

The effect of thermal processing on the antioxidant properties of *Beta vulgaris* and *Raphanus sativus*

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Abstract The aim of this paper was to evaluate the effect of thermal processing (boiled and ripe) on the antioxidant properties of *Beta vulgaris* and *Raphanus sativus*. The methods used to determine total antioxidant capacity (TAC) and total polyphenol content (TPC) was CUPRAC, respectively Folin Ciocalteu. The results show that the two vegetables behave differently under the action of heat treatment, in terms of total antioxidant capacity and total polyphenol content. Regarding total antioxidant capacity, ripe beets recorded the highest value, more than five times higher than that of fresh red beets, while fresh black radish recorded the highest value, followed by ripe black radish and boiled black radish. The total polyphenols content for fresh and processed beet recorded different values. Thus, baked beets recorded the highest value, followed by boiled beets and fresh beets. Regarding black radish, the total polyphenols content was highest in fresh black radishes, followed by ripe black radishes and boiled black radishes.

Key words

antioxidant activity,
CUPRAC method, Folin
Ciocalteu method

The energy value of beets is three times higher than that of black radish. From the comparative analysis of some qualitative parameters for beets and black radishes, we observe that beets have higher values of protein, total lipids, carbohydrates and fiber. Black radish is distinguished by a content of vitamin C three times higher, by the high content of lutein and zeaxanthin as well as betaine [21, 22].

Beetroot is a significant source of nutrients, with a beneficial role for health. It is a low-calorie food, does not contain cholesterol, the nutritional value coming mostly from fiber, vitamins, minerals and antioxidants [23]. Consumption of beetroot, especially fresh, unheated, can lower blood pressure and reduce cardiovascular risk. Nitrates help blood circulation, including to the brain, heart or muscles. Natural sources of nitrates increase the concentration of nitric oxide molecules in blood vessels, thus benefiting the dilation of blood vessels and the acceptance of the passage of oxygen molecules [3]. The content of inorganic nitrates positively influences blood pressure and endothelial functions. The positive effects on the cardiovascular system were directly proportional to the amount of inorganic nitrates ingested [9].

Black radish contains antioxidants in important doses and helps fight diseases of the internal organs, but also has an excellent effect on hair or skin [10]. Black radish is very rich in antioxidants, thus being a very strong anti-inflammatory agent. So it is a reliable help against colds.

Thanks to the antioxidants it contains, radish is an amazing anti-cancer drug. Antioxidants control the formation of free radicals in cells and tissues, thus reducing the risk of cancer [20]. Black radish contains several natural antioxidants. It has a high content of vitamin C [18].

Beetroot is generally processed before consumption, which in turn influences the stability of betaines. Numerous studies aimed to investigate the influence of processing techniques such as microwave treatment, boiling and frying of beets. In the case of antioxidant activity, an increase of 2 to 3 times was found after boiling, frying and microwave treatments, compared to the control [14]. In another study [16], various cooking procedures affected the total polyphenolic content and antioxidant activities of various radish varieties. This study shows that all cooking processes had variable effects on the total polyphenol content and antioxidant properties. In general, the total polyphenolic content and antioxidant activities of thermally processed radishes were lower than those of the raw samples [16]. The health benefits of eating beetroot and black radish, whether processed or fresh, are proven by numerous studies in the field [4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 17, 19].

Material and Method

The beets and black radish samples were acquired from the market. In order to extract the antioxidant compounds, over 1 g of sample was added 20 ml of

50% ethyl alcohol solution. To determine total antioxidant capacity (TAC) and total phenolic content (TPC), we used CUPRAC assay [1] and respective Folin Ciocalteu methods [2].

Results and Discussions

From the results obtained, we can say that the two vegetables (beets and black radishes) behave differently under the action of heat treatment, in terms of total antioxidant capacity and total polyphenol content.

In terms of total antioxidant capacity, ripe beets recorded the highest value (2629.557 mg Trolox equivalent / L), more than five times higher than that of

fresh red beets (503.03 mg Trolox equivalent / L) (figure 1).

Thus, for beets the average value of TAC recorded the following decreasing trend: 2629.557 mg Trolox equivalent / L (ripe red beets) > 633.343 mg Trolox equivalent / L (boiled beets) > 503.03 mg Trolox equivalent / L (fresh red beets).

In terms of total antioxidant capacity, fresh black radish recorded the highest value (173.37 mg Trolox equivalent / L), followed by ripe black radish (165 mg Trolox equivalent / L) and boiled black radish (150.14 mg Trolox equivalent / L) (figure 2)

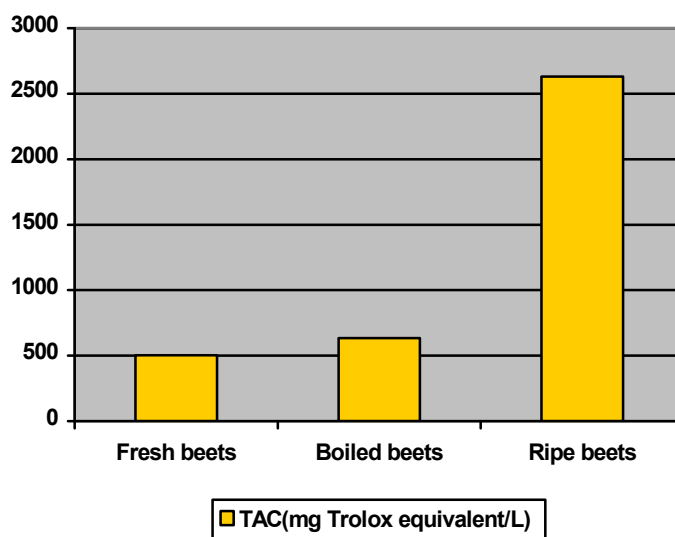


Fig. 1. Total antioxidant capacity of beets (mg Trolox equivalent/L extract)

Our results are in line with specialized studies [16]. As ripe beets have a higher total antioxidant capacity,

we recommend consuming beets in this form, in order to benefit from a maximum amount of antioxidants.

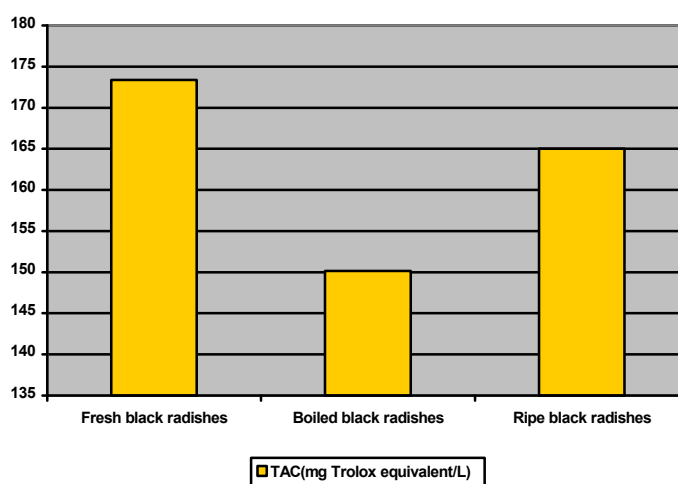


Fig. 2. Total antioxidant capacity of black radishes (mg Trolox equivalent/L extract)

The total polyphenol content (μmol gallic acid equivalent / mL) for fresh and processed red beet recorded different values (figure 3). However, cooked beets recorded the highest value, at

2.314 (μmol gallic acid / mL), followed by boiled beets (0.822 μmol gallic acid / mL) and fresh beets (0.781 μmol gallic acid / mL).

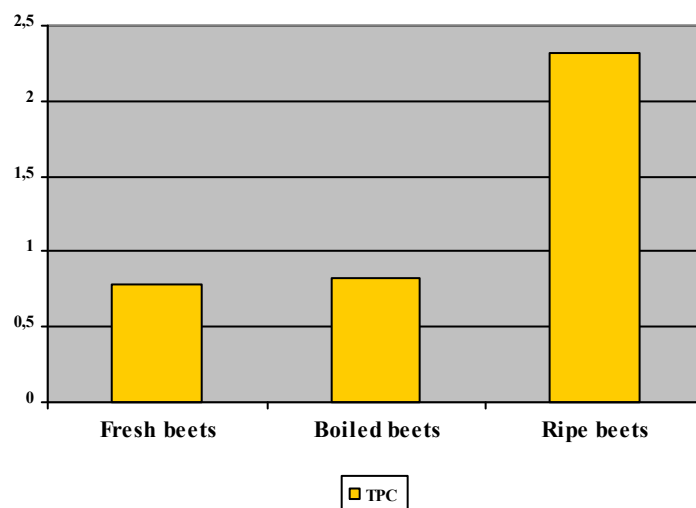


Fig. 3. Total content of polyphenols in beet ($\mu\text{mol gallic acid / mL extract}$)

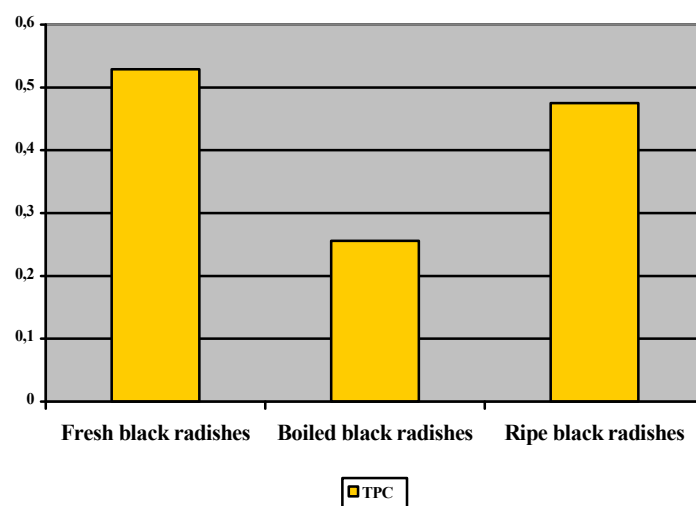


Fig. 4. Total polyphenols content (TPC) of black radish ($\mu\text{mol gallic acid / mL extract}$)

For black radish, the total polyphenol content was highest in fresh black radish ($0.529 \mu\text{mol gallic acid / ml}$), followed by ripe black radish ($0.475 \mu\text{mol gallic acid / ml}$) and boiled black radish ($0.256 \mu\text{mol gallic acid / ml}$). Our results are consistent with studies in the literature [16].

Conclusions

Heat processing has different effects on TAC and TPC in beets and black radishes. In the case of beets, the total antioxidant capacity and the total content of polyphenols have higher values for cooked or ripe products, while for black radish the thermal processing causes a decrease in their value.

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