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QUALITY CHANGES IN CURDS OF WHITE, GREEN, AND ROMANESCO CAULIFLOWER DURING STORAGE

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Between 2002 and 2004 studies of cauliflower grown for autumn harvest were conducted. The investigated plants included cauliflower of white, green and romanesco cultivars, produced at different nitrogen fertilisation and degree of curd development. Following the harvesting, curds were placed for a period of 5 weeks in a cooling room at 2°C and a relative air humidity of 85–90%. The largest curds were obtained from the plants of white cauliflower and the smallest ones from the romanesco cauliflower. Fertilisation with a higher dose of nitrogen led to the formation of larger curds in the white and green cultivars of cauliflower. Larger curds were obtained when harvest was at the time where curds reached standard commercial quality (possibly maximum weight and simultaneous compact and smooth surface). The green cultivar of cauliflower was characterised by the longest duration of storage. In comparison with green and romanesco cultivars, curds of the white cultivar contained higher concentrations of calcium and sodium. Compared to the romanesco cultivar, curds of green cauliflower contained a higher concentration of L-ascorbic acid, potassium and sodium. Following the storage period, the content of almost all analysed elements increased in every cultivar of cauliflower.

INTRODUCTION

In Poland, like in most countries all over the world, the cultivar of cauliflower forming white curds is cultivated most often. Recently, however, there has emerged information concerning cultivations of cauliflower of different colours. It concerns mostly green or yellow-green cultivars which, due to their outstanding taste and nutritional values, have enjoyed growing popularity in West European countries and the USA. As on the Polish market they are still a novelty [Osińska *et al*., 1996], results of studies on their nutritional values can serve as an impulse for cultivating them on a larger scale. Besides headed cabbages, broccoli and Brussels sprouts, cauliflower is among the most valued brassicas vegetables as far as the content of carotenoids, polyphenol compounds and glucosinolates is concerned [Lipecki & Libik, 2003]. Compared with the white cultivars, curds of green cauliflower usually have a higher content of vitamin C and folic acid [Csizinszky, 1996; Adamicki & Czerko, 2002].

Problems concerning cauliflower storage are very important for horticulture practice, as curd storage is aimed, on one hand, on prolonging the period of their market availability in the fresh state and, on the other hand, during certain seasons, on managing the considerable surplus of the product, due to yielding accumulation [Wheeler & Salter, 1974]. Cauliflower like its biological relative broccoli, belongs to the vegetables of a high perishability. During the storage period changes in the chemical composition of their curds progress very fast even under conditions of controlled atmosphere [Hansen *et al*., 1995; Rodrigues & Rosa, 1998; Hansen *et al*., 2001].

Depending on the degree of curd maturity and storing conditions, the storage life for cauliflower curds ranges from 2 to 10 weeks [Kader, 1992; Adamicki & Czerko, 2002]. Studies on storage for the period of 6 weeks under conditions of controlled atmosphere have shown higher storage ability of the curds of green and romanesco cultivars as compared with the white cultivar [Gajewski, 1999, 2001].

The aim of this research was to determine the amount of fresh mass loss and changes in the content of dry matter, L-ascorbic acid, sugars, chlorophyll, carotenoids as well as certain elements (P, K, Ca, Mg, Na and Fe) during the storage of curds of three cultivars of cauliflower (white, green and romanesco).

MATERIAL AND METHODS

The studies of cauliflower for autumn harvest were carried out between 2002 and 2004 at the Research Station of the Agricultural University in Kraków on typical brown soil (pH 6.9), formed from stabilized river alluvia of organic carbon content equal to 2.02%. Each year, the experiment was established in randomised blocks with four replications and concerned three factors: (1) cauliflower form: white ('Planita F_1' cultivar), green ('Trevi F_1' cultivar) and romanesco ('Amfora F_1' cultivar); (2) nitrogen fertilisation (150 and 250 kg N/ha); and (3) degree of curd maturity (curds were cropped 4–5 days before reaching harvesting maturity (B) and at the time of obtaining standard commercial quality (A) – which means possibly maximum weight and simultaneous

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compact and smooth surface. Nitrogen had been used before the planting of seedlings in the form of nitrochalk (NH_4NO_3 + $CaCO_3$) at a dose of 100 kg/ha and after the planting in the third (in plots with the dose of 150 kg N/ha) as well as fifth and seventh weeks (in plots with the dose of 250 kg N/ha) calculated from the date of seedling planting, every time using 50 kg N/ha in the form of lime saltpeter – $Ca(NO_3)_2$.

Only properly shaped, healthy, firm and undamaged curds were chosen for storage. Immediately following harvesting, curds with partly cut-off leaves, were placed into plastic boxes (5-6 pieces per box) and put into a cooling room at 2°C and a relative air humidity of 85-90%, where they were stored for a period of 5 weeks. The dates of curd storage in consecutive years of the experiment are presented in Table 1. In 2003, due to insufficient amount of material, the romanesco cultivar of cauliflower was not taken into account in the experiment.

TABLE 1. Storage period of cauliflower curds in 2002–2004.

Year	Form of cauliflower	Period of storage	
		Beginning	End
2002	White	09.09	14.10
	Green	12.09	17.10
	Romanesco	29.09	03.10
2003	White	03.09	08.10
	Green	03.09	09.10
2004	White	16.09	20.10
	Green	27.09	02.11
	Romanesco	16.09	21.10

The chemical analysis of cauliflower curds was assessed (in four replications), taking into account the contents of: dry matter (drier method at 105°C), L-ascorbic acid by Tillmans's method [Krełowska-Kułas, 1993], chlorophyll "a", "b", carotenoids by the spectrophotometric method [Lichtenthaler & Wellburn, 1983], total sugars – analysed colorimetrically using anthrone [Yemm & Willis, 1954] and elements – P, K, Ca, Mg, Na, Fe – phosphorus by the colorimetric analysis [Lityński *et al*., 1976], other elements with the method of atomic absorption [Nowosielski, 1974]. In the tables, data concerning the content of total sugars, L-ascorbic acid, chlorophylls, and carotenoids are given both in g/100 g of fresh matter and in g/kg of dry matter.

The results obtained were presented as averages of data from the three years (with exception of the romanesco cultivar, where only averages of two years were taken into account) and processed statistically with the method of variance analysis (t-Student test) at a significance level of p=0.95.

RESULTS AND DISCUSSION

Data included in Table 2 show that the curds of the largest mass were obtained from the plants of white cauliflower, medium-ones from green cauliflower plant, and the smallest ones from the romanesco cultivar (1.546, 1.058, and 1.002 kg, respectively, as an average mass of 10 curds). Regardless of the cauliflower cultivar and nitrogen dose, larger curds were obtained during harvesting in standard time, whereas, in the case of white and green cultivars, regardless of the cropping time, the larger curds were formed by plants fertilised with a higher dose of nitrogen (250 kg/ha). On the other hand, the plants of the romanesco cultivar formed curds of higher mass when fertilised with a smaller dose of nitrogen (150 kg/ha). Csizinszky [1996] and Osińska *et al*. [1996] obtained also a higher yield from the plants of white cauliflower as compared with the green one grown at the same level of nitrogen fertilisation, Csizinszky [1996] obtained thus a higher commercial yield of green cauliflower fertilised with a dose of 294 kg N/ha as compared to a dose of 196 kg N/ha.

TABLE 2. Mean weight of curd of three forms of cauliflower before (1) and after storage (2).

Form of cauliflower	Dose of N (kg/ha) / Stage of curd maturity	Mean weight of curd (kg)	
		1	2
White	150 / A*	1.747	1.237
	250 / A	1.823	1.362
	150 / B **	1.228	0.843
	250 / B	1.386	0.956
Green	150 / A	1.174	0.903
	250 / A	1.289	1.022
	150 / B	0.866	0.671
	250 / B	0.904	0.699
Romanesco	150 / A	1.229	0.857
	250 / A	0.984	0.694
	150 / B	1.014	0.668
	250 / B	0.780	0.539

*A – standard market quality, **B – before harvest maturity

Natural mass loss of cauliflower curds after the 5-week long storage period appeared to depend on the cultivar and ranged from 0.195 to 0.510 kg (Table 2). The greatest loss of the absolute mass was observed for white cauliflower curds harvested at standard cropping time (from 0.461 to 0.510 kg), and the smallest one for green cauliflower curds harvested before reaching harvesting maturity (from 0.195 to 0.205 kg). For the cauliflower cultivars studied, the absolute mass loss occurred in curds harvested after reaching standard commercial quality. Figure 1 shows that the greatest loss of

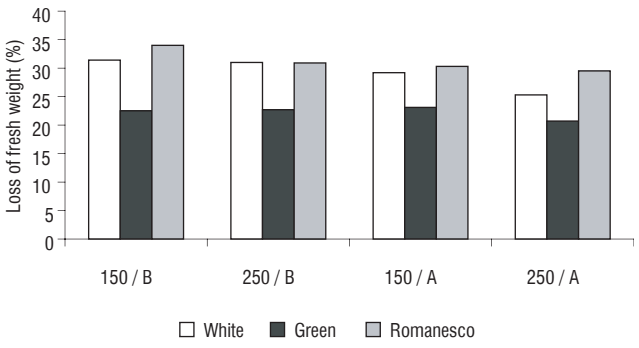

FIGURE 1. Loss of fresh weight (%) of cauliflower curds (white, green, and romanesco) during storage depending on the dose of nitrogen (150 or 250 kg/ha) and stage of curd maturity (A – standard market quality; B – before harvest maturity).

TABLE 3. Content of dry matter (% f.m.), total sugars (g/100 g f.m.), and L-ascorbic acid (mg/100 g f.m.) in curds of white, green, and romanesco cauliflower before (1) and after (2) storage.

Dose of N (kg/ha) / Stage of curd maturity		Dry matter		Total sugars		L-ascorbic acid	
		1	2	1	2	1	2
White	150 / A	6.58^{a}	7.27^{b}	2.07^{ab} (314.6)	1.92^{c} (264.1)	31.58^{c} (4.80)	53.71^{de} (7.39)
	250 / A	6.57^{a}	6.77^{a}	2.02^{a} (307.5)	1.68^{a} (248.2)	30.45^{b} (4.64)	47.41^{a} (7.00)
	150 / B	7.10^{b}	7.72^{d}	2.34^{g} (329.6)	1.94^{c} (251.3)	31.39^{bc} (4.42)	51.69^{bc} (6.70)
	250 / B	7.06^{b}	7.52^{c}	2.29^{fg} (324.4)	1.77^{b} (235.4)	28.92^{a} (4.10)	57.35^{f} (7.63)
Green	150 / A	8.55^{cd}	9.16^{f}	2.23^{ef} (260.8)	2.18^{e} (238.0)	45.35^{h} (5.30)	68.37^{i} (7.46)
	250 / A	8.48^{c}	9.01^{e}	2.13^{bc} (251.2)	2.19^{ef} (243.1)	45.58^{h} (5.38)	63.46^{g} (7.04)
	150 / B	8.64^{e}	9.09^{ef}	2.15^{cd} (248.8)	2.13^{de} (234.3)	41.88^{fg} (4.85)	67.23^{i} (7.40)
	250 / B	8.58^{de}	9.06^{e}	2.23^{def} (259.9)	2.09^{d} (230.7)	42.26^{g} (4.93)	65.74^{h} (7.26)
Romanesco	150 / A	8.76^{f}	10.03^{g}	2.32^{g} (264.8)	2.35^{g} (234.3)	40.78^{e} (4.66)	52.65^{cd} (5.25)
	250 / A	8.65^{e}	9.99^{g}	2.21^{de} (255.5)	2.37^{g} (237.2)	41.08^{ef} (4.75)	52.23^{bc} (5.23)
	150 / B	8.89^{g}	10.43^{i}	2.23^{def} (250.8)	2.36^{g} (226.3)	36.29^{d} (4.08)	53.96^{e} (5.17)
	250 / B	9.07^{h}	10.31^{h}	2.23^{def} (245.9)	2.26^{f} (219.2)	36.38^{d} (4.01)	51.33^{b} (4.98)

*A – standard market quality, **B – before harvest maturity. Means in the columns marked with different letters are significantly different (p = 0.95). Data in the brackets are given in g/kg d.m.

the mass occurred in the case of romanesco and white cultivars of cauliflower.

Mass loss was especially high for curds of earlier harvesting time (30.9–34.0%). Adamicki & Czerko [2002] stated, however, that the storage duration of compact, well-formed but incompletely mature curds is much better than that of fully mature curds. Mass loss of curds obtained during standard harvesting time was similar for both of these cultivars (romanesco and white) and varied from 25.3 to 30.3%. The lowest losses of curd mass were found for green cauliflower; they were similar for both cropping times (20.7 to 23.1%). The determined mass losses were much higher from those found by Gajewski [2001] in curds stored under conditions of controlled atmosphere recommended for cauliflower (from 0.8 to 1.54%).

The data presented in Table 3 shows that, regardless of the fertilisation level and the degree of curd maturity, before storage, the highest content of dry mass was found in curds of romanesco (on average 8.84% of fresh matter), green (on average 8.56%) and white (on average 6.83%) cultivars of cauliflower. Similar data were published by Osińska *et al*. [1996]. Total sugar content was on average 2.25, 2.19 and 2.18 mg/100 g f.m. L-ascorbic acid was found in curds of green cauliflower at higher level (43.77 mg/100 g f.m.), in romanesco cauliflower curds at a level of 38.63 mg, and in white cauliflower curds at the lowest level (30.59 mg). Similarly, Gajewski [1999, 2001] and Osińska *et al*. [1996] proved that the green cultivar of cauliflower contained more dry matter and vitamin C.

Data shown in Table 3 and Figure 2 indicate an increase in dry mass (by 7, 6 and 15%) and L-ascorbic acid (by 72, 52 and 37%) after a period of storage, respectively for curds of white, green and romanesco cultivars of cauliflower. A similar tendency was shown by Gajewski [1999]. Sugar content increased only in the case of romanesco cauliflower curds (by 4%) whereas for the other two types, the total sugar content was observed to decrease by 1.6 and 15.9% for green and white cauliflower, respectively.

White cauliflower curds contain small amounts of carot-

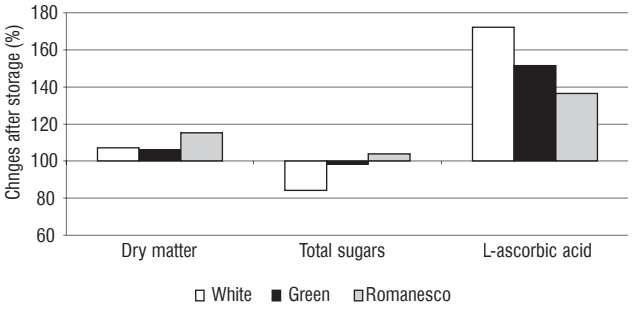

FIGURE 2. Changes in the content of dry matter, total sugars, and L-ascorbic acid (in %) in curds of three cauliflower forms (white, green, and romanesco) after storage (content before storage = 100%).

enoids and high amounts of mineral salts [Osińska *et al*., 1996; Kunachowicz *et al*., 1999]. Of the two cauliflower cultivars studied, regardless the nitrogen level of fertilisation and the degree of curd maturity, a higher content of chlorophyll "a" (on average 2.43 mg/100 g f.m.), chlorophyll "b" (on average 1.36 mg) and carotenoids (on average 1.08 mg/100 g f.m.) prior to storage was found for romanesco cauliflower curds (Table 4). The data included in this table show also a decrease in the contents of chlorophyll and carotenoids in all combinations with the exception of prematurely harvested curds of green cauliflower fertilised with nitrogen at a dose of 250 kg/ha. In this case, contents of chlorophyll "a" and "b" as well as carotenoids were noted to increase (by 20, 19 and 39%, respectively). The same tendency occurred in the case of carotenoids in green cauliflower curds from both harvesting times obtained from plants fertilised with nitrogen at a dose of 150 kg/ha, *i.e.* an increase from 2 to 8%. A greater loss of chlorophyll "a" and "b" and carotenoids was observed in the curds of the romanesco cauliflower (respectively, on average, by 43, 39 and 25%). The greatest loss in the content of these components occurred in the case of the romanesco cauliflower curds harvested before they achieved cropping maturity.

Table 5 shows that the highest average content of phosphorus before storage was found in the curds of romanes-

TABLE 4. Content of chlorophyll "a" and "b", and carotenoids (mg/100 g f.m.) in curds of green and romanesco cauliflower before (1) and after (2) storage.

Dose of N (kg/ha) / Stage of curd maturity		Chlorophyll "a"		Chlorophyll "b"		Carotenoids	
		1	2	1	2	1	2
Green	150 / A	1.93^{ab} (0.226)	1.75^{cd} (0.191)	0.95^{a} (0.111)	0.80^{a} (0.087)	0.83^{ab} (0.097)	0.90^{bc} (0.098)
	250 / A	2.05^{abc} (0.242)	1.65^{bc} (0.183)	1.23^{b} (0.145)	0.90^{a} (0.100)	0.95^{bcd} (0.112)	0.85^{abc} (0.094)
	150 / B	2.18^{bcd} (0.252)	1.93^{d} (0.212)	1.20^{b} (0.139)	0.90^{a} (0.099)	0.93^{bc} (0.108)	0.95^{c} (0.105)
	250 / B	1.83^{a} (0.213)	2.20^{e} (0.243)	0.95^{a} (0.111)	1.13^{b} (0.125)	0.78^{a} (0.091)	1.08^{d} (0.119)
Romanesco	150 / A	2.15^{bcd} (0.245)	1.38^{a} (0.138)	1.25^{b} (0.143)	0.78^{a} (0.078)	1.00^{cd} (0.114)	0.75^{a} (0.075)
	250 / A	2.28^{cd} (0.264)	1.48^{ab} (0.148)	1.25^{b} (0.145)	0.90^{a} (0.090)	1.08^{de} (0.125)	0.85^{abc} (0.085)
	150 / B	2.83^{e} (0.318)	1.30^{a} (0.125)	1.55^{d} (0.174)	0.75^{a} (0.072)	1.18^{e} (0.133)	0.78^{a} (0.075)
	250 / B	2.45^{d} (0.270)	1.35^{a} (0.131)	1.40^{c} (0.154)	0.85^{a} (0.082)	1.05^{cde} (0.116)	0.83^{ab} (0.081)

*A – standard market quality, **B – before harvest maturity. Means in the columns marked with different letters are significantly different (p = 0.95). Data in brackets are given in g/kg d.m.

co, green and white cauliflower (5988, 5513 and 4400 mg/kg of dry matter, respectively). The highest content of this element (6195 and 6152 mg/kg of dry matter) was characteristic for curds of romanesco cauliflower harvested before they achieve cropping maturity for both doses of nitrogen fertilisation as well as those cropped in the usual time and fertilised with 250 kg N/ha (5993 mg). However, the lowest phosphorus content was found in the curds of white cauliflower cropped in standard time in plants fertilised with nitrogen at a dose of 150 kg/ha (4126 mg/kg of dry matter).

The highest content of potassium was found, regardless of the time of cropping and nitrogen dose, in the curds of green cauliflower (on average 31406 mg/kg of dry matter) and the curds of the romanesco cauliflower (on average 28543 mg), especially in those cropped earlier from plants fertilised with nitrogen at a dose of 150 kg/ha. The lowest content of potassium, regardless of nitrogen dose, was found for the curds of white cauliflower (on average 24617 mg) harvested before they achieve cropping maturity.

The highest content of calcium was found in white cauliflower curds cropped in usual time for both nitrogen doses (on average 2472 mg/kg of dry matter), and the lowest one in green cauliflower curds harvested in standard cropping time (on average 2093 mg) and the curds of the romanesco cauliflower from the same cropping time (on average 2236 mg).

The lowest content of magnesium was characteristic for the white cauliflower curds, regardless of the cropping time and nitrogen dose (from 1434 to 1491 mg/kg of dry matter). On the other hand, the highest magnesium content was found for romanesco curds cropped in standard time, regardless of the nitrogen dose (from 1834 to 1902 mg).

The lowest content of sodium was found for romanesco curds, cropped in earlier time from plants fertilised with a higher nitrogen dose (1534 mg/kg of dry matter), as well as in usual cropping time, and the highest one for green cauliflower curds cropped in usual harvesting time from plants fertilised with nitrogen at a dose of 250 kg/ha (2893 mg) and in other combinations for this cultivar of cauliflower (between 2674 and 2745 mg).

Generally, the lowest content of iron was typical of white cauliflower curds (between 40.60 and 49.92 mg/kg of dry matter), whereas for curds of green and romanesco cau-

TABLE 5. Content of some mineral components (mg/kg d.m.) in curds of white, green, and romanesco cauliflower before (1) and after (2) storage.

Dose of N (kg/ha) / Stage of curd maturity		P		K		Ca		Mg		Na		Fe	
		1	2	1	2	1	2	1	2	1	2	1	2
White	150 / A	4126^{a}	6037^{a}	25313^{bc}	41369^{f}	2458^{e}	2941^{f}	1449^{a}	2096de	2302e^{f}	3192^{h}	49.92^{c}	61.69^{c}
	250 / A	4582^{b}	6038^{a}	25488^{bc}	37167^{e}	2485^{e}	2800^{e}	1434^{a}	2090de	2232de	3059^{g}	40.60^{a}	56.90^{b}
	150 / B	4457^{b}	6071^{ab}	25222^{ab}	40020^{f}	2343^{cd}	2762^{e}	1491^{a}	2108de	2185^{d}	2819^{f}	45.18^{b}	53.33^{a}
	250 / B	4433^{b}	6483^{cd}	24012^{a}	40352^{d}	2348^{d}	2615^{d}	1463^{a}	2117^{e}	2367^{f}	2695^{e}	47.13^{bc}	58.31^{b}
Green	150 / A	5331^{c}	6060^{a}	31089^{ef}	35333^{d}	2092^{a}	1969^{a}	1709^{bc}	1811^{a}	2741^{g}	2663de	73.96^{d}	83.44^{e}
	250 / A	5492^{cd}	6109^{ab}	32146^{f}	34837^{d}	2093^{a}	2016^{ab}	1733^{bc}	1904^{b}	2893^{h}	2967^{g}	77.68^{e}	90.06^{f}
	150 / B	5508^{cd}	6209^{ab}	31542^{ef}	37214^{e}	2242^{b}	2031^{ab}	1712^{bc}	1893^{b}	2674^{g}	2582^{d}	78.75^{e}	91.71^{f}
	250 / B	5721^{e}	6282^{bc}	30845^{e}	35111^{d}	2267^{bc}	2088^{b}	1744^{c}	1917^{b}	2745^{g}	2852^{f}	82.75^{f}	97.83^{g}
Romanesco	150 / A	5610de	6465^{cd}	28427^{d}	33046^{c}	2137^{a}	2641^{d}	1902^{e}	2015^{c}	1866^{c}	2003^{c}	76.23^{de}	80.69^{de}
	250 / A	5993^{f}	6220^{ab}	28424^{d}	30483^{a}	2334^{cd}	2397^{c}	1834de	2087de	1676^{b}	2048^{c}	76.87^{de}	79.47^{d}
	150 / B	6195^{f}	6702^{e}	30772^{e}	32097^{bc}	2267^{bc}	2621^{d}	1775^{cd}	2105de	1810^{c}	1865^{b}	77.44^{e}	79.58^{d}
	250 / B	6152^{f}	6526de	26548^{c}	31262^{ab}	2641^{f}	2441^{c}	1664^{b}	2055^{cd}	1534^{a}	1650^{a}	73.75^{d}	83.19^{e}

*A – standard market quality, **B – before harvest maturity. Means in the columns marked with different letters are significantly different (p = 0.95)

liflower cultivars the content of this element was higher (between 73.75 and 82.75 mg).

The content of P, K, Ca, Mg, Na, and Fe determined in the curds of white cauliflower was in agreement with the data given by Kunachowicz *et al.* [1999] and Yamaguchi [1983]. The content of P, K, and Fe determined in green and romanesco cauliflower was similar to that given for broccoli heads [Yamaguchi, 1983].

The analysis of data included in Table 5 and Figure 3 shows generally the increase in the majority of elements, particularly for the curds of white cauliflower. A decrease was only observed in the case of calcium for green cauliflower curds for all combinations and the romanesco curds harvested before they achieved cropping maturity from plants fertilised with nitrogen at a dose of 250 kg/ha and in the case of sodium in the curds of green cauliflower cropped from plants fertilised with nitrogen at a dose of 150 kg/ha in both harvesting times.

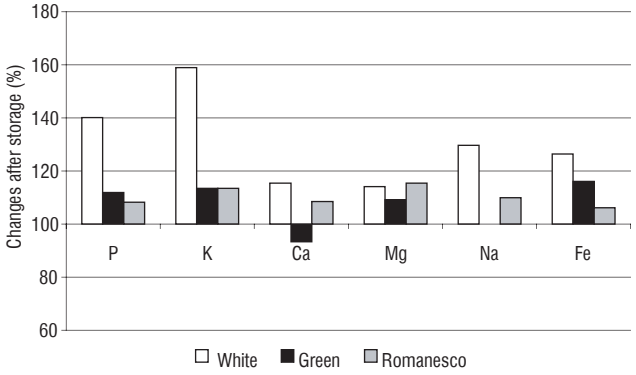

FIGURE 3. Changes in the content of some mineral components (in %) in curds of three cauliflower forms (white, green, and romanesco) after storage (content before storage = 100%).

CONCLUSIONS

Among the cauliflower cultivars studied, the biggest curds were obtained from the plants of white cauliflower and the smallest ones from the romanesco cultivar. Fertilisation with nitrogen at a dose of 250 kg/ha, as compared with the dose of 150 kg/ha, led to the formation of bigger curds in white and green cauliflower cultivars. Opposite dependency was found for the romanesco cultivar. For all three cauliflower cultivars, bigger curds were obtained from the crop at the time they have achieved standard commercial quality. The longest storage life, based on natural mass loss, was found for the green cauliflower, whereas the shortest but similar for the other two cultivars of cauliflower. As compared with the green and romanesco cultivars of cauliflower, the curds of the white cultivar contained less dry matter, L-ascorbic acid, total sugars, phosphorus, potassium, magnesium and iron with the higher content of calcium and sodium. As compared with the romanesco cultivar, the curds of green cauliflower contained less dry matter, total sugars, both chlorophyll types, carotenoids, phosphorus, calcium and magnesium with the higher content of L-ascorbic acid, potassium and sodium. Iron content was similar for both these cultivars. Following the five-week storage time, the increase of almost all analysed elements was noted in all cultivars of the cauliflower. A loss was only observed for calcium content in the curds of the green and romanesco cultivars, and for that of sodium in the case of the green cauliflower cultivar.

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ZMIANY JAKOŚCIOWE ZACHODZĄCE W RÓŻACH KALAFIORA BIAŁEGO, ZIELONEGO I ROMANESCO PODCZAS PRZECHOWYWANIA

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W latach 2002–2004 prowadzono badania w uprawie kalafiora na zbiór jesienny. Badanymi czynnikami były formy kalafiora: biały, zielony i romanesco; nawożenie azotowe i stopień dojrzałości róży. Po zbiorze róże umieszczono na okres 5 tygodni w chłodni z temperaturą 2°C i wilgotnością względną powietrza 85–90%. Największe róże uzyskano z roślin kalafiora białego, a najmniejsze kalafiora romanesco. Nawożenie azotem w wyższej dawce spowodowało wytworzenie większych róż u kalafiora białego i zielonego (tab. 1). Większe róże uzyskano ze zbioru w momencie osiągnięcia przez nie standardowej jakości handlowej (czyli po osiągnięciu możliwie największych rozmiarów przy zachowaniu zwartej i gładkiej powierzchni). Największą trwałość przechowalniczą wykazał kalafior zielony. W porównaniu z kalafiorem zielonym i romanesco, róże kalafiora białego zawierały więcej jedynie wapnia i sodu. W porównaniu z kalafiorem romanesco, róże kalafiora zielonego zawierały więcej kwasu L-askorbinowego, potasu oraz sodu (tab. 3 i 5). Po przechowaniu stwierdzono wzrost zawartości prawie wszystkich analizowanych pierwiastków u wszystkich form kalafiora.