PHYTOCHEMICAL CONTENT AND ANTIOXIDANT ACTIVITY OF TWO CULTIVARS OF WHITE CABBAGE

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Abstract

The purpose of this study was to evaluate comparatively the phytochemical content, the antioxidant enzymes activities and the antioxidant activity in two cultivars of white cabbage (Brassica oleracea var. capitata f. alba). The content of reducing sugar, ascorbic acid, total phenolic, flavonoids, catalase and peroxidase activity were determined by colorimetric methods. The antioxidant activity was evaluated by DPPH and ABTS radical scavenging assay. The results show that studied chemical indices vary depending on the analyzed cultivar. This study recommends introducing the investigated varieties in diet due to the rich content of compounds with antioxidant properties.

***Key words**: antioxidant activity, phytochemicals, white cabbage.*

INTRODUCTION

Cabbage (*Brassica oleracea L. var Capitata*) is one of the most important dietary vegetables consumed in Romania and in the world. Cabbage consumption is associated with a decrease in the risk of many chronic diseases, cardiovascular and cerebrovascular diseases, neurological diseases, diabetes, cancer, hypertension or obesity (Kapusta-Duch et al., 2012a).

These beneficial effects are due to the content rich in bioactive compounds with health promoting properties (Samec et al., 2017). Many of these compounds with antioxidant activity that act synergistically are involved in combating oxidative stress caused by excess free radicals. Many studies have shown that bioactive compounds present in cabbage are able to induce detoxification enzymes, stimulate the immune system and inhibit tumor cell growth, malignant transformation and carcinogenic mutations (Maritess et al, 2005, Kumar and Andy, 2012). Cabbage has an historical use in traditional medicine for improving digestive disorders (gastritis, peptic and duodenal ulcers, irritable bowel syndrome) as well as in treatment of minor cuts and wounds.

The cabbage had a low caloric value due to the low content of protein and fat, an appropriate content of fibre and a high content of potassium, calcium, magnesium and phosphorus, vitamins C, E, K and carotenoids: β-carotene, lutein and zeaxanthin (Podsedek, 2007). The white cabbage is a rich sourse of phytochemicals: polyphenols, anthocyanins, flavonoids, terpenes, glucosinolates or sulphur-containing compounds, S-methylcysteine sulfoxide, coumarins, tocopherols and antioxidant enzymes (Podsedek, 2007).

The variation in phytochemicals content in plants is dependent on many factors: variety, stage of harvesting, growing conditions, soil, storage conditions (Kusznierewicz et al, 2008). In this context, the purpose of the study was to evaluate the bioactive compounds content and the antioxidant activity in two white cabbage cultivars in order to provide information

about the nutritional value for consumers and industrial processors.

MATERIALS AND METHODS

This research investigated two white cabbage cultivars: Sarmalin (cultivar 1) and a local population (cultivar 2) cultivated in a private farm in Almaj, Dolj.

Analytical methods: *Dry matter content* % was determined gravimetrically at 105°C.

Total soluble solids content SSC (%) was determined using a digital refractometer (Kruss Optronic DR 301-95) at 20°C;

Reducing sugars (%) were assayed colorimetric at 540 nm with 3,5 dinitrosalicylic acid reagent using glucose as standard (Soare et al., 2019).

Ascorbic acid (AsA) was determined by iodometric redox titration and the content was expressed as mg/100 g f.w.

For antioxidant *enzymes extraction*, fresh tissue was homogenised with 0,1M phosphate buffer (pH 7.5) containing 0,1mM EDTA. The homogenates were centrifuged for 20 min at 6000 r.p.m. and the supernatants were used for enzyme assays. *Total soluble peroxidase activity (POX)* was assayed colorimetric at 470 nm and was expressed as ΔA/min/1g fw. (Soare et al., 2017). *Catalase activity (CAT*) was assayed colorimetric at 570 nm and the results were expressed as mM H_2O_2/min/g fw at 25 °C (Dinu et al., 2021).

For the determination of *antioxidant activity, total phenolic and total flavonoids content* samples were extracted with 80% aqueous methanol (1:10 w:v) by sonicating for 60 min in a sonicate bath Fungilab (Madrid, Spain). The resulting slurries were centrifuged at 4000 g for 5 min and the supernatants were analyzed.

The total phenolics content (TPC) was determined colorimetric at 765 nm by using the Folin-Ciocalteu reagent (Soare et al., 2016). The results were calculated using gallic acid as standard and expressed as mg gallic acid equivalents GAE/100 g fw.

The total flavonoids content (TFC) was determined by colorimetric methods at 500 nm using quercetin Q as standard (Soare et al., 2016). The total flavonoid content was expressed as mg Q/100g fw.

DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay: was measured colorimetric at 517 nm using Trolox as standard (Soare et al., 2016). Antioxidant capacity values were expressed as μM TE/100 g fw.

ABTS radical cation scavenging activity (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) was measured colorimetric at 734 nm using Trolox as standard (Dinu et al., 2021). The final results were expressed as μM TE/100g fw. All the spectrophotometric measurements were performed with a Thermo Scientific Evolution 600 UV-Vis spectrophotometer with VISION PRO software. All determinations were performed in triplicate, and all results were calculated as mean.

RESULTS AND DISCUSSIONS

The investigated biochemical indices vary with the analyzed cultivar.

Soluble solids content varies from 4.6% to 5,7 % and dry matter from 7,08% to 7,92% (Figure 1). *Soluble solids content* (SSC) is a quality indicator for many vegetables that contribute to flavor perception and consumer acceptance. It is also an index that indicates the sweetness determined by the content of glucose, fructose and sucrose that contribute differently to the sweet sensation. The *reducing sugars* content determined in studied cultivars is 1,54% (cultivar 1) and 3,55% (cultivar 2).

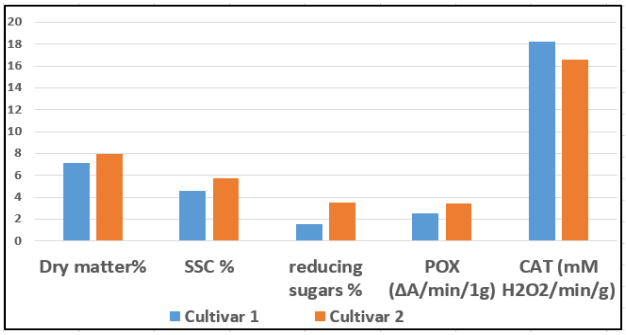

Figure 1. Dry matter, soluble solids, reducing sugars content and enzymatic activities of catalase and peroxidase

The enzymatic antioxidant activities: The enzymatic activity of peroxidase and the enzymatic activity of catalase were determined.

The enzymatic antioxidant system plays a key role in the scavenging and regulation of the level of reactive oxygen species generated in aerobic metabolic processes. Cultivar 2 showed maximum peroxidase activity (3.42 ΔA/min/1g fw) while the peroxidase activity was lower (2,56 ΔA/min/1g fw in cultivar 1 (Figure 1). Singh et al., 2010 report for 36 genotypes the peroxidase activity ranging between 415.00 and 5314.00 µM tetraguaiacol/min/1g f.w. In the case of catalase the enzymatic activity ranges from 16,58 mM H_2O_2/min/g (cultivar 2) to 18,2 mM H_2O_2/min/g (cultivar 1). Our results are similar to those obtained by Singh et al., 2010. Of the 36 genotypes studied where the average catalase activity is 101.83 mM H_2O_2/min/g, four of them exhibit enzymatic activity ranging between 14.2 mM H_2O_2/min/g and 17.77 mM H_2O_2/min/g (Singh et al., 2010).

The ascorbic acid content is presented in figure 2. The content of ascorbic acid is 26,45 mg/100g fw for cultivar 1 and 28,63 mg/100g fw for cultivar 2. In a previous research our team determined an ascorbic acid content that ranged from 20,51 mg/100g fw to 25,52 mg/100g fw for five white cabbage cultivars (Soare et al., 2016).

The obtained results are similar to data reported in the scientific literature. In India in eighteen different cabbage the Vitamin C content ranged from 5.66 to 23.50 mg/100 g fw. (Singh et al., 2006). In white head cabbage grown under diversified ecological conditions the ascorbic acid content ranged from 34,0 mg/100 g fw to 41,2 mg /100g fw (Kapusta-Duch and Leszczynska, 2013)

The content of total phenolic compounds (TPC) and *the content of total flavonoids (TFC)* varies between 35,6 mg GAE/100g and 62,19 mg GAE/100g respectively between 18,84 mgQE/100g fw and 33,19 mgQE/100g fw (figure 2). The results obtained in this study are similar to those reported by other authors. In fourteen cultivars the values for TPC were in range from 12.58 to 34.41 mg/100g fw (Singh et al. 2006). In another study TPC ranged from 58,4 to 59,8 mg chlorogenic acid/100 g fw (Kapusta-Duch et al., 2012b) *Antioxidant activity* varies depending on the studied cultivar (figure 2).

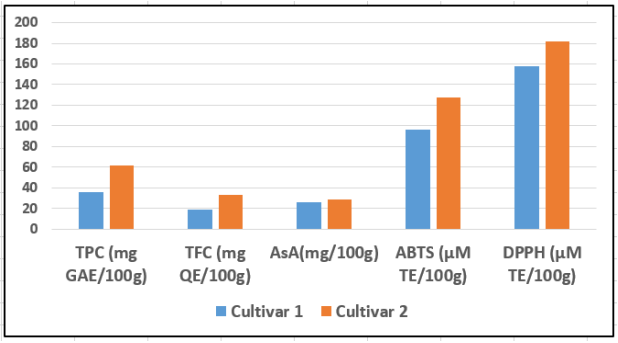

Figure 2. Total phenolic, total flavonoids, ascorbic acid content and antioxidant activities

The two studied cultivars present strong radicals scavenging activity confirming the high content of compounds with antioxidant properties. The values of DPPH radical scavenging activity is 157,56 µM TE/100g fw and 182,12 µM TE/100g fw. The values of ABTS radical scavenging activity varies between 96,6 µM TE/100g fw and 127,6 µM TE/100g fw (figure 2).

CONCLUSIONS

The content of determined phytochemicals varies with the investigated cultivar.

White cabbage is a rich source of bioactive compounds with health promoting properties. The studied cultivars have a high enzymatic antioxidant activity, high content of phenols, flavonoids and ascorbic acid and strong radicals scavenging activity.

The results of this study recommend introducing the investigated cultivars in diet as a source of naturals antioxidants.

REFERENCES

Dinu, M., Soare, R., Hoza G., Becherescu, A. D., Babeanu, C., (2021). Bioactive compounds content and antioxidant activity

in the leaves of some sweet potato cultivars (Ipomoea batatas l.), *Scientific Papers. Series B, Horticulture.* LXV (1), 415-422.

Kapusta-Duch, J., Kopeć, A., Piątkowska, E., Borczak, B., Leszczyńska, T. (2012a). The beneficial effects of Brassica vegetables on human health, *Rocz Panstw Zakl Hig*, 63 (4) 389- 395.

Kapusta-Duch, J., Leszczyńska, T, Filipiak-Florkiewicz, A., (2012b). Comparison of total polyphenol contents and antioxidant activity in cruciferous vegetables grown in diversified ecological conditions, *Acta Sci. Pol., Technol. Aliment*, 11(4), 335-346.

Kapusta-Duch, J and Leszczyńska, T (2013). Comparison of vitamin c and β-carotene in cruciferous vegetables grown in diversified ecological conditions, *Pol. J. Environ. Stud., 22 (1), 167-173.*

Kumar, S. and Andy, A. (2012). Health promoting bioactive phytochemicals from *Brassica, International Food Research Journal,* 19(1), 141-152*.*

Kusznierewicz, B, Bartoszek, A, Wolska, L, Drzewiecki, J, Gorinstein, S, Namiesnik. J (2008) Partial characterization of white cabbages (*Brassica oleracea* var. capitata f. alba) from different regions by glucosinolates, bioactive compounds, total antioxidant activities and proteins. *LWT Food Sci Technol*., 41, 1-9.

Maritess, C., Small, S., Waltz-Hill, M. (2005). Alternative nutrition therapies in cancer. S*em. Oncol. Nurs.,* 21 (3), 173-176.

Podsedek, A. (2007). Natural Antioxidants and Antioxidant Capacity of *Brassica* Vegetables: A Review. *LWT-Food Science and Technology*, 40, 1-11.

Samec, D, Piljac-Zegarac, J, Bogovic, M, Habjanic K, Gruz J (2011). Antioxidant potency of white (*Brassica oleracea* L. var. capitata) and Chinese (*Brassica rapa* L. var.pekinensis (Lour.)) cabbage: the influence of development stage, cultivar choice and seed selection. *Sci Hortic.,* 128, 78–83.

Singh, J., Upadhyay, A.K., Bahadur A., Singh B., Singh K.P., Mathura, R. (2006). Antioxidant phytochemicals in cabbage (*Brassica oleracea* L. var. capitata). *Sci. Hort*., 108, 223–237.

Singh, B.K., Sharma, S.R., Singh B. (2010). Antioxidant enzymes in cabbage: Variability and inheritance of superoxide dismutase, peroxidase and catalase, *Scientia Horticulturae*, 124, 9–13.

Soare, R., Dinu, M., Babeanu, C., Fortofoiu, M. (2016). Bioactive compounds and antioxidant capacity in some genotypes of white cabbage (*Brassica oleracea* var. capitata f. alba). *International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & Mining Ecology Management,* 1, 437-444.

Soare, R., Dinu, M., Babeanu, C., Popescu M. (2017). Antioxidant Enzyme Activities of some *Brassica* Species, *Bulletin UASVM Horticulture,* 74(2), 191-196.

Soare, R., Dinu, M., Hoza, G., Bonea, D., Babeanu, C., Soare, M. (2019). The influence of the hybrid and the sowing period on the production of sweet corn. *Scientific Papers-Series B-Horticulture*, 63 (1), 391- 397.