

## THE EFFECT OF STORAGE CONDITIONS ON CONCENTRATION OF VITAMIN C IN LETTUCE (*LACTUCA SATIVA*, L.)

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**Abstract.** Lettuce (*Lactuca sativa*) is a nutritious leafy vegetable, rich in minerals and vitamins. It is considered as one of the most important salad crops, grown around the world, which is used particularly as the base for salad. Salad has short vegetation period, so several production cycles can be achieved during the year. It has sedative, diuretic and expectorant features and is beneficial for functioning of the cardiovascular and digestive systems. Among the other valuable compounds, lettuce contains vitamin C, one of the essential nutrients for humans. It is very important to store lettuce after harvest in the environment in which its nutritional value does not deteriorate. Therefore, the aim of this study was to assess the effect of different cold storage conditions on concentration of vitamin C in lettuce. Four cultivars of lettuce (Murai, Kitare, Carmesi and Levistro) were included in the experiment. Plants were grown under controlled conditions of a greenhouse to technological maturity, in growing cubes. After harvest, lettuce heads were stored in the refrigerator in two ways: 1) together with growing cube or 2) without growing cube. Every three days after the beginning of the storage period, at three time points in total, concentration of vitamin C was determined. These results were also compared to concentration of vitamin C in lettuce which was not harvested and continued growth in a greenhouse, in growing cubes, during the entire period. Storage conditions effected concentration of vitamin C to varying extent in different cultivars. In cultivar Murai concentration of vitamin C declined the least over time, regardless of storage conditions (the lowest recorded value was 60% since the beginning of storage period). In the other three cultivars concentrations of vitamin C were very similar in cold storage. However, the differences between cultivars were observed in lettuce stored with growing cubes in a greenhouse where Kitare and Murai had 98 – 80% of vitamin C in comparison with respective controls. In Carmesi and Levistro concentration of vitamin C declined much more (in Levistro to about 25%, and this cultivar had the highest initial concentration of vitamin C). Generally, the results showed that there was a decrease in the concentration of vitamin C in lettuce over time, but less when lettuce was stored in the refrigerator without a growing cube.

**Key words:** Vitamin C, lettuce cultivars, postharvest storage

### INTRODUCTION

The lettuce (*Lactuca sativa*) is an annual plant of the family *Asteraceae*. It is most often grown nutritious leafy vegetable, rich in minerals and vitamins, but also sometimes for its stem and seeds. It is now considered as one of the most important salad crops, grown around the world, and is used particularly as the base for salad. Lettuce is easily cultivated because it has short vegetation period, so several production cycles can be achieved during the year. It requires relatively low temperatures to remain in vegetative phase (to prevent flowering) (BAHRI ET AL., 2012). Except for salads, lettuce is also seen in other kinds of food, such as soups, sandwiches and wraps. Lettuce is a good source of vitamin A and potassium, as well as a minor source of several other vitamins and nutrients (NIARI ET AL., 2012). Lettuce has sedative, diuretic and expectorant features and is beneficial for functioning of the cardiovascular and digestive systems. Among the other valuable compounds, lettuce contains vitamin C, one of the essential nutrients for humans.

It is very important to store lettuce after harvest in the environment in which its nutritional value does not deteriorate. The best methods that are being used to preserve fruits and vegetables during storage and marketing are generally based on refrigeration with or without

control of composition of the atmosphere (SMITH AND STOW, 1984; SMITH ET AL., 1987). Several methods that have been used are refrigeration, controlled atmosphere packaging, modified atmosphere packaging and the use of chemical preservatives (AHMAD AND KHAN, 1987; BALDWIN ET AL., 1996; ZHANG AND QUANTICK, 1997). Low temperature storage is expensive and therefore not economically feasible in most developing countries (LI AND YU, 2000) but it is indispensable to keep nutritive and market value of this vegetable. Storage temperature, but also other conditions like air humidity in storage atmosphere as well as features of lettuce that enters storage space, may significantly influence potential changes of quality and longevity of shelf life. Therefore, the aim of this study was to assess the effect of different cold storage conditions on concentration of vitamin C in different cultivars of lettuce.

### MATERIAL AND METHOD

Lettuce cultivars Murai, Kitare, Carmesi and Levistro were included in the experiment. Plants of the aforementioned cultivars were grown under controlled conditions of a greenhouse to technological maturity, in growing cubes. After harvest, lettuce heads were stored in the refrigerator in two ways:

- 1) together with growing cube (RC)
- 2) without growing cube (R).

Every three days after the beginning of the storage period, at three time points in total, concentrations of vitamin C and dry matter (DM) were determined. These results were also compared to concentration of vitamin C in lettuce which was not harvested and continued growth in a greenhouse, in growing cubes (GC), during the entire period.

Concentrations of vitamin C were determined as described by BENDERITTER ET AL. (1998).

### RESULTS AND DISCUSSION

Storage conditions affected concentration of vitamin C to varying extent in different cultivars (Figure 1). Higher concentrations of vitamin C were found in plants stored in refrigerator without nutritive cubes.

The largest decrease in concentration of vitamin C, compared to initial analysis, was in the variety Levistro which had the highest initial concentration of vitamin C, whereas the smallest changes were observed in the variety Murai. The large difference between storing in a greenhouse (GC) and in refrigerator (R, RC) was found in Kitare, which in general contained the least concentration of vitamin C (in the refrigerator, when stored with cube, RC).

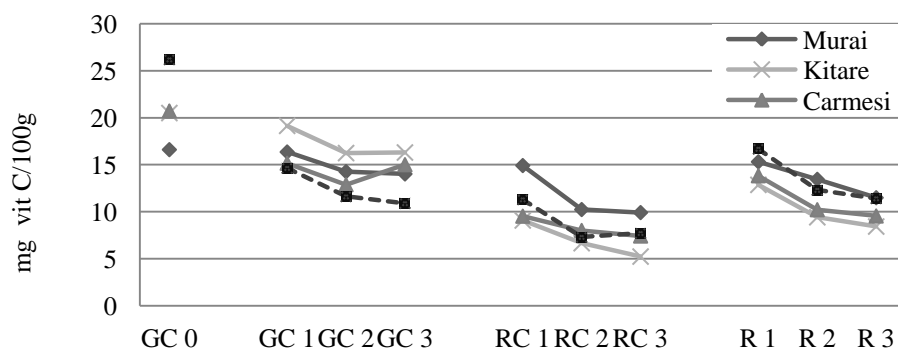


Figure 1. Concentration of vitamin C in lettuce under different storage conditions (GC, growing cube; RC, refrigerated with growing cube; R, refrigerated without growing cube; 0, initial concentration of vitamin C; 1-3, time points of analyzes)

In cultivar Murai concentration of vitamin C declined the least over time, regardless of storage conditions (the lowest recorded value was 60% since the beginning of storage period). In the other three cultivars concentrations of vitamin C were very similar in cold storage (Figure 2). However, the differences between cultivars were observed in lettuce stored with growing cubes in a greenhouse where Kitare and Murai had 98 – 80% of vitamin C in comparison with respective controls (Figure 2). In Carmesi and Levistro concentration of vitamin C declined much more (in Levistro to about 25%, and this cultivar had the highest initial concentration of vitamin C).

Generally, the results showed that concentration of vitamin C in lettuce declined over time, but to a smaller extent when it was stored in the refrigerator without a growing cube. BELTRÁN ET AL. (2005) also concluded that the content of vitamin C (ascorbic acid and dehydroascorbic acid) decreases during storage, while BAHRI ET AL. (2012) found that the length of storage period significantly affected concentration of vitamin C in Iranian white lettuce during cold storage.

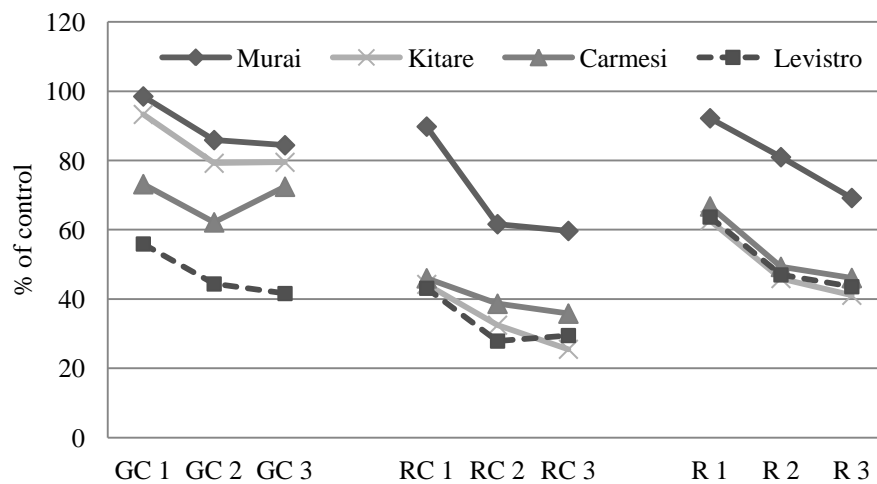


Figure 2. Relative genotypic differences in concentration of vitamin C in percents of respective controls, in lettuce under different storage conditions (GC, growing cube; RC, refrigerated with growing cube; R, refrigerated without growing cube; 0, initial concentration of vitamin C; 1-3, time points of analyzes)

The percent of dry matter decreased over time (Figure 3), but lesser when lettuce was stored in the refrigerator without a growing cube, similarly as concentration of vitamin C.

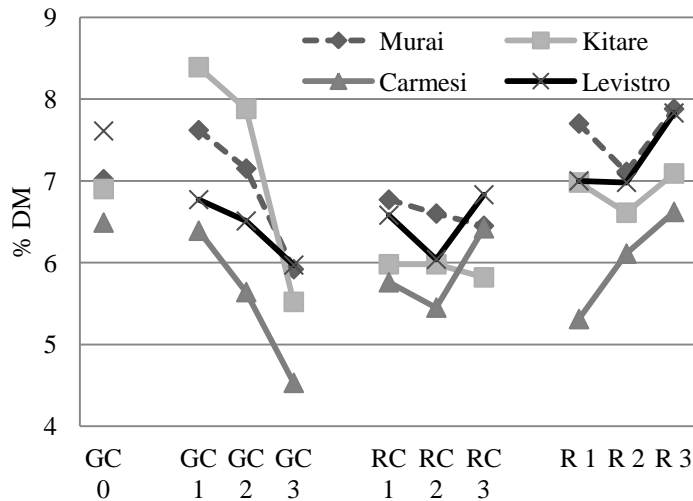


Figure 3. Genotypic differences in percent of dry matter (DM) in lettuce under different storage conditions (GC, growing cube; RC, refrigerated with growing cube; R, refrigerated without growing cube; 0, initial concentration of vitamin C; 1-3, time points of analyzes)

In cultivar Kitara dry matter content was the most variable during different storage conditions. However, POULSEN ET AL. (1995) and BOTTCHE (1988) found that dry matter content did not significantly decrease with an increase in length of storage period, which is in disagreement with our results.

### CONCLUSION

Four tested lettuce cultivars (Murai, Kitare, Carmesi and Levistro) had very different reactions with respect to changes in percentage of dry matter and concentration of vitamin C over the storage time. In cultivar Murai changes over storage time were the smallest. During the storage period the content of vitamin C significantly declined. Changes in the content of dry matter depended on the cultivar and on length of storage period.

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