

The effect of thermal processing on the antioxidant properties of white and red cabbage

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Abstract The goal of this study was to evaluate the effect of thermal processing on the antioxidant properties of white and red cabbage. In terms of total antioxidant capacity, red cabbage, regardless of the type of heat processing, recorded the highest value, almost nine times higher than those recorded by white cabbage. Thus, the average value of the total antioxidant capacity registered the following decreasing trend: cooked or riped red cabbage > boiled red cabbage > fresh red cabbage > cooked or riped white cabbage > boiled white cabbage > raw white cabbage. The total polyphenol content for white and red cabbage recorded different values, much higher for red cabbage, regardless of the processing method, than for white cabbage. From the obtained results we conclude that the thermal processes of baking and boiling have a positive effect on the antioxidant capacity of both types of cabbage, the value of this quality parameter increasing significantly.

Key words

CUPRAC method, Folin Ciocalteu method, *Brassica oleracea* var. *capitata*

Fresh red cabbage has a higher content of potassium and especially beta carotene and a content of lutein and zeaxanthin 10 times higher than white cabbage [24, 25]. White cabbage, on the other hand, has a vitamin K content almost double that of red cabbage [24, 25]. The health benefits of eating cabbage due to their high antioxidant content are proven by numerous studies [3, 4, 8, 9, 11, 12, 16, 18, 21, 22].

Cruciferous vegetables, such as cabbage, are known for their high glucosinolate content. Glucosinolates and their derived forms, namely isothiocyanate, have a special attraction in the pharmaceutical and food industry due to their antimicrobial, neuroprotective and anticarcinogenic properties [6, 9]. These compounds are soluble in water and sensitive to heat and have been shown to be lost during heat processing.

Cabbage (*Brassica oleracea*) is prepared and eaten in many ways. The simplest options include eating raw vegetables or steaming. Pickles are one of the best known ways to preserve cabbage. Full of probiotics, cabbage is beneficial for the immune and digestive system, enzymes created in fermentation make vitamins and minerals easier to digest [10]. Recent studies have shown that raw cabbage can provide higher amounts of certain nutrients than boiled or fermented cabbage. Heat processing causes inactivation of antithyroid substances in cabbage [10]. Vegetables and fruits suffer, by boiling, a softening of their texture due to the hydrolysis of components such as cellulose, pectic substances etc., located in the spaces between plant cells that help maintain structural integrity [18].

Vitamins and minerals undergo essential transformations in terms of quantity and quality when subjected to heat treatment.

Significant losses of vitamin C occur when vegetables are cooked for a long time. Minerals from food pass into a large proportion in the boiling medium, significant amounts being lost in boiling water.

Smothering or boiling in superheated steam is a method used especially for cooking meat products, but also vegetable ones. This method has the advantage of shortening the heat processing time by increasing the temperature and, at the same time, minimizing the loss of heat-sensitive nutrients, such as water-soluble vitamins [10]. Baking is the thermal processing of food in an atmosphere of warm air obtained by introducing them in the heated oven. Under the action of caloric radiation, a crust is formed on the surface, from caramelized carbohydrates and coagulated proteins, and inside the same phenomena occur during grilling [23]. In addition, previous studies have suggested that new non-thermal technologies, such as high pressure processing or ultraviolet irradiation, may affect the glucosinolate content of cruciferous vegetables. Previous research has reported that heat processing may inactivate the enzyme myrosinase. Therefore, heat treatment can also affect the concentration of indoles, isothiocyanates and other glucosinolate breakdown products [10, 19].

The purpose of this study was to evaluate the effect of thermal processing on the antioxidant properties of white and red cabbage.

Material and Method

The *Brassica oleracea* var. *capitata* f. *alba* and *Brassica oleracea* var. *capitata* f. *rubra* samples were acquired from the Timisoara market.

The extraction of antioxidant compounds was performed by adding 20 ml of 50% ethyl alcohol solution over 1 g of sample.

We used cupric ion reducing antioxidant capacity (CUPRAC) assay to determine total antioxidant capacity (TAC) and Folin Ciocalteu method to determine total phenolic content (TPC), based on the protocols described by Bordean, 2016 [2].

Results and Discussions

From the obtained results, we can state that there are significant differences between the two types of cabbage in terms of total antioxidant capacity (TAC) and total polyphenol content (TPC).

In terms of total antioxidant capacity, red cabbage, regardless of the type of processing, recorded the highest value (expressed in g Trolox equivalent / L), almost nine times higher than those recorded by white cabbage (Figure 1).

Thus, the average value of the total antioxidant capacity registered the following decreasing trend: 889.233 mg TE / L (ripe red cabbage) > 629.13 mg TE / L (boiled red cabbage) > 554.668 mg TE / L (fresh red cabbage) > 107.399 mg TE / L (ripe white cabbage) > 56.411 mg TE / L (boiled white cabbage) > 40,646 (raw white cabbage).

From the obtained results, we conclude that the thermal processes have a positive effect on the antioxidant capacity of both types of cabbage, the value of this quality parameter increasing significantly compared to values registered by fresh white and red cabbage samples.

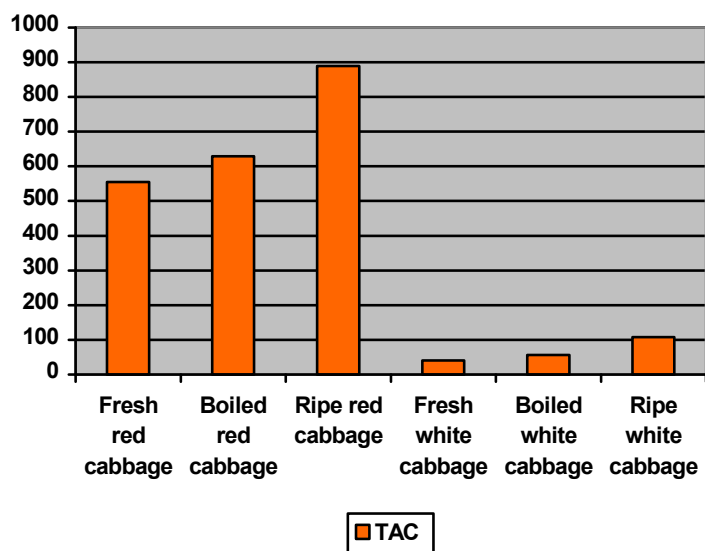


Fig. 1. Results on the total antioxidant capacity(TAC) (g TE / L extract) of the samples

The total polyphenols content (μmol gallic acid equivalent / mL) for white and red cabbage recorded different values, much higher for red cabbage,

regardless of the processing method, than for white cabbage (Figure 2).

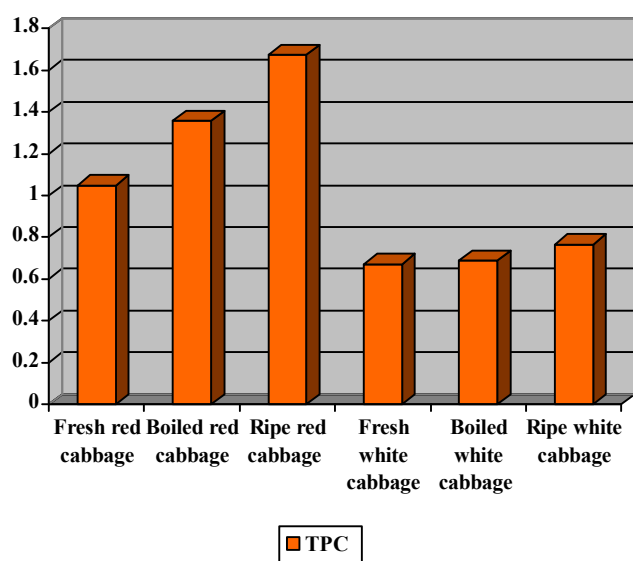


Fig. 2. Total polyphenols content(TPC) ($\mu\text{mol gallic acid / mL extract}$)

Thus, ripe red cabbage recorded the highest content of polyphenols with an average value of 1.673 ($\mu\text{mol gallic acid / mL}$).

In second place is boiled red cabbage with 1.35 ($\mu\text{mol gallic acid / mL}$), followed by fresh red cabbage with 1.048 ($\mu\text{mol gallic acid / mL}$), ripe white cabbage 0.765 ($\mu\text{mol gallic acid / mL}$), and boiled white cabbage with 0.689 ($\mu\text{mol gallic acid / mL}$).

The lowest value of the polyphenols content was raw white cabbage (0.671 $\mu\text{mol gallic acid / mL}$).

Similar results were obtained by other scientists on chinese cabbage showing that thermal treated cabbage presents higher antioxidant activity and total polyphenol content when blanched at 95°C, compared to total antioxidant activity or polyphenols content of raw leaves [15].

Kusznierewicz et al, 2008 shows that thermal treatment increases the initial values of antioxidant activity of white cabbage, encouraging consumption of processed vegetables [13].

Also, an increase of both, total antioxidant capacity, as well as total polyphenols content was discovered in six varieties of onions, thermal treated at 80°, 100° and 120°C [20].

On the other hand there are studies which present a decrease of antioxidant activity and polyphenols content [14].

However, there are researchers, which have shown that the increase or decrease in total phenolic compounds or antioxidant activity depend on the type of processing method, processing temperature and time [15], size of the vegetables cuts, as well as the quantity of water used for thermal treatment (cooking) [5].

Conclusions

Based on the obtained results, we conclude that the applied thermal processes of controlled baking and

boiling methods had positive effects on the studied varieties of cabbage and we intend to extend the study on a higher number of cabbage varieties available on the Romanian market.

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