

Letter to Editor

Content of Basic Nutrients and Minerals in Heads of Selected Varieties of Red Cabbage (*Brassica oleracea* var. *capitata* f. *rubra*)

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Received: September 3, 2007

Accepted: January 2, 2008

Abstract

The presented results concern three varieties of red cabbage: Koda, Kissendrup SWE and Haco POL. During a field experiment conducted in 2003-05, the three varieties were analyzed for their organic and mineral content which is responsible for the nutritive value of cabbage. Significant differences were found between the studied varieties. The reported changes accounted for organic and mineral nutrients. The best results were reported in respect of var. Haco POL, whose edible parts were the richest in dry matter, vitamin C, sugars and organic acids. Haco POL was also characterized by the highest copper content and the lowest iron content among the analyzed varieties.

Keywords: red cabbage, chemical composition

Introduction

Consumers' growing awareness of nutritional issues is accompanied by an increased interest in food products which, in addition to satisfying hunger, carry other important physiological and nutritional functions, improve health and prevent diseases such as cancer, diabetes and atherosclerosis [1-3]. As a rich source of nutrients, red cabbage belongs to this type of plant. Yet its consumption is much lower than that of white cabbage. Red cabbage enjoys the greatest popularity in Silesia and the western provinces of Poland, where it is also most intensively farmed [4].

Red cabbage is used mostly as an ingredient in raw vegetable salads which contain a full range of vitamins, minerals and substances which have a beneficial impact on human health. It is increasingly often used in the vegetable processing industry to make pickled and dry prod-

ucts. The popularity of red cabbage as a natural colorant for products with a slightly alkaline or neutral reaction is on the rise [3].

The objective of this study was to compare the content of selected organic and mineral nutrients in the edible parts of three varieties of red cabbage.

Materials and Methods

A one-factorial experiment in a completely randomized block design with four replications was conducted in 2003-05 in the Garden of the Experimental and Didactic Unit of the University of Warmia and Mazury in Olsztyn. Red cabbage was grown on brown soil of IV b class, good rye complex, developed from loamy sand underlain by loam with pH 6.7 and a humus content of 2.8%. Before the experiment, the mineral content of soil was as follows: N-NO₃ – 38, P – 127, K – 90, Ca – 1840, Mg – 194 (mg·dm⁻³). Mineral fertilization was supplemented to an optimal level for red cabbage.

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Three varieties of red cabbage were evaluated: Koda, Kissendrup SWE and Haco POL. Each year dressed seeds were sown in the nursery bed in the last ten days of April. Seedlings were planted manually in the field in the last ten days of May at a spacing of 50x60 cm. The area of a single plot was 3.6 m² (length of 2.0 m and width of 1.8 m).

Cultivation measures were taken in line with the recommendations for red cabbage.

The crop was harvested once as the heads of particular varieties matured. After the harvest, 15 heads of each cabbage variety were sampled and subjected to a chemical analysis to determine the content of:

- dry matter – with the use of the drying method by drying plant material at a temperature of 105°C to constant mass [5],
- vitamin C – with the use of Tillman's method modified by Pijanowski [6],
- sugars – with the use of Luff-Schoorl's method [5],
- organic acids – in terms of apple acid according to Pieterburgski [6].

Five heads of each variety were disintegrated and dried to constant mass at 65°C in a KBC G 65/250 drier, and ground in an electric grinder. Then the material was forwarded to the laboratory at the Chemical-Agricultural Station in Olsztyn, where it was mineralized and marked for the presence of the following macroelements: nitrogen by the potentiometric method, phosphorus by the vanadium and molybdenum method; potassium by flame photometry, magnesium by atomic absorption spectroscopy (AAS), calcium and sodium by flame photometry, and nutrients copper, iron by atomic absorption spectroscopy [7]. The analysis was subject to accreditation: Accreditation Certificate No. AB 277 issued by the Polish Centre for Accreditation in Warsaw.

The results were processed statistically by analysis of variance. The differences between mean values were evaluated with the use of Tukey's test at the level of significance $\alpha=0.05$. The study presents mean values of three years, i.e. 2003 to 2005.

Results and Discussion

The results obtained for every year of the study indicate significant differences in the content of dry matter, vitamin C, total sugars and monosaccharides subject to the analyzed variety (Table 1). Dry matter content varied significantly depending on the analyzed variety. The highest dry matter content was reported in the leaves of var. Kissendrup SWE (7.76g/100g), while the lowest levels were observed in Koda (5.19 g/100g). The above results approximate the values indicated by Wierzbicka and Kuskowska for white cabbage [8]. The L-ascorbic acid content of the edible parts of particular varieties was lower than that postulated by Kunachowicz et al. [9]. In his study, the content of L-ascorbic acid in var. Haco POL and Kissendrup SWE reached 36.38 mg/100g, and in var. Koda – only 31.57 mg/100g.

The taste of a vegetable is determined by its sugar and organic acid content. The highest level of total sugars and monosaccharides was observed in var. Haco POL – 3.66g/100g and 2.35g/100g, and the lowest in var. Koda – 2.17 g/100g and 0.89 g/100g, respectively. The differences in the content of disaccharides and organic acids in the edible parts of red cabbage were statistically non-significant, ranging from 0.9 g/100g to 0.12g/100g.

The content of macronutrients in red cabbage (nitrogen, phosphorus, potassium, magnesium and sodium), as well as nutrients (copper and iron), was similar to the values indicated by Jędrzejczak et al., Cebula et al. and Kunachowicz et al. [9-11]. The study showed statistically significant differences in the content of elements – total N, K, Mg, Ca, copper and iron, in the edible parts of particular varieties. There were no statistically significant differences in the levels of P, Mg and Na in plant tissue of the studied varieties (Table 2).

The highest content of total N was reported in cabbage heads of var. Kissendrup SWE (2.44 g/100g dry matter) and the lowest in var. Haco POL (2.36 g/100g dry matter). The average potassium content was 3.45 g/100g dry matter. The greatest quantities of this macroelement were accumulated in the leaves of var. Haco POL, and the smallest – in Kissendrup SWE.

Table 1. Content of basic nutrients (dry matter (g/100g), vitamin C (mg/100g), sugars and organic acids (g/100g)) in red cabbage (mean values of 2003-05).

Variety	Dry matter	Vitamin C	Sugars			Organic acids
			total	monosaccharides	disaccharides	
Koda	5.19	31.57	2.17	0.89	1.29	0.12
Kissendrup SWE	7.76	36.38	2.87	1.70	1.17	0.09
Haco POL	6.87	36.38	3.66	2.35	1.31	0.12
Average for all varieties	6.61	34.38	2.90	1.65	1.26	0.11
LSD _{0.05}						
Cultivar	0.34	0.35	0.33	0.23	ns	ns
Years	0.44	0.38	0.33	0.23	ns	ns

Table 2. Content of nutrients: total-N, P, K, Mg, Ca, NA (g/100g dry matter) and Cu, Fe (mg/kg dry matter) in red cabbage (mean values of 2003-2005).

Variety	Nutrients							
	N – total	P	K	Mg	Ca	Na	Cu	Fe
Koda	2.41	0.36	3.42	0.13	0.69	0.05	4.36	57.50
Kissendrup SWE	2.44	0.36	3.35	0.13	0.41	0.04	3.57	52.00
Haco POL	2.36	0.39	3.57	0.13	0.58	0.05	6.83	50.00
Average for all varieties	2.40	0.37	3.45	0.13	0.56	0.05	4.92	53.17
LSD _{0.05}								
Cultivar	0.02	ns	0.12	ns	0.12	ns	0.16	2.64
Years	0.02	ns	0.12	ns	0.12	ns	0.16	2.64

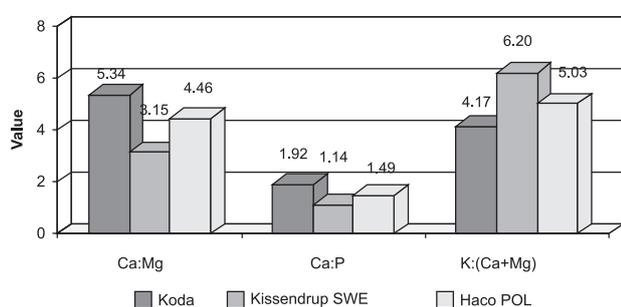


Fig. 1. Ca:Mg, Ca:P and K:(Mg+Ca) ratios in the analyzed varieties of red cabbage (mean values of 2003-05).

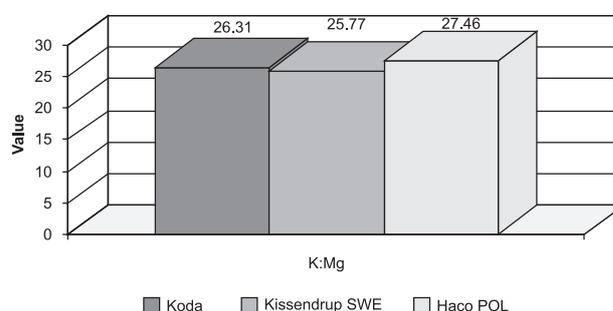


Fig. 2. K:Mg ratio in the analyzed varieties of red cabbage (mean values of 2003-05).

The content of nutrients in the edible parts of red head cabbage ranged from 3.57 to 6.83 mg/kg dry matter for copper and from 52.00 to 50.00 mg/kg dry matter for iron. The highest concentration of both microelements was reported in var. Haco POL, and the lowest – in Kissendrup SWE (Table 2).

As postulated by Kotowska and Wybieralski [12], the quality of the edible parts of a plant is determined not only by the content of macroelements and microelements, but also their mutual proportions. According to the above authors, the following ratios are of particular significance: K to Mg, Ca to Mg and K:(Mg+Ca). The ratios between the analyzed elements differed among the studied varieties of red cabbage. According to Czaplą and Nowak and Radkowski et al., the optimum Ca:Mg ratio should not exceed 3, and Ca:P – 2 [13,14]. When the above values are exceeded, they are indicative of a magnesium or phosphorus deficiency in food. The analyzed cabbage was characterized by an unfavorable Ca:Mg ratio and a favorable Ca:P ratio. The optimum dietary Ca:Mg ratio was reported in Kissendrup SWE (3.15) and the lowest – in Koda (5.31) (Fig. 1). The Ca:P ratio was most favorable in Kissendrup SWE cabbage (1.14). The study showed a wider ratio of potassium to magnesium as well as potassium to total magnesium and calcium ions in all of the examined varieties. According to Radkowski et al. [14], the above ratios should reach K:Mg – 6:1, K:(Mg+Ca) – 1.6-2.2. A particularly elevated K:Mg ratio was observed in the edible parts of var. Haco POL, and K(Mg+Ca) ratio – in var. Kissendrup SWE (Fig. 2).

Conclusions

The edible parts of the studied red cabbage varieties covered by the statistical analysis differed significantly with regard to the content of organic (vitamin C, sugar total and monosaccharides) and mineral nutrients (N-total, K, Ca, Cu i Fe). The highest levels of those elements were found in var. Haco POL, and the lowest in var. Koda.

Significant differences were reported in the content of total N, K and Ca in the analyzed varieties. The edible parts of var. Haco POL were marked by a significantly higher accumulation of total nitrogen and potassium. This variety was also characterized by the highest copper content and the lowest iron content.

The calcium-to-magnesium ratio was unfavorable and the calcium-to-phosphorus ratio was favorable in the analyzed cabbage varieties.

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