VITAMIN C LEVEL IN WHEAT, BARLEY AND OAT SHOOTS CONSECUTIVE SODIUM SELENITE TREATMENT

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Abstract: *The purpose of this paper was to improve the content of active principles of seedlings obtained by germination of wheat, barley and oat seeds in the presence of sodium selenite with an known antioxidant role. Selenium intake is absolutely necessary because the Romanian soil is, generally, poor in this element. The three cereals were chosen for this experiment because it is known that they are dietary sources of selenium. There were studied the effects of selenium intake at doses of 5 and 10 ppm, on the synthesis of vitamin C (another strong antioxidant). Evaluation of vitamin C content was performed by iodometric method. The novelty of this paper is to assess the level of vitamin C in seedlings of wheat, barley and oats in succession to their germination in the presence of sodium selenite while most research in this area have assessed the level of vitamin C in mature plants (or their fruits). Seedlings treated with sodium selenite, vitamin C levels have been significantly ($p<0.05$) higher in experimental compared to the control. Thus, consecutive to intake of sodium selenite, vitamin C level in wheat seedlings was on average higher by +1360.65%, to barley has increased by +8.14% and the average growth of oats was +11.815%. The level of vitamin C was directly correlated with the doses of selenium applied to all three plant species. Enrichment technique in vitamin C in raw foods products (sprout), by sodium selenite supplementation has proved to be cheap and beneficial especially for wheat seedlings, making them truly functional food. Moreover, the sprout associated with increased levels of vitamin C, offers to the consumer a better antioxidant protection, increasing its nutritional value. Natural vitamin C is also easier to assimilate by animal organisms than vitamin C obtained by synthesis or fermentation. The high content of vitamin C in seedlings increases their preservation period.*

Key words**:** *Vitamin C, wheat, barley, oat, seedlings, selenium*

INTRODUCTION

The trend today is to bring in food products with high biological value (antioxidants, dietary fiber) and to abandon the high processing food practices. Eating raw foods and minimal processing of foods is key to maintaining optimal health status. However, feeding raw foods is considered as a preventive medicine and redress. A full-scale acquired gemoterapy lately - a therapy based on the consumption of the young plants (seedlings, germs, buds, etc.) particularly good results in restoring metabolic equilibrium of the human body.

Vitamin C is the most abundant antioxidant in plants, but its functions are entirely unknown (HARTIKAINEN and XUE, 1999; HU et al., 2003; SMIRNOFF et al., 2007). Ascorbic acid is well known for its antioxidant activity, acting as a reducing agent to reverse oxidation in liquids. When there are more free radicals (reactive oxygen species, ROS) in the human body than antioxidants, the condition is called oxidative stress (MCGREGOR et al., 2006) and has an impact on cardiovascular disease, hypertension, chronic inflammatory diseases, diabetes (KELLY, 1998; MAYNE, 2003; GOODYEAR-BRUCH and PIERCE, 2002) as well as on critically ill patients and individuals with severe burns (GOODYEAR-BRUCH and PIERCE, 2002; MCGREGOR et al., 2006).

It is known that vitamin C helps plants against drought stress, UV radiation, but until now, no one knew that plants could not grow without vitamin C. In the publication Science

DAILY (2007) researchers at the University of Exeter and Shimane University in Japan have proved for the first time that vitamin C is essential for plant growth. This discovery could have applications in agriculture and production of dietary supplements with vitamin C.

Currently, vitamin C is produced by mixed fermentation or synthesis, but equivalent forms for most animal bodies are natural, summarized the plant bodies. In plants, responsible for the synthesis of vitamin C is the enzyme GDP-galactose phosphorylase (RASANU et al., 2005).

The content of vitamin C in plants is influenced by several factors: the variety exact plant parts (fruit, leaves, roots), soil and climate conditions in which it developed, the development phase, time of harvesting, storage conditions, preparation method (RASANU et al., 2005; DVFA, 2010).

The high content of vitamin C (mg/100g) is in the billy goat plum fruit (3150), camu camu (2800), sea buckthorn and goji fencing (2500), kakadu plum (2150), rosehip (200) currant (200), broccoli (90), pepper (80), strawberry (60), orange (53), lemon (46), grapefruit (34), spinach (30), mango (20), tomato, pineapple, blueberries, grapes, apricots, plums (10), banana, carrot (9), peach (7), apple, blackberry (6), beets (5), pear, salad (4), cucumber (3) (BREENE, 1994; NDL, 2007; HEC, 2007; NFH, 2007).

Beneficial effects of vitamin C consumption are compelling and familiar to all, but its combination with other antioxidant substances are still being studied. Scientists worldwide are concerned about finding new ways to enrich the level of vitamin C in plants.

In the cereal germination, vitamin C content of seedlings (sprout) increases substantially against unsprouted grains (MARTINEZ-VILLALUENGA et al., 2010; MARTON et al., 2010).

In wheat seedlings are about 2.6-3 mg vitamin C/100 g and in soybean are 15.3 mg vitamin C/100g (MARTON et al., 2010).

Along with vitamin C, another antioxidant is selenium. The importance of selenium for living organisms is being increasingly studied (MARTON et al., 2010). Selenium shows strategic roles in animal bodies. Best known role of selenium in biological systems is the co-factor for GSH-Px, antioxidant enzyme.

The level of selenium in food depends on the natural differences of essential foods and availability of selenium in the environment and human activities. Soils low in selenium are most Scandinavian countries, England, Scotland, Romania, China. Selenium-rich soils are in America.

Because Romanian soil is poor in selenium, plants can not gain optimum selenium content, generating imbalances in the food chain of animal bodies. For this purpose different techniques biofortification agronomists use compounds of selenium fertilization (GRAHAM et al., 2003).

The purpose of this experiment was to improve the content of active principles, especially vitamin C, in the seedlings obtained by germinating seeds of wheat, barley and oats in the presence of sodium selenite, thereby achieving functional foods.

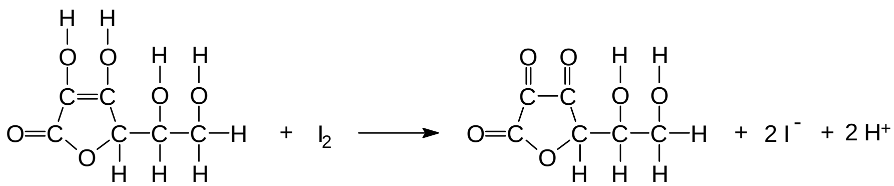
MATERIAL AND METHODS

The study was conducted on 34 cultivars of wheat Lovrin, barley System and oat Lovrin variety, obtained by germination in the presence of sodium selenite. For germination were used textile germination supports.

There were four groups, two control (M - treated with distilled water and M'- treated with drinking water) and two experimentals (E - treated with 5, respectively 10 ppm). Seedlings were watered daily for 10 days, in the same environmental conditions (temperature, humidity, light).

Determination of vitamin C

Determination of vitamin C was made with potassium dichromate in the presence of potassium iodide-starch. Initially, vitamin C (ascorbic acid) is oxidized to dehydroascorbic acid by iodine.



ascorbic acid dehydroascorbic acid

Thereafter, the reaction occurs:

$$Cr_2O_7^{2-} + 6\ I^- + 14\ H^+ = 3\ I_2 + 2\ Cr^{3+} + 7\ H_20$$

Iodine released thus starch stained blue.

It was weighed 0.1 g sample at analytical balance, then was brought quantitatively into a titration vessel, were added 10 ml of 2n hydrochloric acid, diluted to 50 ml with distilled water and then triturated, added 1 ml 1% of starch solution (freshly prepared) and 1 ml 0.1 N potassium iodide, after which the solution was titrated with 0.1 N potassium dichromate until persistent blue color.

Quantification of vitamin C content was done according to the relation:

1 ml 0.1 N potassium dichromate is equivalent to 0.008806 g vitamin C.

Data were statistically analysed by ANOVA descriptive statistics method.

RESULTS AND DISCUSSIONS

The level of vitamin C from wheat seedlings germinated in the presence of sodium selenite is shown in Table 1 and figures 1-3.

Table 1

Vitamin C level in wheat, barley and oat seedlings obtained by seed germination in the presence of natrium selenite

	Group	**$\bar{X}$±Sx**
Wheat	M_1 (distilled water)	0,30±0,01
	M'_1 (drinking water)	0,3±0,03
	$E_{1.1}$ (5 ppm Se)	3,25±0,01
	$E_{1.2}$ (10 ppm Se)	5,61±0,04
Barley	M_2 (distilled water)	4,38±0,02
	M'_2 (drinking water)	4,66±0,05
	$E_{2.1}$ (5 ppm Se)	4,75±0,03
	$E_{2.2}$ (10 ppm Se)	5,02±0,03
Oat	M_3 (distilled water)	3,81±0,02
	M'_3 (drinking water)	4,09±0,01
	$E_{3.1}$ (5 ppm Se)	4,21±0,04
	$E_{3.2}$ (10 ppm Se)	4,61±0,02

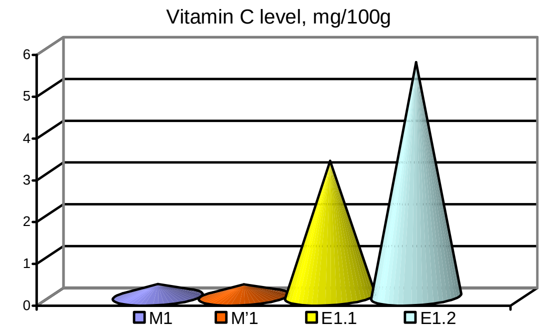


Figure 1: Vitamin C level dynamics in wheat seedlings obtained by seed germination in the presence of natrium selenite

Intake of selenium wheat consignments $E_{1.1}$ and $E_{1.2}$ led to a significant increase ($p<0.05$) levels of vitamin C in seedlings of these groups, compared with control groups. Increases were $E_{1.1}/M_1$: +958.63%; $E_{1.1}/M'_1$: +984.66%; $E_{1.2}/M_1$: +1728.33%; $E_{1.2}/M'_1$: +1771.0%. Vitamin C level was directly correlated with the dose of selenium administered ($E_{1.2}/E_{1.1}$: 72.49%).

In barley seedlings, the amount of vitamin C increased slightly ($p>0.05$) in experimental ($E_{2.1}$ and $E_{2.2}$) compared with control groups ($E_{2.1}/M_2$: 8.46%, $E_{2.1}/M'_2$: 1.9%; $E_{2.2}/M_2$: 14.58%; $E_{2.2}/M'_2$: 7.65%). Also, the vitamin C was directly correlated with the dose of selenium ($E_{2.2}/E_{2.1}$: 5.63%).

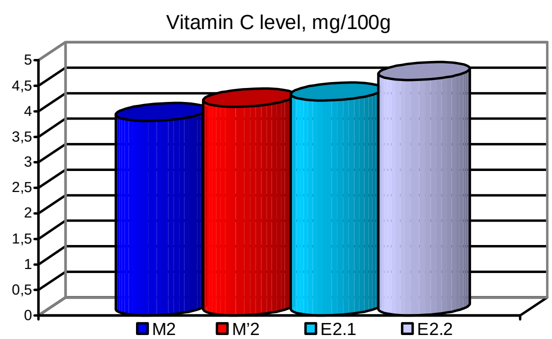


Figure 2: Vitamin C level dynamics in barley seedlings obtained by seed germination in the presence of natrium selenite

The level of vitamin C in oat seedlings was insignificant ($p>0.05$) higher in experimental groups compared to control groups. Increases were $E_{3.1}/M_3$: 10.54%; $E_{3.1}/M'_3$: 2.95%; $E_{3.2}/M_3$: 21.04%; $E_{3.2}/M'_3$: 12.73%. The level of vitamin C in oat seedlings directly correlated with the dose of selenium administered ($E_{3.2}/E_{3.1}$: 9.49%).

The results were consistent with data reported by QINGMAO and col. (1998) in salad, JUNG et al. (2000) in coriander plant and HU et al. (2001), XU et al., (2003) and HUANG et al., (2005), that the treatment with sodium selenite of plants green tea, causes a significant improvement in the level of vitamin C.

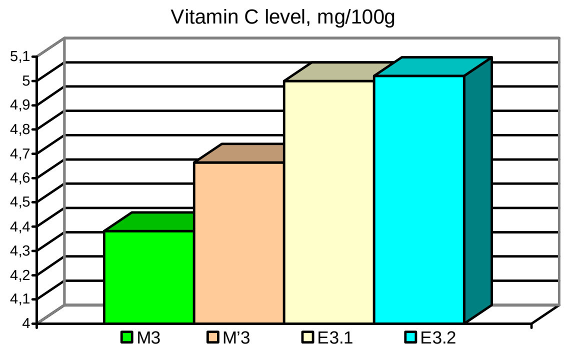


Figure 3: Vitamin C level dynamics in oat seedlings obtained by seed germination in the presence of natrium selenite

The level of vitamin C in seedlings of wheat, barley and oats germinated in the presence of sodium selenite was comparable to the level of vitamin C in pears, lettuce, cucumber (3-4 mg/100g), beets, apples, pears, blackberries (5-6 mg/100g) (NFH, 2007).

CONCLUSIONS

Research on vitamin C content in seedlings of wheat, barley and oats from seeds germinated in the presence of sodium selenite showed:

- effect of sodium selenite on the level of vitamin C in wheat seedlings directly correlated with the dose of selenium;
- vitamin C concentrations was higher than those of control groups in wheat, barlez and oat seedlings;
- hierarchy, in descending order, depending on the concentration of vitamin C were: barley, oats, wheat, regardless of the experimental version.

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