Effect of temperature and type of packages on nitrates and nitrites content in lettuce

JÓZEF BAKOWSKI, HELENA MICHALIK, MARCIN HORBOWICZ

Research Institute of Vegetable Crops, Department of Storage and Processing, Konstytucji 3 Maja 1/3, 96-100 Skierniewice, Poland

Abstract

Lettuce wrapped in unperforated PE film, perforated PE film, stretch film and without wrapping was stored at 1, 6, 20 and 28°C. Freshly harvested lettuce and after one day of storage, independently on storage conditions, did not contains nitrites. During storage of lettuce at 1°C only one time small quantities of nitrites (4.3 mg NO_2/kg fresh matter) were found – after twelve days storage in perforated PE film. Storage of lettuce longer than 7 days at 6°C caused formation of nitrites. Lettuce stored at 20 and 28°C in unperforated PE film contained nitrites already after 2 or 3 days of storage. Decline of nitrates during storage of lettuce was independent from film used to wrapping.

INTRODUCTION

Lettuce is one of most popular vegetable, available on Polish market all around year. Lettuce, as a main components of salads, is eaten very often because its taste and nutritional value. Lettuce belongs to the group of fast grown vegetables and characterized a short growing period therefore it has predisposition to nitrates accumulation. During last several years those phenomena was widely studied and discussed. The latest studies has stated that nitrates can have a positive meaning. The nitrates are partly converted by saliva enzymes to nitrites, and the nitrites can be converted in stomach to nitric oxide and nitric acid. Both compounds are known as a bactericidals for *Salmonella* and *Shigella* species. This explain a positive role of nitrates uptake by human organism together with food, especially vegetables.

There are many publications concerning nitrates and nitrites in lettuce. Prugar and Prugarova (1985) summarized results of many studies and noted that lettuce contains from 409 to 4026 mg NO₃/kg of fresh matter. Other authors were presented similar data (Stopes et al., 1988; Borowski and Michałek, 1994; Michalik and Stepowska, 1995).

During many years studies carried out in our laboratory we did not notice measurable (above limit of detection of used method – 0.5 mg NO₂/kg fresh matter) of nitrites in freshly harvested lettuce (M i c h a l i k and B ą k o w s k i, 1996; B ą k o w s k i et al., 1996 b). Other authors (E c k e r and C o l l e t, 1988; H u n t and T u r n e r, 1994) have published similar results. According to H u n t and T u r n e r (1994) the nitrites are formed only in withered or rotten spinach tissue. Similar observations were noticed by B ą k o w s k i et al. (1996 a). Some authors (M y c z k o w s k i et al., 1991; R o ż e k et al., 1994, 1995) have found in freshly harvested lettuce relatively large concentration of nitrites.

The aim of our studies was to determine the conditions and time needed to forming of nitrites, and decline pattern of nitrates in stored lettuce.

MATERIALS AND METHODS

Details of storage experiments and used material were presented in our previous paper (B a k o w s k i et al., 1996 b). Nitrates were determined in dried and fine powdered lettuce tissue using potentiometric method (Orion). Nitrites were analyzed in fresh lettuce tissue by the official spectrophotometric method described in PN-92A-75112.

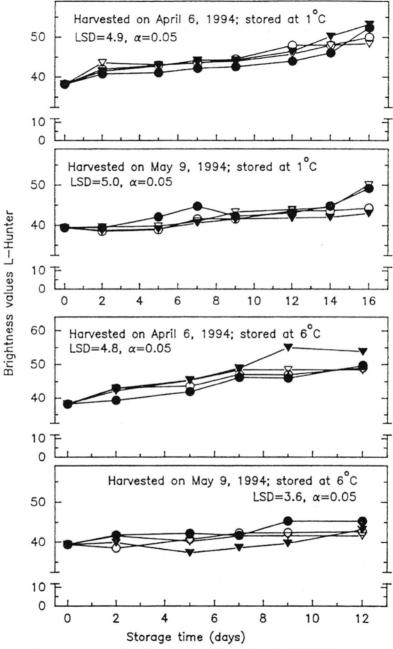
Because of the non-uniform distribution of nitrates in lettuce head the whole heads should be taken to analyses (Table 1). The heads should be at first chopped using knife, and then after well mixing a representative subsample can be analyzed.

\$T\$ a b l e $\,1$$ Distribution of nitrates in lettuce head (mg NO $_3/kg$ fresh matter)

Analyzed part of lettuce head	Nitrates content
Outer leaves	4303
Inner leaves	1645
Stem	5990

RESULTS AND DISCUSSION

The main aim of the studies was to find conditions and time of nitrites forming in stored lettuce. A lettuce taken to the experiments was grown on well fertilized substrate at greenhouse. Nevertheless we were not observed measurable amounts of nitrites in freshly harvested lettuce (Figs. 1 and 2). Quite similar results were obtained earlier (M i c h a l i k and B ą k o w s k i, 1996). However R o ż e k et al. (1994) have found quite large (50-70 g NO₂/g of dry matter) level of nitrites in freshly harvested lettuce grown using film nutrient technique.



O non-wrapped; ● wrapped in perforated PE film

∨ wrapped in unperforated PE film; ▼ wrapped in stretch film

Fig. 1. Effect of storage conditions on level of nitrates (line plots) and nitrites (bar plots) in lettuce – temperature of storage: 1 and 6°C

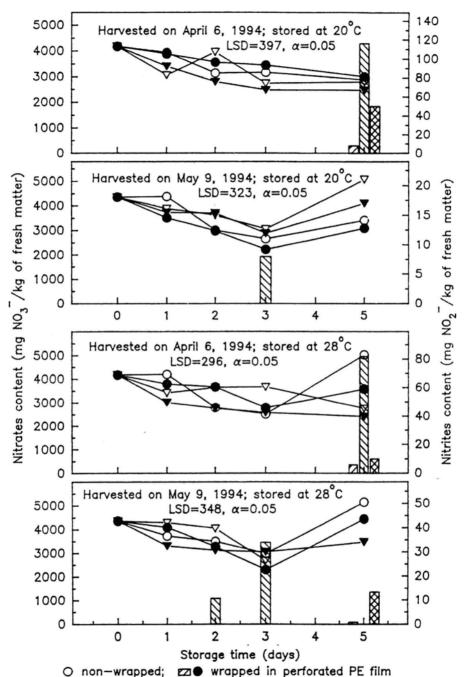


Fig. 2. Effect of storage conditions on level of nitrates (line plots) and nitrites (bar plots) in lettuce – temperature of storage: 20 and 28°C

During seven days of storage at 1 and 6°C the lettuce we were not observed accumulation the nitrites. The lettuce stored at 1°C did not contain nitrites, only in one case, where the lettuce was harvested in May and after 12 days of storage in perforated PE film we have observed appearance of nitrites in amount 4.3 mg NO₂/kg fresh matter. This can be explain by microbiological infection of the lettuce (Fig. 1). Nitrates were much easier converted to nitrites during storage of lettuce at 6°C. Quite large quantities of the nitrites were observed after 9 and 11 days of those conditions. Our observations on accumulation of nitrites in stored lettuce are similar with those published earlier by H u n t and T u r n e r (1994).

Special care should be taken during storage of lettuce at temperatures 20 and 28°C. Such temperatures are not recommended for storage of lettuce. During storage at high temperatures lettuce can not be stored in unperforated or stretch films. In such packages the respiration processes quickly utilize oxygen, and then anaerobic microorganisms can convert the nitrates into nitrites.

The fresh lettuce contained relatively large content of nitrates – over 4000 mg NO₃/kg of fresh matter. During storage time the nitrates level slowly decreased. The nitrates level of lettuce in many cases again increased at time of lose of marketable value (Figs.1 and 2). There was not observed clear effect of kind of film used for wrapping, and temperature of lettuce storage on nitrates decreasing.

CONCLUSIONS

- 1. Freshly harvested lettuce and after one day of storage, independently on storage conditions, did not contains nitrites.
- 2. During storage of lettuce at 1°C only ones small quantities of nitrites (4.3 mg NO₂/kg fresh matter) were found after twelve days storage in perforated PE film.
- 3. Storage of lettuce at 6°C longer than 7 days caused formation of nitrites. Lettuce stored at 20 and 28°C in unperforated PE film contained nitrites already after 5 days of storage.
- 4. Decline of nitrates during storage of lettuce did not depend from film used to wrapping.

The studies were supported by Grant No. 5S 307 04606 obtained from Polish Committee for Scientific Research (KBN).

REFERENCES

- Bąkowski J., Michalik H., Horbowicz M., 1996 a. Wpływ opakowania i warunków składowania na zmiany ilościowe azotanów i zawartość azotynów w szpinaku. Materiały II Sympozjum "Nowe rośliny i technologie w ogrodnictwie", Poznań, 17-19.09.1996, tom II, s. 84-87.
- Bakowski J., Michalik H., Horbowicz M., 1996 b. Effect of temperature and type of packages on quality of stored lettuce. Acta Agrobotanica. (in press).

- B o r o w s k i E., M i c h a ł e k W., 1994. Wpływ czasu i warunków przechowywania na zawartość wybranych składników w liściach sałaty. 1. Zmiany zawartości wody, azotanów i azotynów. Annales. Universitatis M. Curie-Skłodowska II, 51: 33-41.
- Ecker C., Collet P., 1988. Microbiologische bedingte Nitritbildung in Salat-Fertigpackungen. Archiv für Lebensmittelhygiene 39: 123-127.
- Hunt A. U., Turner M. K., 1994. A survey of nitrite concentrations in retail fresh vegetables. Food additives and contaminants 11 (3): 327-332.
- M i c h a l i k H., B ą k o w s k i J., 1996. Wpływ opakowania i warunków składowania na zmiany ilościowe azotanów i zawartość azotynów w sałacie kruchej. Biul. Warzyw. XLIV: 51-60.
- Michalik H., Stępowska A., 1995. Zawartość azotanów w kilku odmianach sałaty masłowej uprawianej pod osłonami. Materiały Sympozjum "Żywność, Technologia, Jakość", Kraków, 7-9.06.1995. 2 (3): 115.
- M y c z k o w s k i J., R o ż e k S., S a d y W., 1991. The effect of fertilization with different forms on nitrogen on yield and nitrate metabolism in leaves of greenhouse lettuce. II Effect of growth regulators. Folia Horticulturae III/I: 13-25.
- Prugar J., Prugarova A., 1985. Dusicnany v zeleninie. Priroda. Bratislava, Slovakia.
- Rożek S., Sady W., Leja M., Myczkowski J., 1994. The effect of fertilization with different forms of nitrogen on greenhouse lettuce quality and its changes during storage. II. Nitrate and nitrite content. Folia Horticulturae VI/1: 53-62.
- Rożek S., Sady W., Leja M., Myczkowski J., 1995. The effect of fertilization with nitrate and urea forms of nitrogen on quality and storage ability of lettuce grown in a foil tunnel. II Nitrate and nitrite content activity of nitrate and nitrite reductase. Folia Horticulturae 7/1: 107-116.
- Stopes C., Woodward L., Forde G., Vogtmam H., 1988. The nitrate content of vegetable and salad crops "offered to the consumer as from organic or conventional production systems". Biological Agriculture and Horticulturae 5 (3): 215-221.

Wpływ temperatury i rodzaju opakowania na zawartość azotanów i azotynów w sałacie

Streszczenie

Sałatę opakowaną w folię PE litą, perforowaną i folię rozciągliwą, oraz bez opakowania przechowywano w temperaturach 1, 6, 20 i 28°C. Sałata świeżo zebrana oraz po pierwszym dniu przechowywania niezależnie od temperatury nie zawierała azotynów. Nie stwierdzono azotynów podczas całego okresu przechowywania sałaty w temperaturze 1°C niezależnie od zastosowanego rodzaju opakowania, za wyjątkiem niewielkich ilości (4.3 mg/kg świeżej masy) po 12 dniach przechowywania. Sałata przechowywana w temperaturach 20 i 28°C opakowana w folię PE litą i rozciągliwą po krótkim okresie składowania zawierała azotyny. W sałacie przechowywanej w temperaturze 6°C po 7 dniach zanotowano obecność azotynów. Nie stwierdzono wpływu zastosowanych rodzajów opakowań na zmiany zawartości azotanów podczas przechowywania sałaty w badanych temperaturach.