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ARBNORE BYTYÇI, HYRIJE KORAQI, CENGIZ ÇESKO, BUJAR QAZIMI, ANILA KOPALI, ANKA TRAJKOVSKA PETKOSKA

NUTRIENTS AND ANTI-NUTRIENTS ANALYSIS OF GREEN CABBAGE (*BRASSICA OLERACEA VAR. CAPITATA*)

S u m m a r y

Background. Green cabbage (*Brassica oleracea* var. *capitata*) is a highly nutritious vegetable, offering a wide array of vitamins, minerals, antioxidants and fiber. While it does contain some anti-nutrients, such as goitrogens and oxalates, these compounds generally pose a minimal risk when the vegetable is eaten as part of a balanced diet and consumed in normal amounts. Assessing the content of minerals, vitamin C, β-carotene and anti-nutrient content of green cabbage originating from the Kosovo region was the aim of this study.

Results and conclusions. The majority of nutritional indicators had an inverse or no link with anti-nutrients, according to Pearson correlation data. Significantly positive correlations were found between crude protein and carbohydrates (0.90**), while cyanogenic glycosides (-0.90**) indicated a negative Pearson correlation data. Moreover, cyanogenic glycosides exhibited significant negative relationships with carbohydrates (-0.44*), calcium (-0.66**) and potassium (-0.63**). The vitamins content did not significantly correlate with oxalate and tannin, while tannins and phytate did not significantly correlate with the corresponding mineral content. The results demonstrated the nutrient-dense nature of green cabbage, which may lessen the impact of micronutrient deficits. In addition, the results indicated that green cabbage has a low fat and anti-nutrient content, but it is high in potassium, magnesium and calcium content, which are beneficial to human health.

Key words: green cabbage (*Brassica oleracea* var. *capitata*), minerals, vitamins, anti-nutrients

M. Sc. A. Bytyçi, Faculty of Technology and Technical Sciences, University St. Kliment Ohridski - Bitola, Dimitar Vlahov, Veles 1400, Republic of North Macedonia; prof. dr H. Koraqi ORCID: 0000-0002-4320-8237; Dr C. Çesko ORCID: 0000-0001-6611-3962; Dr B. Qazimi ORCID: 0000-0002-9292-829X; Faculty of Food Science and Biotechnology, UBT-Higher Education Institution, St. Rexhep Krasniqi No. 56, 10000 Pristina, Kosovo; prof. dr A. Kopali, Faculty of Biotechnology and Food, Agricultural University of Tirana, Tirana, Albania; prof. dr A. Trajkovska-Petkoska, ORCID: 0000-0002-9258-7966, Faculty of Technology and Technical Sciences, University St. Kliment Ohridski - Bitola, Dimitar Vlahov, Veles 1400, Republic of North Macedonia, Department of Materials Science and Engineering, Korea University, Seoul, South Korea. Contakt e-mail: anka.trajkovska@uklo.edu.mk

Introduction

The nutrient-dense nature of green vegetables is well acknowledged, particularly by communities that follow plant-based diets [10]. Green vegetables like green cabbage (*Brassica oleracea* var. *capitata*) contain valuable dietary elements that the body can use effectively and are known as unique food crops. They have a significant amount of vitamins and minerals, which are good for preventing illnesses and overall wellbeing [17, 18]. Along with having a low protein content, they are also rich in dietary fiber. Brussels sprouts, broccoli, cauliflower and kale are among the numerous crop species in the Brassicaceae family [16], which includes green cabbage (Brassica *oleracea* var. *capitata*), herbaceous green leafy vegetable [38]. It has a distinct flavor, a crisp texture, a distinctively compact head with tightly packed leaves and colors that range from light green to dark green [2, 39]. Since ancient times, green cabbage (*Brassica oleracea* var. *capitata*) has been used as food and a medicine [20]. Cabbage is also a rich source of essential minerals, such as iron (Fe), calcium (Ca), magnesium (Mg), potassium (K), sodium (Na) and phosphorus (P) [32, 40].

On the other hand, plant food components known as antinutrients or antinutritional factors can have a negative impact on the consumption, absorption of vital nutrients or may produce toxic compounds when they break down [6]. The effects of these substances on human health are so contentious that while some authors point to possible advantages, others advise consuming foods containing them with extra caution and only after processing [25].

A nutrient-dense vegetable like green cabbage (*Brassica oleracea* var. *capitata*) has many health advantages, including anti-inflammatory properties, liver detoxification, better bone health, weight management /loss, improved digestion, skin health, cancer prevention, blood sugar regulation and it can boost the immune system [27]. Evaluating the minerals, proximate analysis, vitamins and anti-nutrient composition of green cabbage (*Brassica oleracea* var. *capitata*) can raise the awareness of abundant nutrients in this vegetable and help nutritionists create balanced diet plans, as well as pave the path towards sustainable food systems, food security and overall better planetary health [40].

To improve sustainable food and nutritional security, nutritionists, agronomists and crop breeders should start considering nutritional and anti-nutritional traits and their interrelationships in vegetables and staple food crops, rather than just yield and yield components. Evaluating the proximate analysis, mineral, vitamin C, β-carotene, anti-nutrient contents and their correlations in green cabbage grown in the region of Kosovo is the main goal behind this study.

Materials and methods

Sample preparation

In the period of May/June of 2024, fresh green cabbage (*Brassica oleracea* var. *capitata*) samples were bought randomly at the local market in Pristina (Kosovo). After being collected, each sample was packaged individually in polyethylene bags and brought to a laboratory for preliminary treatment and analysis.

Preliminary sample treatment

Green cabbage samples were thoroughly cleaned under running water and in some cases the outer layer was removed (1 ÷ 2 mm). The material prepared in this way was cut into sample pieces (2.5 × 2.5 cm). After each treatment, the samples were drained of water and dried on a paper towel at room temperature.

Laboratory analysis

The proximate, mineral, vitamin and anti-nutrient contents were determined through a laboratory analysis. Following a standard protocol, the proximate composition – which comprises moisture, crude protein, crude fat, ash and carbohydrates – was ascertained in triplicate by AOAC (2005) [4]. The crude protein concentration in the samples was determined using the standard semi-micro Kjeldahl method – AOAC (2005) method 988.05, [4] while the crude fat in the samples was analyzed using AOAC (2005) method 2003.06. Moreover, moisture contents were determined using AOAC (2005) method 967.08, the ash concentrations were determined using AOAC (2005) method 942.05, and the crude fiber was analyzed using AOAC (2005) method 958.06 [4]. Finally, the carbohydrate was determined by difference – by subtracting (% moisture + % crude protein + % ether extract + % crude fiber + % ash) from 100%.

The Microwave Plasma Atomic Emission Spectroscopy (MP-AES 4200, Agilent Technologies, Inc. USA) equipment was used to measure the mineral content using a technique that Shemnsa et al. [30] had previously explained. Standard procedures were used to evaluate vitamin C and β-carotene by AOAC (2005) method [4]. Also, standard procedures were used to evaluate antinutrients like tannin, oxalate, phytate and cyanogenic glucosides, too [4]. The phytate contents of the samples were determined using the AOAC (2006) method while oxalate concentration was analyzed using the AOAC (2006) method [5]. In addition, tannin contents in the leaf samples also were analyzed using the AOAC (2006) method [5], and cyanogenic glycoside was analyzed by use of AOAC (2005) method 915.03 [4].

Statistical analysis

Origin Pro 9.0 software (Origin Lab Corporation) was used to statistically analyze the analysis results, which were then presented as the mean ± standard deviation (SD).

To validate and compare the average values of the elements across various sampling sites, a one-way ANOVA and Tukey's test were used to compare the mean values ($p < 0.05$) among samples. Pearson correlation was used to investigate the relationship between the mineral, vitamin and anti-nutrient contents of green cabbage.

Results and discussion

Proximate composition

According to the results in table 1, the moisture content of green cabbage (*Brassica oleracea* var. *capitata*) is 88.61 ± 0.54 g/100 g WB, which is similar to findings of other studieslike 88.4 g/100 g WB in green cabbage and 88.2 g/100 g WB in broccoli [19], but lower than findings in studies showing the following values: 96 g/100 g WB in lettuce, 93.5 g/100 g WB in spinach [19], 92.0 ± 0.12 g/100 g WB in green cabbage, 92.0 ± 0.26 g/100 g WB in cauliflower and 91.0 ± 0.06 g/100 g WB in lettuce [20]. Fruit with a high moisture content (over 15 %) has been shown to support microbial activity during storage; however, *Brassica oleracea* var. *capitata's* compact and fibrous head makes it somewhat difficult for microorganisms to access, extending its shelf life. The amount of ash in the sample, which indicates its inorganic materials, was 1.06 ± 0.10 g/100 g WB. This number is lower than the 2.0 g/100 g WB in spinach but higher than the 0.7 g/100 g WB in cauliflower, 0.6 g/100 g WB in broccoli, 0.6 g/100 g WB in carrots, and 0.4 g/100 g WB in lettuce [19]. The crude fat content of the sample was 0.32 ± 0.06 g/100 g WB, which is somewhat higher than that of 0.3 g/100 g WB in broccoli and 0.3 g/100 g WB in cauliflower, but lower than that of 0.5 % in Brussels sprouts and 0.6 g/100 g WB in kale [3].

The main sources of energy in diets are fats and oils, yet diets heavy in fat are linked to obesity and a number of cardiovascular diseases, including atherosclerosis, cancer, and aging. Compared to 2.3 g/100 g WB in cauliflower, 2.0 g/100 g WB in kale and 2.5 g/100 gWB in Brussels sprouts [3], the crude fiber content of 3.81 ± 0.11 g/100 g DW is greater; nevertheless, it is lower than 4 % in broccoli and 3.9 g/100 g WB in carrots [19]. Dietary fiber is a key component of *Brassica oleracea* var. *capitata* and other Brassica vegetables. It lowers blood cholesterol, lowers the risk of coronary heart disease and helps prevent hypertension, breast and colon cancers, and more. According to Rumeza et al. [26], the crude protein content of the sample amounting to 1.96 ± 0.10 g/100 g DW is higher than the 1.6 ± 0.20 g/100 g WB reported for the same vegetable, 1.40 g/100 g WB for Brussels sprouts, and 1.8 % for cauliflower.

However, it is lower than the 4.6 g/100 g WB for broccoli, 3.4 g/100 g WB for kale [3] and 2.1 ± 0.15 for spinach [26]. The 4.55 ± 0.22 g/100 g DW carbohydrate content is slightly lower than the 4.8 ± 0.01 g/100 g WB reported by Rumeza et al. [26]

for the same vegetable, but it is still within the 2.0–4.6 (g/100gWB) range described by Anon [3] for Brassica plants. The body uses carbohydrates primarily for energy, and people with diabetes and those controlling their weight have been found to benefit from food that contains modest amounts of carbohydrates, such as fruit and vegetables [7]. This demonstrates how low-energy foods like *Brassica oleracea* var. *capitata* can be particularly beneficial for weight-loss programs [9].

Table 1. Content of nutrients of green cabbage *Brassica oleracea* var. *capitata*
Tabela 1. Zawartość składników odżywczych w zielonej kapuście *Brassica oleracea* var. *capitata*

Parameter / Parametr	Content / Zawartość [g/100 g DW]
Moisture / Wilgotność	88.6 ± 0.5
Total Ash / Popiół całkowity	1.1 ± 0.1
Crude fat / Tłuszcz surowy	0.3 ± 0.06
Crude fiber / Włókno surowe	3.8 ± 0.1
Protein / Białko (5.71 × % N)	1.8 ± 0.1
Carbohydrate / Węglowodany	4.6 ± 0.2

Mineral compositions

As demonstrated by the results of the mineral analyses of green cabbage (*Brassica oleracea* var. *capitata*) in Tab. 2, the plant has a higher potassium content than other minerals. Compared to the range of 300 ÷ 400 mg/100 g DW reported for several species of Brassica vegetables, the potassium concentration of 4680 ± 48.1 mg/kg is higher [3]. When it comes to potassium, green cabbage (*Brassica oleracea* var. *capitata*) may offer 33.9 % of the recommended daily amount (RDA), which is 2000 mg for adults. Compared to broccoli cultivars with a sodium concentration of 0.21 ÷ 0.52 g/kg DW, this one has a greater sodium level of 260 ± 50.1 mg/kg DW [15]. Compared to the 600 mg RDA requirement for adults, this vegetable has a high salt level, accounting for 29.33 % of the RDA amount.

It has been suggested that lowering high blood pressure can be achieved with a sodium to potassium ion ratio of less than one ($Na^+/K^+ < 1$). Thus, it implies that the vegetable can be a healthy meal option for people with high blood pressure. The content of calcium, 2980 ± 45.2 mg/kg DW, falls within the range of 2337.3 ÷ 5635 mg/kg for green cabbage (*Brassica oleracea* var. *capitata*) [40]. The results show that this vegetable can provide a significant quantity of dietary calcium, which is necessary for the development and upkeep of bones, teeth and muscles. As a result, it can be used as a supplement in diets that are deficient in calcium ions. A phosphorus concentration of 1234 ± 15.2 mg/kg is less than the 40 mg/100 g DW of the same vegetable that has been reported [3]. The mineral phosphorus helps the body absorb calcium, which is necessary for the development and upkeep of bones, teeth and muscles. While the iron level of 65.8 ± 1.8 mg/kg is higher than the 0.4 mg/100 g DW for the same vegetable, it is lower than the 1.1 mg/100 g DW for broccoli [3], 1.6 mg/100 g for spinach and 0.7 mg/100 g DW for lettuce [37].

Iron is an essential micronutrient for the synthesis of hemoglobin and is a component needed for the oxygen transport system of the body. Additionally, iron serves as a cofactor for a number of crucial enzyme functions. Zinc concentration of 3.4 ± 0.1 mg/kg DW is lower than that of 0.95 mg/100 g DW in broccoli, 0.64 mg/100 g in cauliflower and 0.2 mg/100 g for the same vegetable [36]. In addition to being a cofactor for various enzyme activities, zinc is crucial for controlling cellular development and gene expression. The manganese concentration of 4.10 ± 0.10 mg/kg is higher than the 0.2 mg/100 g DW found in the same vegetable, 0.3 mg/100 g in kale, 0.23 mg/100 g in Brussels sprouts and 0.13 mg/100 g in cauliflower [36].

Together with vitamin K, manganese aids in the production of prothrombin and promotes healthy skeletal growth and development. It is also a crucial cofactor for a variety of enzyme functions [28]. The copper content of 5.52 mg/kg is comparable to the 2.73 ÷ 11.21 mg/kg reported for the same vegetable [40] and falls within the range of 0.04 ÷ 0.09 mg/100 g for different species of Brassica oleracea vegetables [36]. Copper is an essential trace mineral found in green cabbage and many other types of food. While it is required in small amounts, copper plays a vital role in several important physiological processes in the human body [35]. Including cabbage in a balanced diet can help contribute to overall copper intake, especially when combined with other copper-rich foods.

Vitamin C and β-carotene contents

The vitamin C content of 57.4 ± 3.3 mg/100 g in Tab. 2 is lower than that of 120 mg/100 g in broccoli, 90 mg/100 g in brussels sprouts, 110 mg/100 g in kale and 61.5 mg/100 g in cauliflower [3], but higher than that of *Brassica oleracea* capitata 55 ± 0.06 mg/100 g [26] and 28.41 ÷ 45.04 mg/100 g in cabbage (*Brassica Oleracea* L.) [22]. On the other hand, it is higher compared with 5.66 ÷ 23.50 mg/100 g in cabbage (*Brassica oleracea* L. var. *capitata*) reported by authors Singh et al. [31]. The body uses vitamin C as its main antioxidant; a lower risk of colon cancer is linked to consuming foods high in vitamin C. Compared to some fruit, brassica vegetables have been found to be much higher in vitamin C, therefore the *Brassica oleracea* var. *capitata* provides 70.5 % of the daily recommended dietary requirement of 80 mg/100 g.

The β-carotene concentration of 111.8 ± 4.2 μg/100 g is lower than that of 85.9 μg/100 g of broccoli, 35.8 μg/100 g of Brussels sprouts and 765.8 μg/100 g of kale, but greater than the 5.5 μg/100 g found in the same vegetable, 0.9 μg/100 g in cauliflower and 6.0 μg/100 g in turnips [3]. A very good source of β-carotene, *Brassica oleracea* var. *capitata* provides 11 % of the 800 μg/100 g recommended dietary intake

[13]. Consuming foods high in β-carotenoids or pro-vitamin A, has been linked in studies to a decreased risk of developing a number of epithelial malignancies [34].

Anti-nutrient composition

The results of anti-nutrient analysis on green cabbage (*Brassica oleracea* var. *capitata*) are shown in Tab. 2. The tannin concentration of 2.9 ± 0.6 mg/100 g is higher than 1.50 mg/100 g in green cabbage, 1.57 mg/100 g in red cabbage and 1.57 ± 0.36 mg/100 g in Chinese cabbage, but lower than the 261.76 ± 0.23 mg/100 g in cabbage (*Brassica oleracea*) reported by authors Abdi et al. [1]. Food palatability is impacted by tannins, which give them an astringent taste. They have demonstrated anti-nutrient effects by forming complexes with essential nutrients, including digestive system enzymes, which prevent essential nutrients from being absorbed and utilized [29]. However, it has been demonstrated that tannin molecules possess antibacterial, antiviral and antiparasitic properties [23]. The oxalate level of 8.6 ± 0.7 mg/100g is lower than that of Chinese cabbage (265 ± 13.70 mg/100 g), red cabbage (265 ± 13.70 mg/100 g) and green cabbage (225 ± 6.60 mg/100g) [21].

Its phytate amount of 231 ± 0.8 mg/100 g is lower than that of green cabbage (27.83 ± 0.40 mg/100 g), red cabbage (30.36 ± 0.90 mg/100 g) and Chinese cabbage (27.83 ± 0.40 mg/100 g) [21]. High amounts of phytate and oxalate, two anti-nutritional substances present in many fruit and vegetables, have been shown to significantly impact the bioavailability of minerals in a diet. The cyanogenic glycosides content of 10.5±1.0 mg/100 g is lower when compared to 82.50 ± 2.60 mg/100 g in green cabbage, 82.50 ± 2.80 mg/100 g in red cabbage and 75.63 ± 1.60 mg/100 g in Chinese cabbage [21]. The overconsumption of cyanogenic glycosides can be quite dangerous because they interfere with the electron transport chain in the mitochondria, which stops energy from being produced [41]. The anti-nutrients (phytate, cyanogenic glycosides, tannins and oxalate) identified in this study may not be detrimental if consumed because their concentrations are below the acceptable level [12].

Antinutrients are plant compounds that have traditionally been considered harmful to health due to their potential to limit the bioavailability of essential nutrients [19]. Although various thermal and non-thermal processing methods, such as cooking, boiling and fermentation processes, have been practiced to decrease the antinutrients level, these processes may also undesirably influence the final products. More advanced practices, such as ozonation and cold plasma processing (CPP), have been applied to decrease the antinutrients without majorly affecting the physicochemical and nutritional aspects of the commodities [11]. However, in recent years, these so-called anti-nutrients have become known to possess beneficial effects and therapeutic potential on several diseases [24].

Table 2. Mineral content, vitamin C, β-carotene and anti-nutrients composition of green cabbage *Brassica oleracea* var. *capitata*

Tabela 2. Zawartość składników mineralnych, witaminy C, β-karotenu oraz antyodżywczych składników w zielonej kapuście *Brassica oleracea* var. *capitata*

Mineral content [mg/kg DW] (±SD)	
Sodium / Sód	260 ± 50.1
Potassium / Potas	4680 ± 48.1
Calcium / Wapń	2980 ± 45.2
Manganese / Magnez	4.1 ± 0.1
Copper / Miedź	5.5 ± 0.1
Iron / Żelazo	65.8 ± 1.7
Zinc / Cynk	3.4 ± 0.1
Phosphorus / Fosfor	1234 ± 15.2
Vitamin C and β-carotene contents [per 100 g DW] (±SD)	
Vitamin C / Witamina C [mg]	57.4 ± 3.3
β-carotene / β-kroten [µg]	111.8 ± 4.2
Anti-nutrients content [mg/100 g DW] (±SD)	
Tannins / Taniny	2.9 ± 0.6
Phytate / Fityniany	23.1 ± 0.8
Cyanogenic glycosides / Glikozydy cyjanogenne	10.5 ± 1.0
Oxalate / Szczawiany	8.6 ± 0.7

Proximate and anti-nutrient correlations

Carbohydrates and moisture had a substantial positive correlation (0.90**), while moisture (0.90**) and cyanogenic glycosides (-0.57**) had a significant negative correlation. There were notable negative relationships between crude fat and oxalates (-0.47*) and total ash (-0.63**). Crude fat and crude fiber had a substantial positive correlation (0.83**). A significant negative correlation (-0.45*) was observed between oxalate and crude fiber. There was a noteworthy positive correlation between total ash and oxalate (0.77**). Cyanogenic glycosides showed a negative correlation (-0.44*) with carbohydrates. There was no correlation between the approximate composition of green cabbage (*Brassica oleracea* var. *capitata*) and phytate or tannin.

These results imply that when protein content increases, carbohydrates increases and cyanogenic glycosides decrease. Green cabbage (*Brassica oleracea* var. *capitata*) with high carbohydrate has more protein and fewer cyanogenic glycosides. The protein content of this green vegetable will rise and cyanogenic glycosides will decrease with agronomic management techniques that increase carbohydrates. Any crop management technique that increases the amount of crude fiber and fat in this crop will result in a decrease in its oxalate concentration since oxalate, fat and crude fiber have positive correlations. The positive and very significant ($p<0.01$) association between oxalate and total ash suggests that when the amount of oxalate in a vegetable grows, so does its total ash content.

Growers of vegetables who wish to enhance the nutritional value of *Brassica oleracea* var. *capitata* should use this information to breed this green vegetable with enhanced nutrient and lower anti-nutrient content [33]. Agronomists can also benefit from these correlations by using them to better manage crops for the best nutritional density, while food scientists/nutritionists can use them during the preparation/cooking of this green vegetable in order to achieve a better nutrient bioavailability and improved human nutrition and health [8] (Tab. 3).

Minerals and anti-nutrient correlations

Cyanogenic glycosides exhibited a positive and moderate correlation with iron (0.54*) and a significant negative correlation with calcium (-0.66**), potassium (-0.63**) and sodium (0.66**). A substantial negative correlation was found between tannin and sodium (-0.60**). Magnesium and oxalate had a positive correlation (0.53*). According to these findings, green cabbage (*Brassica oleracea* var. *capitata*) may have a higher calcium and potassium content if cyanogenic glycosides are reduced through agronomic practices.

This is important information because green cabbage (*Brassica oleracea* var. *capitata*) is high in potassium and calcium [40]. Future breeding initiatives of green cabbage (*Brassica oleracea* var. *capitata*) can be guided by the positive correlation between cyanogenic glycosides and iron to create varieties with high minerals and low cyanogenic glycosides [14]. However, no correlation was found between tannins and phytates of green cabbage (*Brassica oleracea* var. *capi capitata*).

Vitamin and anti-nutrient correlations

Vitamin C and phytates had a significant negative correlation (-0.45*), which suggests that breeding initiatives that increase the amount of vitamin C in green cabbage (*Brassica oleracea* var. *capitata*) will also lower the amount of phytate. Vitamin C and cyanogenic glycosides had a positive correlation (0.45**). In order to improve the nutritional quality of green cabbage (*Brassica oleracea* var. *capitata*), breeding and selection efforts should investigate the possibility of finding varieties of green cabbage that have higher vitamin C content and lower levels of cyanogenic glycosides [40]. Green cabbage (*Brassica oleracea* var. *capitata*) exhibited no correlation between oxalate and tannin and vitamins [33], which implies that the vitamin content of this vegetable will not be adversely affected by breeding initiatives or crop management techniques that lower oxalate and tannin [6] (Tab. 5).

Table 3. Linear correlation coefficients between proximate composition and anti-nutrients in green cabbage (*Brassica oleracea* var. *capitata*)
Tabela 3. Współczynniki korelacji liniowej pomiędzy składem odżywczym a składnikami antyodżywczymi zielonej kapusty (*Brassica oleracea* var. *capitata*)

	Crude protein / Białko surowe	Crude fat / Tłuszcz surowy	Crude fiber / Włókno surowe	Total ash / Popiół całkowity	Moisture / Wilgotność	Carbohydrate / Węglowodany	Phytate / Fityniany	Tannin / Taniny	Oxalate Szczawiany	Cyanogenic glycoside / Glikozydy cyjanogenne
Crude protein / Białko surowe	1									
Crude fat / Tłuszcz surowy	0.19	1								
Crude fiber / Włókno surowe	0.29	0.83**	1							
Total ash / Popiół całkowity	-0.58**	-0.63**	-0.58**	1						
Moisture / Wilgotność	-0.90**	-0.34	-0.50*	0.51 *	1					
Carbohydrate / Węglwodany	0.90**	0.34	0.50*	-0.51*	0.90**	1				
Phytate / Fityniany	0.07	-0.20	-0.32	0.08	-0.06	0.06	1			
Tannin / Taniny	0.11	0.00	-0.36	0.04	0.04	-0.04	0.10	1		
Oxalate / Szczawiany	-0.30	-0.47*	-0.45*	0.77**	0.32	-0.32	0.13	0.01	1	
Cyanogenic glycoside / Glikozydy cyjanogenne	-0.44**	0.09	0.12	0.23	-0.57*	-0.44*	-0.17	-0.09	0.29	1

Explanatory notes / Objaśnienia: *A correlation is significant at the 0.05 level / korelacja jest istotna przy poziomie 0,05; **A correlation is significant at the 0.01 level / / korelacja jest istotna przy poziomie 0,01

Table 4. Linear correlation coefficients between minerals and anti-nutrients in green cabbage (*Brassica oleracea* var. *capitata*)

Tabela 4. Współczynniki korelacji liniowej pomiędzy zawartością składników mineralnych a składnikami antyodżywczymi zielonej kapusty (*Brassica oleracea* var. *capitata*)

	Fe	Zn	Ca	Mg	P	K	Na	Cu	Phytate / Fityniany	Tannin / Taniny	Oxalate Szczawiany	Cyanogenic glycoside / Glikozydy cyjanogenne
Fe	1											
Zn	-0.29	1										
Ca	-0.15	-0.66**	1									
Mg	0.65**	-0.13	-0.11	1								
P	0.45*	0.25	-0.33	0.17	1							
K	0.06	-0.43	0.65**	-0.10	-0.51*	1						
Na	0.20	-0.10	-0.19	-0.12	-0.57**	-0.52*	1					
Cu	-0.27	-0.30	0.27	0.12	-0.09	-0.28	-0.07	1				
Phytate / Fityniany	0.20	-0.23	0.30	0.12	0.00	0.16	-0.20	0.00	1			
Tannin / Taniny	0.09	0.03	0.00	0.19	-0.10	0.07	-0.60**	0.40	0.10	1		
Oxalate / Szczawiany	0.27	0.20	-0.07	0.53*	0.61**	-0.42	0.29	0.24	0.13	0.01	1	
Cyanogenic glycoside / Glikozydy cyjanogenne	0.54*	0.07	-0.66**	0.21	0.60**	-0.63**	0.66**	-0.07	-0.17	-0.09	0.29	1

Explanatory notes / Objaśnienia: *A correlation is significant at the 0.05 level / korelacja jest istotna przy poziomie 0,05; **A correlation is significant at the 0.01 level / / korelacja jest istotna przy poziomie 0,01

Table 5. Linear correlation coefficients between vitamins and anti-nutrients in the leaves of green cabbage (*Brassica oleracea* var. *capitata*)

Tabela 5. Współczynniki korelacji liniowej pomiędzy zawartością witaminami i substancji antyodżywczch w liściach kapusty zielonej (*Brassica oleracea* var. *capitata*)

	β-carotene / β-karoten	Vitamin C / Witamina C	Phytate / Fityniany	Tannin / Taniny	Oxalate / Sczawiany	Cyanogenic glycoside / Glikozydy cyjanogenne
β-carotene / β-karoten	1					
Vitamin C / Witamina C	-0.41	1				
Phytate / Fityniany	0.00	-0.45*	1			
Tannin / Taniny	-0.01	-0.10	0.10	1		
Oxalate / Szczawiany	0.22	-0.33	0.13	0.01	1	
Cyanogenic glycoside / Glikozydy cyjanogenne	-0.30**	0.45*	-0.17	-0.09	0.29	1

*A correlation is significant at the 0.05 level; **A correlation is significant at the 0.01 level

Conclusions

1. This study investigated the nutritional composition, mineral, vitamin C, β-carotene and anti-nutrient contents of green cabbage (*Brassica oleracea* var. *capitata*) commonly consumed and grown in the Kosovo region. The study results highlighted the fact that green cabbage (*Brassica oleracea* var. *capitata*) is a nutrient-rich vegetable with great nutritional potential and health benefits.
2. The high content of vitamin C and β-carotene, minerals such as potassium, calcium and magnesium, low fat and low anti-nutrient content of this green vegetable make it an excellent source for promoting food security and a good nutritive food item.
3. The results from Pearson correlations suggest that increasing the nutritional quality of green cabbage (*Brassica oleracea* var. *capitata*) is possible without increasing the concentration of anti-nutrients.

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ANALIZA SKŁADNIKÓW ODŻYWCZYCH I ANTYODŻYWCZYCH W ZIELONEJ KAPUSTCE (*BRASSICA OLERACEA VAR. CAPITATA*)

S t r e s z c z e n i e

Wprowadzenie. Zielona kapusta (*Brassica oleracea* var. *capitata*) jest bardzo odżywczym warzywem, oferującym szeroką gamę witamin, składników mineralnych, przeciwutleniaczy oraz błonnika. Chociaż zawiera pewne antyodżywcze substancje, takie jak goitrogeny i szczawiany, związki te stanowią na ogół minimalne ryzyko, gdy warzywo to jest spożywane jako część zbilansowanej diety i w normalnych ilościach. Celem tego badania była ocena zawartości składników mineralnych, witaminy C, β-karotenu oraz zawartości antyodżywczych substancji w zielonej kapuście pochodzącej z regionu Kosowa.

Wyniki i wnioski. Zgodnie z przeprowadzoną analizą korelacji liniowej Pearsona, większość wskaźników odżywczych miała odwrotny związek lub nie miała związku z antyodżywczymi substancjami. Wykazano istotnie dodatnią korelacje między zawartością surowego białka a zawartością węglowodanów (0,90**), oraz ujemną z zawartością glikozydów cyjanogennych (-0,90**). Ponadto, glikozydy cyjanogenne wykazały istotne negatywne korelację z zawartością węglowodanów (-0,44*), wapna (-0,66**) i potasu (-0,63**). Zawartośc witamin nie korelowały istotnie ze szczawianami i taninami, podczas gdy taniny i fitynian nie korelowały istotnie z odpowiadającą im zawartością składników mineralnych. Wyniki wykazały, że zielona kapusta jest bogata w składniki odżywcze, co może zmniejszyć wpływ niedoborów mikroelementów. Ponadto wyniki wskazały, że zielona kapusta ma niską zawartość tłuszczu i substancji antyodżywczych, ale jest bogata w potas, magnez i wapń, które są korzystne dla zdrowia człowieka.

Słowa kluczowe: kapusta zielona (*Brassica oleracea* var. *capitata*), skłądniki mineralne, witaminy, substancje antyodżywcze