EVALUATION OF THE ANTIRADICAL POTENTIAL OF DIFFERENT CABBAGE VARIETIES

EVALUAREA POTENŢIALULUI ANTIRADICALIC A DIFERITE SOIURI DE VARZĂ

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Abstract. *External and internal leaves extracts of white and red cabbage were analzyed for antiradical potential and total phenolics content. The antocyanins content of red cabbage was also determined. Total phenolics content ranged from 42.75±0.17 mg gallic acid/100 g fresh weight, found in white cabbage – external leaves, to 245.16±0.37 mg gallic acid/100 g fresh weight, found in red cabbage – external leaves. Red cabbage exhibit high antiradical activity than white cabbage. No significant differences were recorded between antiradical activity of external and internal leaves of cabbage varieties studied. Liniar regression analysis of the data showed a weak correlation (R^2=0.671) between antiradical potential and total phenolics content, implying that cabbage contain another compound with antioxidant potential beside pehnolics.*

Key words: antiradical activity, cabbage, total phenolics.

Rezumat. *Extractele frunzelor exterioare şi interioare de la varza albă şi de la varza roşie au fost analizate pntru potenţialul antiradicalic şi conţinutul de fenoli totali. La varza roşie s-a determinat şi conţinutul de antociani. Conţinutul de fenoli totali a variat de la 42.75±0.17 mg acid galic/100 g produs proaspăt, înregistrat la varza albă – frunze exterioare, la 245.16±0.37 mg acid galic/100 g produs proaspăt, înregistrat la varza roşie – frunze exterioare. Activitatea antiradicalică găsită la varza roşie este mult mai mare decât cea găsită la varza albă. Nu s-au înregistrat diferenţe mari între potenţialul antiradicalic al frunzelor exterioare şi interioare la ambele soiuri de varză studiate. Analiza regresiei liniare a datelor a arătat o corelaţie slabă (R^2=0.671) între activitatea antiradicalică şi conţinutul de fenoli totali a probelor analizate, ceea ce înseamnă că varza conţine şi alţi compuşi cu rol antioxidant pe lângă fenoli.*

Cuvinte cheie: activitate antiradicalică, varză , fenoli totali.

INTRODUCTION

Brassicaceae vegetables are an abundant source of health-promoting substances, which reduce the risk of diseases. Apart from anticancerogenic glucosinolates, they possess antioxidants of both hydrophilic (vitamin C, polyphenols) and hydrophobic phases (carotenoids, vitamin E), which can neutralize active oxygen species and quench free radicals. Phenolic compounds

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with ascorbic acid are major antioxidants of *Brassicaceae* vegetables, while lipid-soluble antioxidants are responsible for only 20% of the total antiradical capacity (Podsedek A., 2007).

White cabbage is currently the most important vegetable species in Romania in terms of production, exceeding tomatoes almost every year (except only in 2004) during 2000-2008 period. Cabbage production in Romania in 2009 was 1.004 million tonnes. In Romania, the consumption of cabbage represent more than one quarter of total vegetables consumption. White cabbages appears staggered on market: protected crops (March - May, maximum consumption in May), early (months from May to July, maximum consumption in June), summer (July - September, maximum consumption in August) fall to the share of 70% (September to November, with a maximum consumption in October). Red cabbage is produced from June until November, with maximum consumption during November (Beceanu D., 2011).

White and rubra cabbage form were cultivated from ancient times. They have become gradually the most important vegetables from Europe. Some *Brassica* vegetables peculiarities are: they are biennial plants (except cauliflower), are resistant to low temperatures and excess moisture requirements, generally give high yields and good storage capacity of fresh and preserved (Bălaşa M., 1980).

Chemical composition of cabbage (table 1) in terms of food value is supplemented by dietary and medicinal properties of these vegetables (Aruoma O., 2003).

Table 1

The average chemical composition of white and red cabbage (Beceanu D., 2011)

Product	Carbohydrates g%	Protids g%	cellulose g%	Fibers g%	Minerals g%	Kcal/ kg
White cabbage	3,5-6	1,8-2,1	1,2-1,6	2,8	0,6	330
Red cabbage	3,3-5,6	1,4-1,9	0,7-1,1	3	0,8	230-330

The possibility of a distribution of consumption over a long period of time, both in fresh and industrialized, coupled with high food value, led to the inclusion of vegetable *Brassica* in a rational and balanced nutrition regimen. The rich content in salts and vitamins (table 2) gives them a special value (Bălaşa M., 1980).

Table 2

The content of vitamins and minerals of the white and red cabbage (Beceanu D., 2011)

Product	Vit. C mg%	carotene mg%	Vit. B mg%	Vit. PP mg%	Vit. E mg %	K mg %	Mg mg %	P mg %
White cabbage	40-60	0,3-0,5	0,2-0,3	0,30,8	2,4	400	70	60
Red cabbage	50-90	-	0,55	0,38	0,9	250	17	32

Experts claim that cabbage has therapeutic role in over 100 diseases. Active substances varies according to species (Zhenzhen X., 2010).

Research done in the last 20 years have confirmed that a frequent consumption of raw or juice cabbage have a beneficial effect in preventing colon cancer. American Studies at the National Cancer Institute showed that people who eat cruciferous vegetables (especially cabbage) are less exposed to illness of the colon cancer. Similar research was conducted in the U.S., Greece, Norway and Israel universities. White cabbage is a nutritive food, energizing, remineralizing, diuretic, anti-haemorrhagics, antiseptic, healing, antidiabetic and antianemic.

Consumption of cabbage three times a week help to supplement the vitamins and minerals necessary for patients with anemia. In the elderly, cabbage is refreshing and combat premature aging. Consumption of cabbage is also indicated for pregnant women, due to folic acid. Studies have shown that lack of this acid in the diet during pregnancy leads to birth of children with neurological problems. Cabbage speeds up healing of wounds, the sprains and neuralgia (Yu-Ping *et. al*., 2008).

MATERIAL AND METHOD

Two white and red cabbage varieties were analyzed for potential antiradical. Samples were placed in dark plastic bags and stored at -20°C until extract performance (not less than one week).

To prepare cabbage extract 50 g were homogenized and extracted in 200 ml extraction solvent (ethanol: acetone: acetic acid in the ratio 70: 29: 1) for 1 h at 37°C (Guorong *et al*., 2009). The extract obtained was filtered through Whatman paper no. 41 and then rinsed with 50 ml extraction solvent (ethanol: acetone: acetic acid in the ratio 70: 29: 1). The extraction residue was repeated under the same conditions. The two filtrates were combined and stored at -20°C until use.

Antiradical activity was determined by DPPH method proposed by Brand-Williams *et al*, 1995. Absorbance was recorded at 517 nm. The antioxidant activity was calculated as the µmole Trolox equivalent (TE) / 100 g fresh weight with Trolox calibration curve.

Total phenolic compounds of the cabbage extracts were determined with Folin-Ciocalteau method. Absorbance was read at 750 nm, and the results were expressed as mg gallic acid equivalent per 100 g fresh product.

For the determination of anthocyanins from red cabbage pH variation method was used. The extracts were diluted in a pH 0.68 and in a pH 3.5 solutions. Absorbance was measured at 520 and 700 nm. Results were expressed as mg per 100 g fresh product.

Tests were performed in triplicate for each sample. Results were expressed as mean values ± standard deviation. Statistical correlations were calculated using Microsoft Office Excel.

RESULTS AND DISCUSSIONS

Vegetables are sources of natural antioxidants as vitamins, flavonoids, carotenoids and other phenolic compounds (Ismail *et al*., 2004, Kim *et al*., 2007, Good *et al*., 2008). Consumption of *Brassica* vegetable such as broccoli, cauliflower,

cabbages, which have antioxidant activity, may be useful for human health (Podsedek A., 2007, Sikora E.*et al*., 2008).

Brussels sprouts, broccoli, red cabbage are considered the vegetables with the most efficient antiradical system (Podsędek A., 2007).

Antiradical activity in red cabbage stand out from the antiradical activity of white cabbage (table 3). Regarding antiradical potential of inner and outer leaves, no differences were recorded in two varieties. The inner leaves of white cabbage showed a greater antiradical potential than outer leaves. We can not say the same thing about red cabbage, where the situation is different, antiradical activity of the outer leaves was greater than antiradical activity of the inner leaves.

Table 3

Antiradical activity (DPPH), total phenols and anthocyanins content extracts of white and red cabbage

Variety	Phenolics compounds (mg GAE/100 g fresh weight)	Anthocyanins content (mg/100 g fresh weight)	Antiradical activity (μM Trolox/100 g fresh weight)
White cabbage			
Outer leaves	42.75 ± 0.17	-	29.1 ± 1.37
Inner leaves	54.56 ± 0.17	-	29.5 ± 0.93
Red cabbage			
Outer leaves	245.16 ± 0,35	98.57 ± 0.34	86.4 ± 2.38
Inner leaves	108.70 ± 0.17	29.81 ± 0.10	83.6 ± 1.5

The content of anthocyanins in red cabbage ranged from 98.57 ± 0.34 mg/100 g fresh product of the outer leaves to 29.81 ± 0.10 mg/100 g fresh product of the inner leaves. It seems that the outer leaves was much richer in anthocyanins than internal ones. Anthocyanins may be located in different plant organs and in different proportions, their distribution varies from species to species, but also between different varieties of the same species (Maarit R., 2005).

Red cabbage contains 36 different types of anthocyanins, a class of flavonoids that have been linked to cancer protection, according to a new study conducted by researchers from the U.S. Department of Agriculture's Agricultural Research Service (ARS). Recently, it has attracted much attention because of its physiological functions and applications. Anthocyanins rich in red cabbage seem to be responsible for those properties (McDougall *et al*., 2007). Besides giving color to plants, anthocyanins also have an array of health-promoting benefits, as they can protect against a variety of oxidants through a various number of mechanisms (Kong *et al*., 2003). Health benefits associated with anthocyanins include enhancement of sight acuteness, treatment of various blood circulation disorders resulting from capillary fragility, vaso-protective and anti-inflammatory properties, maintenance of normal vascular permeability, controlling diabetes, anti-neoplastic and chemoprotective agents, radiation-protective agents, and

possibly others due to their diverse action on various enzymes and metabolic processes (Giusti *et al.*, 2003).

Phenolics content of red cabbage showed much higher values than white cabbage. In white cabbage the highest content of total phenols was observed in the inner leaves (54.56 ± 0.17 mg g GAE/100 a fresh weight) and in red cabbage the highest content of phenolics compounds was found in the outer leaves (245.16 ± 0.35 mg GAE / 100 g fresh product).

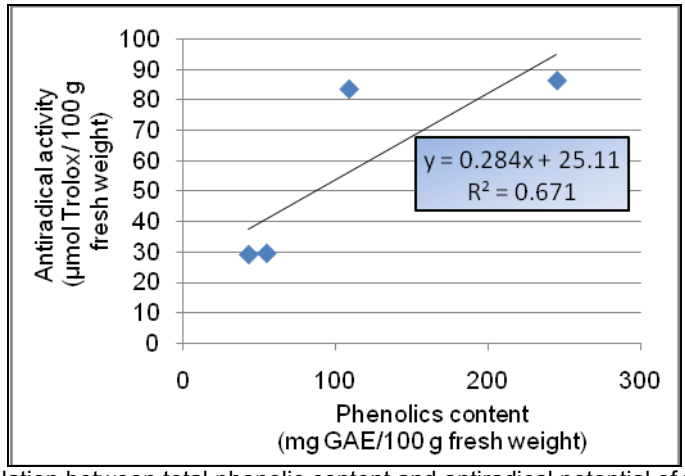

Fig.1 - Correlation between total phenolic content and antiradical potential of the inner and outer leaves of the white and red cabbage

Correlation between antiradical potential and total phenol content of inner and outer leaves from white and red cabbage (fig. 1) is relatively low (R^2 = 0.671). Influence of phenolic compounds in antiradical activity is evident in outer leaves of white and red cabbage. Elevated total phenol content recorded correspond to those of antiradical potential. Cruciferous vegetables, including cabbage (*Brassica oleracea* convar. *capitata*), have a high nutritional value and contain organosulphur phytochemicals that increase their antioxidant capacity, which may have anticarcinogenic effect (Kurilich *et al*. 1999; Kim *et al*. 2004).

CONCLUSIONS

1. Cabbage represent an important source of antioxidants, available throughout the year.

2. Antiradical activity found in red cabbage (86.4 ± 2.38 mm Trolox/100 g fresh product) was higher than in white cabbage (29.5 ± 0.93 mm Trolox/100 g fresh product).

3. Differences between antiradical activity of the outer and inner leaves of the two varieties studied was small.

4. Anthocyanin content of the red cabbage outer leaves (98.57 ± 0.34 mg/100 g fresh product) it clearly distinguishable from that existing in the inner leaves (29.81 ± 0.10 mg/100 g fresh product).

5. Correlation between total phenolics content and antiradical potential of both varieties of cabbage was considered low, which suggests that antiradical activity involve other antioxidant compounds.

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