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STUDY OF THE FRESH-CUT LEAVES VEGETABLES' SHELF LIFE
STUDIJA ČUVANJA SVEŽE UBRANOG LISNATOG POVRĆA

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ABSTRACT

The customers increasingly prefer fresh-cut packed vegetables which can be used at home easily. The production and trade of these products are very close for their limited shelf life. The aim of analysis is to demonstrate the relationship of expiration-date and the date of keeping quality in different storage temperature. Methods: Samples: one component fresh-cut vegetables and mixes. Storage trial: 6, 12, 20ºC, 11 days. Laboratory analysis: organoleptic evaluation, vitamin C and peroxidase enzyme activity. Results: After 3 day storage the vegetables kept their characteristic features, like fresh smell, colour, good taste, fresh habit. The time and the different temperatures induced different changes among others withering, rotting and fermentation. During the storage experiment 3 groups were found to develop. There are some which can be stored well (iceberg lettuce, endivie), can be stored badly with rotting (spinach, corn salad, rocket salad), and can be stored badly with fermentation (cabbage).

Key words: *expiration-date, storage trial, peroxidase enzyme activity, endive, iceberg lettuce, rocket salad, cabbage.*

REZIME

Kupci sve više vole sveže ubrano upakovano povrće koje se lako može upotrebiti kod kuće. Proizvodnja i trgovina ovakvim proizvodima su veoma bliske zbog njihovog ograničenog roka upotrebe. Cilj analize je da prikaže zavisnost perioda upotebe proizvoda i perioda očuvanja kvaliteta pri različitim temperaturama skladištenja. Metod: Uzorci: jedna vrsta sveže ubranog povrća i mešavina. Period skladištenja: 6, 12, 20ºC, 11 dana. Laboratoriske analize: organoleptička ocena, vitamin C i aktivnost enzima peroksidaze.

Rezultati*: Posle tri dana skladištenja povrće je očuvalo svoj karakteristični oblik, svež miris, boju, dobar ukus, svežinu. Vreme i različite temperature izazivaju različite promene, između ostalog odumiranje, truljenje i fermentaciju. Tokom eksperimenta skladištenja razvijene su tri grupe povrća. Postoji ono koje može uspešno da se skladišti (ledena salata, endivija), koje se loše skladišti sa praćenjem procesa truljenja (spanać, kukuruzna salata, rukola) i koje se loše skladišti sa praćenjem procesa fermentacije (kupus).*

Ključne reči: *rok trajanja, uslovi skladištenja, aktivnost enzima peroksidaze, edivija, ledena salata, rukola, kupus.*

INTRODUCTION

In our rushing world the customers increasingly prefer brushed and cut packed vegetables which can be used at home easily. Minimally processed leafy vegetables consumption has been increasing in all developed countries. The production and trade of these products are very close for their limited shelf life. Usually processing industries for consumer safety limits the commercialisation to 6-7 days (*Spinardi et al., 2010*).

According to Codex Alimentarius Hungaricus date of packing, producer's or distributor's name and accessibility must be obligatorily written onto the fresh packed vegetables. These products do not have expiry date, so these items can be stored until the shopkeepers or the customers at home judge them acceptable. Contrarily the cut or sliced vegetables, vegetable mixes are determined processed food. Expiry date must be mentioned on the label in the form of date, which can be kept only if the advanced storage temperature is provided. Over this time limit the item must not be traded even if the quality is unchanged. The expiration date does not necessarily mean the deterioration of the product.

Lettuces and spinach are important vegetable products in the minimally processed leafy vegetables industry. The quality parameters of these products are represented by leaf pigments that effect the visual appearance and by internal quality components such as ascorbic acid, carotenoids and phenols. Because of its lability, ascorbic acid is routinely used as an index to measure handling and processing effects on nutrient retention and tissue senescence as looks product freshness (*Vanderslice et al., 1990*). Spinardi found that the ascorbic acid declined during the storage in lettuce and in spinach both on 4°C and 10°C storage temperature by 6 days, but on the higher temperature the degradation process was faster. The chlorophyll content did not change during the storage (*Spinardi et al., 2010*). The ascorbic acid contents are markedly higher in spinach than in lettuce at harvest. Even within a particular vegetable type, vitamin C content can vary at harvest, depending upon variety, preharvest climatic conditions and cultural practices. Thus, the level of vitamin C is not an indicator of quality per se, but since the vitamin is vulnerable to chemical and enzymic oxidation, it is a sensitive and appropriate marker for monitoring quality changes during transportation, processing and storage (*Lee and Kader, 2000*).

Our previous study resulted that the peroxides enzyme activity in vegetable species used often in fresh-cut packages are very variable. High POD activity was found characteristic in cabbage and rocket salad, medium in spinach, endivie, cut parsley leaves, dill, low activity in iceberg lettuce, carrot, sweet corn, celery leaves. The changes of basic POD activity during the storage on different temperature did not demonstrate clear tendency. (*Gilingerné et al., www.mttt.hu*)

The aim of analysis is to demonstrate the relationship of expiration date and the date of keeping quality in different storage temperatures. During storage trials we analyzed several fresh-cut packed vegetables and vegetable mixes which are sold in trade. In the course of analysis we evaluated the vegetables organoleptic and measured their vitamin C content and peroxidase enzyme activity which alludes to respiratory activity.

MATERIAL AND METHOD

Examined products, sampling

In our storage experiment we investigated vegetables and vegetable mixes presented in Table 1, which we obtained from supermarkets. The chart shows the information described on the labels of the products.

Table 1. Description of fresh-cut salads involved to storage trial.

Name	Spinach	Corn salad	Rocket salad	Iceberg lettuce
Date of packing	30.11.	29.11.	30.11.	-
Expiry date	-	-	-	05.12.
Rec-ommended tem-perature	-	-	-	2-8°C
Place of Origin	Italy	Italy	Italy	Hungary
Ingredi-ents	spinach	corn salad	rocket salad	iceberg lettuce
Name	White cabbage	Mix1	Mix2	Mix3
Date of packing	-	-	-	-
Expiry date	12.07.	12.05.	12.06.	12.02.
Rec-ommended tem-perature	2-8°C	2-8°C	2-8°C	2-8°C
Place of origin	Hungary	Hungary	Hungary	Hungary
Ingredi-ents	white cabbage	white and red cabbage, carrot	endivia salad, frisee salad, beetroot	endivia, radi-chio, white cabbage, sweet corn

Storage trial

We stored the vegetables for 11 days after purchase under different temperatures. We ensured 6°C in a refrigerator, 12°C with a thermostate, and 20°C in the storage chamber. We selected these temperatures because 6°C is the temperature within the range recommended by the producer, 12°C can be measured in bad-cooled shelves or in the warmer parts of a household refrigerator, and if the product will stay at room temperature for a longer period, it is about 20°C. We purchased all the products in their original unopened packages. We do not have information about the package material. It is stated on some products that it contains "shielding gas" but there is no information on what it is and how much the package contains. We conducted the measurements 4 times. After opening the packages, sensory tests were performed. These were recorded in textual evaluations. We examined the colour and smell of the plant, evaluated the freshness, we tasted them when it was possible, and sensed the texture. The view and colour was observed by eyesight and was recorded on digital images.

Laboratory analysis

Our working team used traditional spectrophotometric methods to determine the vitamin C content of samples (*Gilingerné and Varga, 2005*). After watery solution we added ferri-chloride and 2,2,-dipiridil reagent to determine the quantity of ascorbic acid with measuring colour intensity of dipiridil-ferro-ascorbate complex by spectrophotometer (modified Spanyár-method).

Peroxidase enzyme activity was also analysed with spectrophotometric method. We added o-phenilen-diamine reagent and H_2O_2 substrate to the watery solution buffered to pH 5.0. The final values were calculated from the time-absorbance line, 1 enzyme-activity unit means 1x10-3 change in absorbance per 1 minute. The POD activity unit was counted into 1 gram fresh sample.

RESULTS AND DISCUSSION

Fresh products

Figure 1. and 2. show the enzyme activity and vitamin C content of the products on the day of purchase. We considered these the basic starting values. It can be well observed that the highest POD enzyme activity was measured in cabbage and in Mix1 which consisted mainly of cabbage.

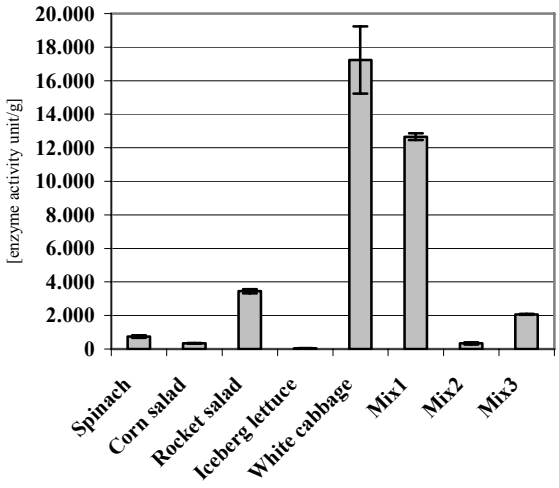

Fig. 1. Basic POD enzyme activity in the products (enzyme activity unit/g, SD, n=4)

Enzyme activity of rocket salad and Mix3 is less than this with one unit, that of spinach, corn salad and Mix2 is less with 2 units, and being less with 3 units, iceberg lettuce has the least enzyme activity. Average vitamin C content does not show such variability. Spinach has the highest level and iceberg lettuce has the lowest.

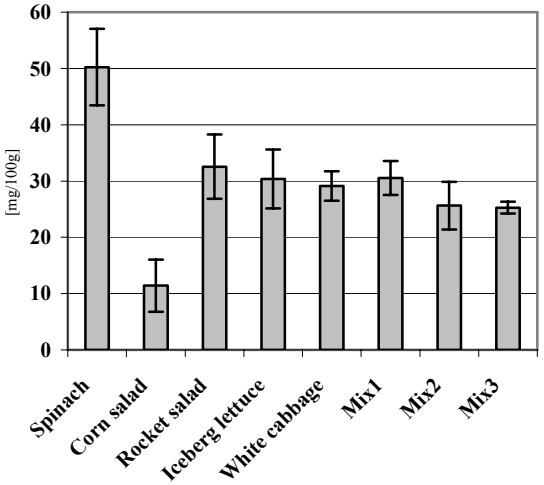

Fig. 2. Basic vitamin C content in the products (mg/100g, SD, n=4)

Stored products

During the storage experiment 3 groups were found to develop. Members of a group had similar behaviours according

both to the organoleptic evaluation and to the laboratory measurements.

1st group - long storability: iceberg lettuce, Mix2

2nd group – short storability with rotting: spinach, corn salad, rocket salad

3rd group – short storability with fermentation: white cabbage, Mix1, Mix3.

One member of each group is shown on the diagram, where the time of experiment is shown with +/- values compared to the date of packing or the expiry date.

The first group can be called stable from all respect. In the case of the iceberg lettuce, the starting green, fresh leaves, fresh smell and good taste could be found when stored at 6°C even at the 3rd measurement, although then some stale-looking leaves were found. The values of the iceberg lettuce are shown on Figure 3. In accordance with the organoleptic description, POD activity also remained stable to the 3rd measurement. In the 4th measurement stale leaves and stale smell were found, and the POD activity increased, which can be a sign of microbiotic decay. During the measurements of vitamin C content we experienced the same stability (Figure 4).

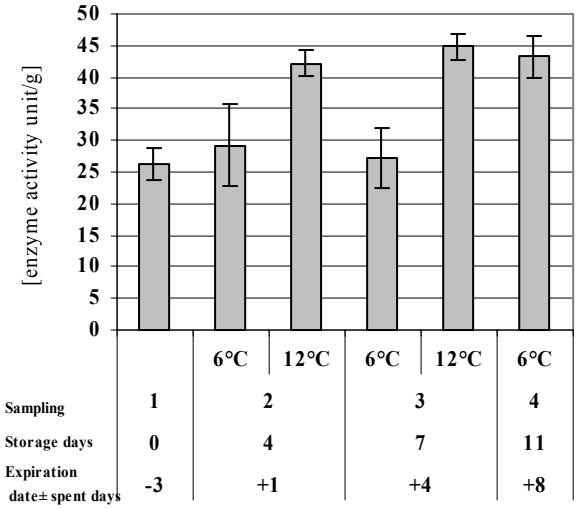

Fig. 3. POD enzyme activity in ICEBERG LETTUCE during the storage (enzyme activity unit/g, SD, n=4)

Consequently, the product could be consumed even 7 days after the expiry date. Stored at 12°C, bad smell and spoiled taste could be experienced, accompanied with perfect looks at the 2nd measurement. The consumer will realize that there is something wrong with the product only after having opened the package. It is true, although, that this happens on the day right after the expiry date, when the product cannot be used in public catering or in restaurants. The increased POD activity also supports the decay, but there is no change in the vitamin C content. The second group means vegetables which rotting with time and with the change of temperature. A characteristic representative of this group is spinach. At the first measurement it had the taste and smell of a fresh green plant. Stored at 6°C, at the 3rd measurement a change in the quality could be assessed, the taste, the smell and the looks were not fresh. At the 4th measurement we smelled rotting "swamp" smell, it lost its colour, and the leaves did not look fresh. At higher temperature the characteristic "swamp" smell appeared already at the second measurement, and it became even more intense with time. Opposite change can be seen on POD and vitamin C values (Figure 5, Figure 6)

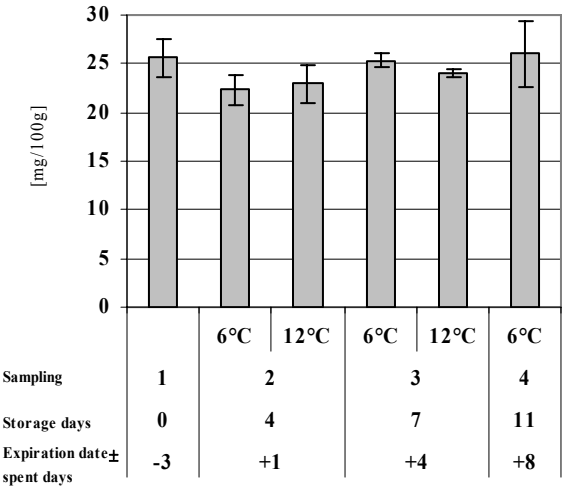

Fig. 4. Vitamin C content in ICEBERG LETTUCE during the storage (mg/100g, SD, n=4)

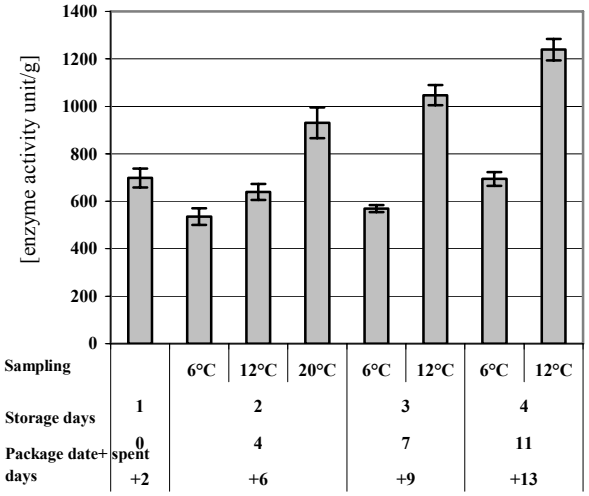

Fig. 5. POD enzyme activity in SPINACH during the storage (enzyme activity unit/g, SD, n=4)

POD activity increases, albeit in different measures at the different temperatures, while the vitamin C content decreases.

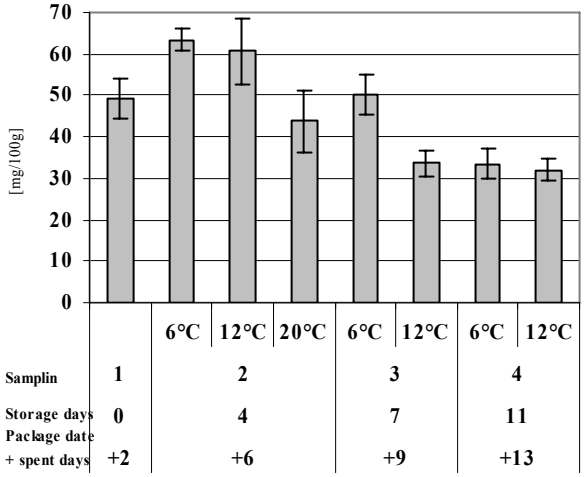

Fig. 6. Vitamin C content in SPINACH during the storage (mg/100g, SD, n=4)

The third group contains cabbage, Mix1 and Mix3. At the first measurement, the taste, colour, smell and texture characteristic to cabbage was experienced. At the second measurement, when stored at 6°C, the one-component cabbage kept its initial freshness, but in the mix, stale taste, smell and looks were observed. At the 3rd measurement at this temperature, the sole cabbage had sour smell but good looks, while the mix had spoiled taste and smell. At higher temperature, in both cases sour smell was experienced already at the second measurement.

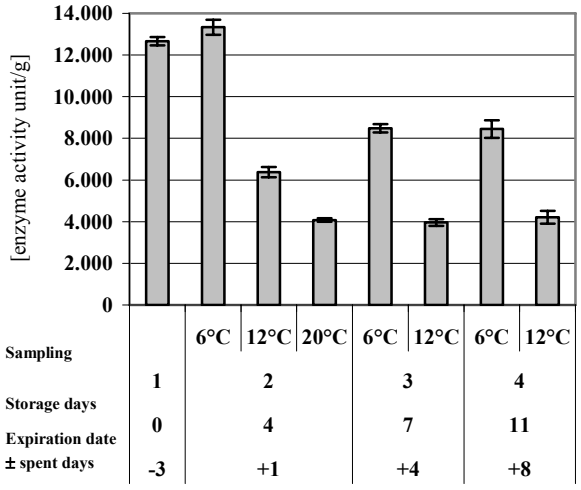

Fig. 7. POD enzyme activity in Mix1 during the storage (enzyme activity unit/g, SD, n=4)

Sour smell might have been caused by lactic acid fermentation, due to anaerob circumstances. During laboratory measurements a decrease in the POD value can be observed, with which the vitamin C content either increases in a small scale, or it does not change. The change of POD activity and vitamin C content of Mix1 is shown in Figure 7 and Figure 8.

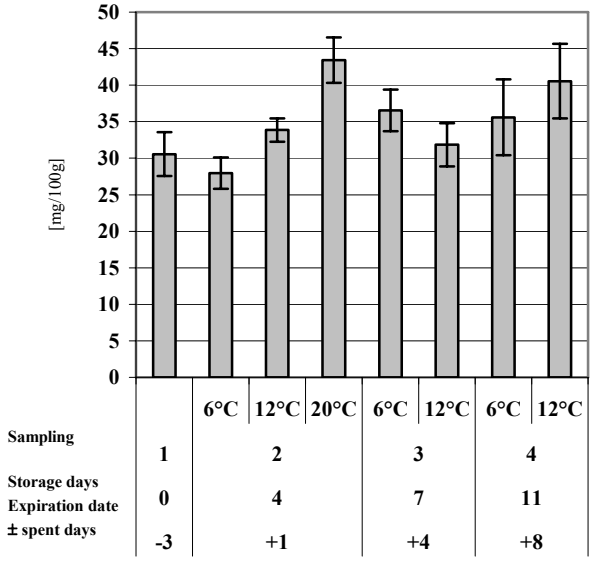

Fig. 8. Vitamin C content in Mix1 during the storage (mg/100g, SD, n=4)

CONCLUSION

After 3 day storage the vegetables kept their characteristic features, like fresh smell, colour, good taste, fresh habit. The time and the different temperatures induced different changes among others withering, rotting, and fermentation.

The initial peroxidase enzyme activity and vitamin C content were substantially diverse among the examined vegetables. Where this value was low, the time and the temperature did not induce large changes during the storage and the vitamin C content did not change (iceberg lettuce, endivie-mix). The initial POD activity increased slowly and the vitamin C content decreased in the rotting products (spinach, corn salad, rocket salad) The high initial POD activity decreased slowly and the vitamin C content did not change significantly in the fermented products (white cabbage, cabbage-mixes).

The different vegetables and mixes behave unlike. The compounds of the mixes affect the storage life. At lower temperature the keeping quality is better, but the attractive appearance does not definitely mean edible quality, especially in case of products without expiration date.

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