 3.60 % dry matter, 2.81 % sugar, 12.25 mg / % vitamin C [7]. The main indicators of fruit and vegetable products are the content of dry matter, sugars, vitamins. The dry matter content in zucchini fruits ranges from 5.0 to 4.2 %, sugars – 3.1–1.6 %. These varieties have high transportability [14].

Taking into account climatic conditions is an important condition for both the geographical location of plants and growing products. Only under favorable conditions there is an intensive tying and rapid growth of zucchini. During this period, it is necessary to collect the fruit daily to prevent overgrowth [16].

Further growth of production and improvement of commodity indicators of fruits depends on quality of carrying out of technological receptions and use of highly productive grades and hybrids [9]. Selection of high-yielding varieties and hybrids of zucchini will allow to obtain high and stable yields of this crop. Therefore, there is a need to study the varietal diversity of zucchini plants.

The aim of the study. Study of indicators of chemical composition of zucchini products, assessment of yield and biometric parameters of fruits in the Forest-Steppe of Ukraine.

Research methodology. Studies to study the chemical composition of zucchini products, yield and biometric parameters of fruits were conducted in 2016–2018 in the Forest-Steppe of Ukraine in the research field of Vinnytsia National Agrarian University. The soil of the experimental field – gray forest, medium loam, is characterized by the following indicators: humus content 2.4 %, the reaction of the soil solution (pH) 5.8, the amount of absorbed bases 15.3 mg./100 g of soil, P₂O₅ – 21.2 mg / 100 g of soil, K₂O – 9.2 mg / 100 g of soil.

The following varieties were studied in the experiment: Gribovsky 37 (control), Zolotinka, Chaklun and hybrids: Alia F₁ (control), Kavili F₁, Iskander F₁. The area of the accounting plot is 40 m², the experiment is repeated four times. Sowing of seeds was carried out according to the scheme of 120x70 cm, which is – 11.9 thousand pieces / ha.

Field, statistical and laboratory research methods were used in the experimental work. According to the method, phenological observations, biometric measurements and records are provided [5]. The number of fruits was determined by calculation. Harvesting was carried out as the fruit was formed in accordance with

the requirements of the current standard - "Fresh zucchini – DSTU 318 – 91" [9]. The technology of growing plants is generally accepted for the Forest-Steppe zone.

Research results. One of the main indicators in the evaluation of varieties and hybrids of F₁ is the yield (Table 1). Among the studied varieties, the highest yield was formed by Chaklun – 62.0 t / ha, variety Hrybovsky 37 (control) – 53.3 t / ha, which is 8.7 t / ha less. The significance of this difference is confirmed by the results of analysis of variance. Zolotinka variety was characterized by significantly lower yields, it was lower

compared to the control by 10.9 t / ha. The significance of this difference is confirmed by the results of analysis of variance. Among hybrids, the highest yield was provided by the Iskander F₁ hybrid – 57.8 t / ha, which is 9.4 t / ha more than in the control. It was found that the yield of the studied method "variety" influenced with a force of 95.0 %.

Important indicators that characterize the biometric parameters of zucchini products are: the number of fruits per plant, weight and diameter of the fruit (Table 2).

Table 1

Commodity yield of zucchini depending on the variety, hybrid

Variety, hybrid	Yield, t / ha				± to control
	2016	2017	2018	average	
Gribovsky 37 (control)	50,4	53,8	55,6	53,3	-
Zolotinka	36,5	40,2	50,6	42,4	-10,9
Chaklun	58,9	61,4	65,5	62,0	+8,7
Alia F ₁ (control)	43,6	47,2	54,4	48,4	-
Kavili F ₁	45,7	53,8	55,2	51,6	+3,2
Iskander F ₁	52,1	57,1	64,3	57,8	+9,4
HIP _{0,5}	3,2	4,1	3,0	-	-

Table 2

Biometric indicators of zucchini production depending on the variety, hybrid (average for 2016–2018)

Variety, hybrid	Number of fruits, pcs / plant	Fruit weight, g	Fruit diameter, cm
Gribovsky 37 (control)	15,6	288	5,0
Zolotinka	12,5	285	4,7
Chaklun	18,0	290	4,8
Alia F ₁ (control)	14,3	284	4,8
Kavili F ₁	14,8	286	4,8
Iskander F ₁	16,9	282	4,9

The largest number of fruits were plants of the Sorcerer variety – 18.0 pieces / plant, which is 2.4 pieces / plant more than the control (Gribovsky variety 37). Among hybrids, this figure was the highest in the hybrid Iskander F₁ – 16.9 units / plant, which is 2.6 units / plant more than the control. The analysis showed a strong direct relationship between yield and fruit quantity ($r = 0.99$).

The highest weight of the fruit was characterized by the variety Chaklun – 290 g, which is higher than the control by 2.0 g. Plants of Hrybovsky 37 variety (control) differed in the diameter of the zucchini fruit (control) – 5.0 cm. In the studied hybrids, the diameter

of the fruit did not differ significantly and was in the range of 4.8–4.9 cm. fetus ($r = 0.94$) and a strong direct relationship between the number of fruits and their diameter ($r = 0.88$).

One of the important indicators that characterize the quality of the harvest is its chemical composition (Table 3.). The highest sugar content in the fruits was in the variety Zolotinka and hybrid Alia F₁ – 2.3 and 2.2 %, respectively. The lowest figure was in the variety Hrybovsky 37 (control) – 1.3 %. In terms of years studied, most varieties and hybrids had the highest data in 2016, except for the variety Sorcerer and hybrid Iskander F₁.

Table 3

The sugar content in the fruits of zucchini, depending on the variety, hybrid

Variety, hybrid	Sugar, %			
	2016	2017	2018	average
Gribovsky 37 (control)	1,4	1,3	1,1	1,3
Zolotinka	2,4	2,2	2,2	2,3
Chaklun	2,4	2,5	1,3	2,1
Alia F ₁ (control)	2,4	2,1	2,0	2,2
Kavili F ₁	1,5	1,4	1,3	1,4
Iskander F ₁	1,6	1,7	1,4	1,6

The highest dry matter content was Zolotinka – 5.6 %, which is 0.1 % more than the control (Table 4). In other studied varieties the dry matter content was at the level of 5.4–5.5 %. Among the hybrids, the highest dry

matter content was contained in the fruits of the hybrid Iskander F₁ – 5.6 %, which is 0.2 % more than in the control variant.

Table 4.

The dry matter content in the fruits of zucchini, depending on the variety, hybrid

Variety, hybrid	Dry matter, %			
	2016	2017	2018	average
Gribovsky 37 (control)	6,2	5,2	5,0	5,5
Zolotinka	6,3	5,3	5,2	5,6
Chaklun	6,8	4,7	4,7	5,4
Alia F ₁ (control)	6,0	5,1	5,0	5,4
Kavili F ₁	6,4	4,8	4,8	5,3
Iskander F ₁	6,3	5,3	5,2	5,6

The content of carotene in all studied varieties and hybrids did not differ significantly and was at the level of 0.12–0.29 mg / kg (Table 5). The content of nitrates in the fruits of varieties and hybrids was within the maximum allowable level and was 54.0–181 mg / kg (Table 6). The lowest content of nitrates among the varieties was characterized by the control variant (variety

Hrybovsky 37) – 54.0 mg / kg. The highest content of nitrates was found in the fruits of the variety Chaklun – 181 mg / kg. Among hybrids, the lowest and highest content of nitrates were characterized by hybrids Alia F₁ and Cavili F₁ – 87.5 and 157 mg / kg, respectively.

Table 5.

The content of carotene in the fruits of zucchini, depending on the variety, hybrid

Variety, hybrid	Carotene, mg / kg			
	2016	2017	2018	average
Gribovsky 37 (control)	0,15	0,13	0,12	0,13
Zolotinka	0,20	0,19	0,16	0,18
Chaklun	0,14	0,14	0,12	0,13
Alia F ₁ (control)	0,16	0,15	0,14	0,15
Kavili F ₁	0,13	0,12	0,12	0,12
Iskander F ₁	0,29	0,30	0,28	0,29

Table 6.

The content of nitrates in the fruits of zucchini, depending on the variety, hybrid

Variety, hybrid	Nitrates, mg / kg			
	2016	2017	2018	average
Gribovsky 37 (control)	52,0	88,7	21,0	54,0
Zolotinka	121	198	89,8	136
Chaklun	198	228	116	181
Alia F ₁ (control)	98,0	125	40,1	87,5
Kavili F ₁	176	212	83,4	157
Iskander F ₁	87,5	98,5	81,9	89,3

Conclusions and prospects for further research. Thus, studies of 2016–2018 showed that the level of fruit yield depends on the variety and hybrid of zucchini. In terms of the studied years, the yield was different, which depended on weather conditions: primarily on the sum of active temperatures and precipitation, but the pattern of crop formation depending on varietal characteristics was observed in all years of the experiment. Nitrates were found in all studied varieties and hybrids, but their content is within normal limits, so the products are safe for consumption. It should be noted that the nitrate content was influenced by varietal characteristics and weather conditions of years of research. Yes, hot dry weather contributes to a greater accumulation of nitrates in the fruits of zucchini.

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