ASPECTS REGARDING ANTIOXIDANT POTENTIAL OF DIFFERENT CABBAGE VARIETIES

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Abstract. In recent years, the agri-food sector and consumers have begun to look at food not only for basic nutrition, but also for health benefits. Green leafy vegetables represent a class of underexploited plants that are stipulated to be rich sources of natural antioxidants.

In this study it was investigated the ability of the methanol extract of different white cabbage (external leaves and core) to act as a scavenger of DPPH.

It was also determinated the content of vitamin C in cabbage with 2,6-dichlorophenolindophenol.

The analysed cabbage presents a higher content of vitamin C in core.

INTRODUCTION

For about 20 years, we've known that many phytonutrients work as antioxidants to discard free radicals before they can damage DNA, cell membranes and fat-containing molecules(cholesterol). Now, new research is revealing that phytonutrients in crucifers, such as cabbage, work at a much deeper level. These compounds actually signal our genes to increase production of enzymes involved in detoxification, the cleansing process through which our bodies eliminate harmful compounds (www.whfoods.com).

Cabbage has a long history of use both as a food and a medicine. It is thought that wild cabbage was brought to Europe around 600 B.C. by groups of Celtic wanderers. It was grown in Ancient Greek and Roman civilizations that held it in high regard as a general panacea capable of treating a host of health conditions.

Recent studies show that those eating the most cruciferous vegetables have a much lower risk of prostate, colorectal and lung cancer-even when compared to those who regularly eat other vegetables.

In the Netherlands Cohort Study on Diet and Cancer, in which data was collected on over 100,000 people for more than 6 years, those eating the most vegetables benefited with a 25% lower risk of colorectal cancers, but those eating the most cruciferous vegetables did almost twice as well with a 49% drop in their colorectal cancer risk. (Voorrips LE, Goldbohm RA, et al., 2000).

A study of Chinese women in Singapore, a city in which air pollution levels are often high putting stress on the detoxification capacity of residents' lungs, found that in non-smokers, eating cruciferous vegetables lowered risk of lung cancer by 30%. In smokers, regular cruciferous vegetable consumption reduced lung cancer risk an amazing 69%.

Human population as well as animal studies consistently show that diets high in cruciferous vegetables, such as cabbage, are associated with lower incidence of a variety of cancers, including lung, colon, breast and ovarian cancer. Research published in the *International Journal of Cancer* (Zhao H, Lin J., 2007) suggests that bladder cancer can join the list.

University of Texas researchers analyzed the diets of 697 newly diagnosed bladder cancer cases and 708 healthy controls matched by age, gender and ethnicity. Average daily intake of cruciferous vegetables was significantly lower in those with bladder cancer than in healthy controls.

Those eating the most cruciferous vegetables were found to have a 29% lower risk of bladder cancer compared to participants eating the least of this family of vegetables. Crucifers' protective benefits were even more pronounced in three groups typically at higher risk for bladder cancer: men, smokers, and older individuals (aged at least 64).
Diagnosed in about 336,000 people every year worldwide, bladder cancer is three times more likely to affect men than women, according to the European School of Oncology.

Crucifers' well known cancer-fighting properties are thought to result from their high levels of active phytochemicals called glucosinolates, which our bodies metabolize into powerful anti-carcinogens called isothiocyanates. Researchers suggested that isothiocyanates offer the bladder, in particular, significant protection, most likely because the majority of compounds produced by isothiocyanate metabolism travel through the bladder en route to excretion in the urine.

Reviewing 94 studies that evaluated the relationship between *Brassica* vegetables and cancer, researchers found that in 67% of the case control studies, eating these vegetables was associated with a reduced risk of cancer. In 70% of the studies, cabbage consumption was associated with a lower risk of cancer, especially of the lung, stomach and colon.

To get the most benefit from your cruciferous vegetables, be sure to choose organically grown vegetables (their phytonutrient levels are higher than conventionally grown), and steam lightly (this method of cooking has been shown to not only retain the most phytonutrients but to maximize their availability). Proper cabbage preparation and cooking methods are essential for receiving its cancer-preventive effects. Cabbage's protective effect was seen only for raw and short-cooked cabbage, not long-cooked.

Cabbage provides anti-carcinogenic glucosinolates, which are formed by the activity of myrosinase enzymes released when cabbage is sliced or chopped. Cooking denatures the myrosinase enzyme, thus stopping the production of glucosinolates.

In the body, the breakdown products of glucosinolates are thought to affect both the initiation phase of carcinogenesis-by decreasing the amount of DNA damage and cell mutation-and the promotion phase, by blocking the processes that inhibit programmed cell death and stimulate unregulated cell growth.

Cabbage is an excellent source of vitamin C. It is also a very good source of fiber, manganese, folate, vitamin B6, potassium, and omega-3 fatty acids. Cabbage is also a good source of thiamin (vitamin B1), riboflavin (vitamin B2), calcium, potassium, magnesium, vitamin A, and protein.

Cruciferous vegetables have relatively abundant sources of antioxidant substances with potential anticarcinogenic activity. These vegetables are known to be rich in antioxidant substances such as ascorbic acid, β-carotene and carotenoids. Both epidemiological studies and experimental research indicated that regular intake of cruciferous vegetables may reduce risk for chronic diseases. On the other hand, low consumption of these vegetables may reduce serum antioxidant capacity. (Kurilich *et al*., 1999).

Cruciferous vegetables such as cabbage are among the most important dietary vegetables consumed in Europe owing to their availability in local markets, cheapness and consumer preference.

The aim of the study was to investigate the antioxidant potential of the cabbage grown in ecological and conventional system. The external and internal leaves of the cabbage were analyzied for their antioxidant activity.

MATERIALS AND METHODS

In the present study, a total of 4 cabbage varieties were analyzed for total antioxidant capacity. The cabbage samples used for determination are presented in the table below.

Table 1

Characterization of white cabbage samples.

No	Cabbage	Geographycal origin	Agricultural system
1	Copenhagen market	Adamache Farm, Iaşi	Organic
2	Gloria	Adamache Farm, Iaşi	Organic
3	Pruktor	Matca, Galaţi	Conventional
4	Bucharest	Matca, Galaţi	Conventional

As a determination method of the antiradical action of the analyzed extracts it was used the DPPH method suggested by Brandt-Williams *et. al.*, 1995, applied with small modifications. We prepare methanolic cabbage extracts wich were mixed with different concentrations of DPPH methanolic solution. Methanol was used as a blank solution.

All chemicals necesarly for the study were provided by the Oenological Research Center – Romanian Academy – Iaşi Branch. Spectrophotometric measurements were performed on Analitkjena Spectrophotometer SPECORD 200 equipped with 1cm quartz cells.

The DPPH method is easy and it uses stable free radical DPPH (2, 2-diphenyl-1-picrylhydrazyl). This radical is often used for testing the compounds capacity for acting as inhibiters of free radicals or as donor of hydrogen, and for the evaluation of antioxidative activity (Anca Dicu, 2009). The DPPH method can be used for solids or liquids tests and it's not specific for a certain component, but it applies for the antioxidative capacity of all tests.

The single electron from the DPPH free radical presents the strong maximum absorption at 515 nm, violet – blue. The color is changing to yellow when the single electron catches a proton from the antioxidant, resulting the reduced form of DPPH-H. The result of the discoloration is stoechiometric respecting the number of cached electrons.

The principle of this analytical method is the measurement of extracts antiradical activity comparative with the DPPH free radical. The radical's structure is presented in figure 1.

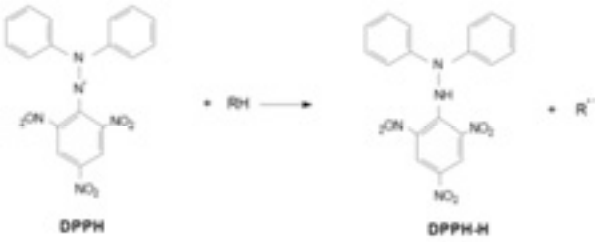

Figure 1: DPPH radical's structure

The studied tests antiradical activity is expressed in percents pursuant to the relation:

$$\% \text{ inhibition} = (A_B - A_A)/A_B * 100$$

Where: - A_B – the witness test absorption ; - A_A – the tested extracts absorption

Ascorbic acid content was estimated titrimetrically with 2,6-dichlorphenolindophenol natrium dye reactant. 10 mL of clear cabbage extract it was titrated with 2,6-dichlorphenolindophenol natrium to pink color. On the basis of 2,6-dichlorphenolindophenol natrium volum it was determined the ascorbic acid amount.(Carol Reiss, 1993).

RESULTS AND DISCUSSION

Oxidative stress has been implicated in the pathology of many diseases, inflammatory conditions, cancer and ageing. Antioxidants may offer resistance to oxidative stress by scavenging free radicals, and thus prevent the onset of deadly diseases. Apart from the antioxidants synthesised naturally, the body requires a supplement of dietary antioxidants, which can be obtained only by the consumption of an antioxidant-rich diet.

The DPPH is a mehthod currently used to provide basic information on the ability of vegetables extracts to scavenge free radicals. Reduction of DPPH radical by an antioxidant results in a loss of absorbance at 515 nm. (Vendula Vrchovska, 2006).

The methanol extracts of the four cabbage varieties, at different concentrations, both internal and external leaves, were tested for their ability to scavenge free radicals. The percentage inhibition for each concentration and IC50 values of the extracts were calculated.

Copenhagen market and Gloria cabbage showed a higher antioxidant potential in external leaves than Bucharest and Pruktor cabbage..(fig. 2).

The results indicated that Copenhagen market cabbage internal leaves was the one with the highest antioxidant potential, followed by Gloria and Bucharest cabbage. Pruktor cabbage exhibited the lowest scavenging activity (fig.3).

Organic gabbage has a higher antioxidant potential than cabbage grown in conventional system, from all types of cabbage investigated.

The antioxidant potential of all cabbage extracted with methanol might be due to the differences in solubility and extractability of the antioxidant contained in each cabbage extract. (B. Subhasree, R. Baskar, 2009).

Variation in the antioxidant contents of *Brassica* vegetables is caused by many factors: variety, maturity at harvest, growing condition, soil state, and condition of post-harvest storage.(K. G. Masamba, 2008).

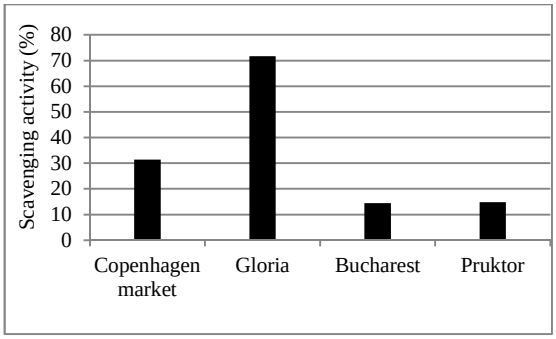

Fig. 2 Scavenging activity of white cabbage external leaves

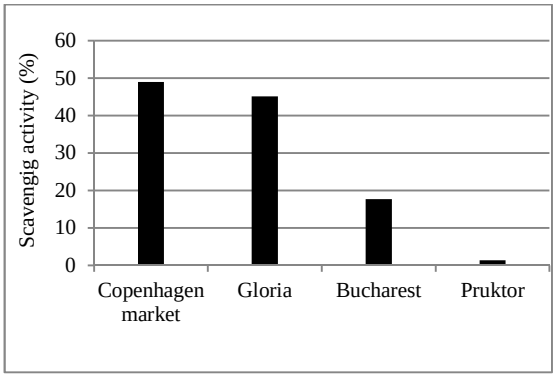

Fig. 3 Scavenging activity of white cabbage internal leaves

Cabbage is an excellent source of vitamin C, an antioxidant that helps protect cells from harmful free radicals. The nutritional and health value of ascorbic acid is of great importance in the human diet, in order to fight diseases such as scurvy, to maintain collagen, to reduce stress damage, and as an antioxidant. Ascorbic acid is important in the biosynthesis of amino acids, formation of adrenaline, and detoxification in the liver (Gherghi A., 1983).

Almost all of the vitamin C in the human diet is supplied by fruits and vegetables.

Ascorbic acid content of fruit and vegetables is very variable. Generally, leafy vegetables, citrus fruit, and some tropical fruits have high levels of ascorbic acid (Anna Podsedek, 2002).

According to Bodea, 1984 cabbage it is one of the commonly used vegetable wich contain as much vitamin C as a lemon.

Results on vitamin C revealed that are some differences between organically and conventionally grown samples. Organically grown samples showed higher vitamin C content than conventionally grown samples.(fig. 4)

The content of vitamin C in the examined cabbages was in the range at 25.87 – 55.3 mg/100 g of fresh cabbage. The only vegetable containing more vitamin C than cabbage is pepper. (Kunachowichz, 2005)

From all types of cabbage analyzied, the highest content of vitamin C was observed at the Gloria organic cabbage internal leaves 55.3 mg/100 g of fresh cabbage and the lowest content of vitamin C was observed at Pruktor conventional cabbage external leaves. Lower values of vitamin C may be the results of growing conditions.

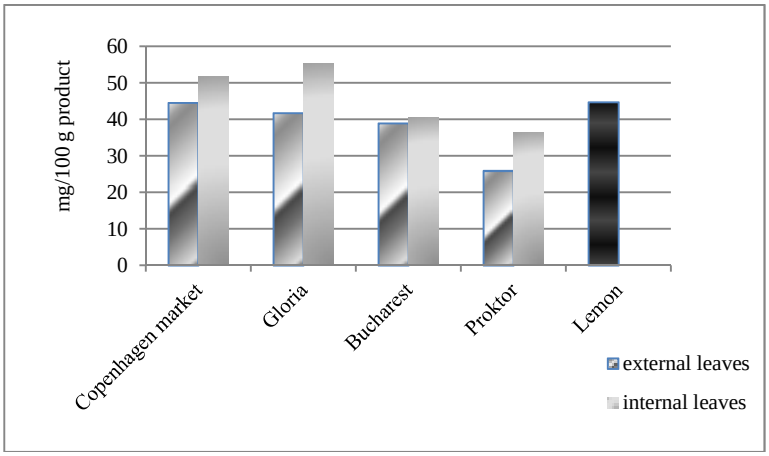

Fig. 4 Vitamin C content of cabbage samples (mg/100 g product)

Green leafy vegetables are major food sources of vitamin C. However, vitamin C is subject to oxidative and enzymatic degradation to dehydroascorbic acid (fig.5) and also irreversible oxidation via dehydroascorbic acid to diketogulonic acid, and the latter has no vitamin C activity.

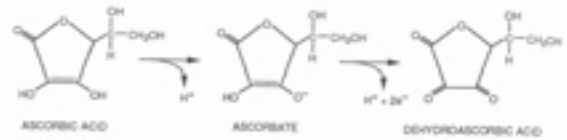

Fig.5 Ascorbic acid and its oxidation to ascorbate and dehydroascorbic acid.

Ascorbic oxidase is the endogenous enzyme involved in this process. Various factors, including the presence of oxygen and metal ions (especially Cu^{2}+, Ag, Fe^{3}+), alkaline pH, and high temperature affect the vitamin C content of raw produce prior to the point of consumption and result in variation in the actual levels in different samples of a given product.

Light, pH, temperature, oxygen exposure, the presence of oxidizing metals, and oxidizing enzymes can be controlled during the assay itself, but must also be controlled during preparation of samples for analysis, especially if the procedures involve maceration or other disruption of cells which release oxidizing enzymes.

Failure to assess stability of vitamin C in raw produce during sample processing and analysis could result in significant errors in analytical results.(Katherine M. Phillips et al., 2009).

CONCLUSION

This study examinated the antioxidant potential of the most consumed cruciferous vegetable – white cabbage, by DPPH method.

Organic gabbage varieties showed a higher antioxidant potential than cabbage varieties grown in conventional system.

The contribution of cabbage to health improvement can be related to their antioxidant capacity.

Vitamin C is the major antioxidants of cabbage, due to it high content and high antioxidant activity.

Vitamin C content and the antioxidant activity it is influenced by the agricultural growing system.

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