

## Quality of kohlrabi stems (*Brassica oleracea* var. *gongylodes* L.) kept in cold storage

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### ABSTRACT

Two green kohlrabi cultivars, 'White Delikates' and 'Korist' F<sub>1</sub>, were kept in cold storage at a temperature of 2°C and a relative humidity of 95%. Natural mass losses were measured at monthly intervals and dry matter content, soluble sugars, L-ascorbic acid and isothiocyanates were analysed. During five months of storage, very low losses of kohlrabi mass were detected. The decrease in dry matter during that time was between 15 and 18%. After a brief increase, soluble sugar content decreased during storage, and in March, 50% of the initial sugar content was calculated for 'Delikates' kohlrabi flesh and 65% for 'Korist'. L-ascorbic acid was well preserved in the kohlrabi, since 90% remained after storage was completed. The isothiocyanate content changed little and the vegetable remained a good source of these compounds throughout the storage period.

Key words: isothiocyanates, L-ascorbic acid, mass losses, soluble sugars

### INTRODUCTION

Kohlrabi, which until recently had been used as an additive in soups, is increasingly more appreciated for its considerable taste and nutritional value. It has a lot of soluble sugars, vitamin C and fibre. Interest in this vegetable has developed owing to the discovery of glucosinolates – compounds with strong anticarcinogenic properties present in all vegetables from the *Brassicaceae* family (Johnson 2002). Amongst the eight glucosinolates determined in kohlrabi flesh, the highest amounts of 4-(methylthio)butylglucosinolate and 3-(methylthio)propylglucosinolate and 2-phenethylglucosinolate were detected (MacLeod and MacLeod 1990, Fisher 1992). Their content varies depending on the variety and growing conditions of kohlrabi, from 150 to 500 mg kg<sup>-1</sup> f.w. (Yen Gow-Chin and Wei Que-King 1993, Lewke et al. 1996). The products of the enzymatic hydrolysis of glucosinolates are aromatic isothiocyanates, one of the main components of flavour and aroma for brassica

plants. These are formed when glucosinolates come into contact with myrosinase ( $\beta$ -thioglucosidase or thioglucoside glucohydrolase) after the rupture of cell walls (Singh et al. 2007). Kohlrabi keeps well, shows a low level of respiration and very low ethylene production (Escalona et al. 2006, Escalona et al. 2007 b). Stems are not sensitive to chilling injury (Escalona et al. 2007 c, Deveci et al. 2010). Despite this, its cultivation for late harvest and storage is not very popular; therefore it is rarely seen on dinner tables during the winter.

The present article aims to determine the changes of selected components in two varieties of green kohlrabi kept in an ordinary cold storage.

### MATERIAL AND METHODS

The experiment was conducted for two years in an experimental cold storage facility of the Horticulture Faculty of the University of Agriculture in Krakow on two kohlrabi cultivars: 'White Delikates' (bred by Spójnia Nochowo, PL)

and ‘Korist’ F<sub>1</sub> (Bejo Zaden, NL). The kohlrabi was harvested at the beginning of October and after its leaves and roots were removed it was taken to the cold storage where it was placed in plastic containers lined with black foil. Four replications were used: one box counted as one replication. The boxes were left in a chamber at a temperature of 2°C and a relative humidity of 95%. The kohlrabi was stored under these conditions for five months, until the beginning of March. The quality of the kohlrabi stems was assessed at monthly intervals. For analyses, two kohlrabies from each replication were collected, and a laboratory sample consisted of eight stems of this vegetable. The average mass of a ‘Delikates’ stem was 440 g, while the average mass of a ‘Korist’ F<sub>1</sub> stem was 310 g. The assessment comprised determining the natural mass losses, analysis of dry matter, soluble sugars using the anthrone method (Yemm and Wills 1954), L-ascorbic acid using the iodate method (Samotus et al. 1982) and isothiocyanate using the colorimetric method according to Chong and Bible (1974). The isothiocyanate content is given in mg of potassium thiocyanate per 1 kg fresh weight. The results were verified statistically using the ANOVA method in a completely randomised design and the significance of differences between means were assessed on the basis of the Duncan test at  $\alpha = 0.05$ .

## RESULTS AND DISCUSSION

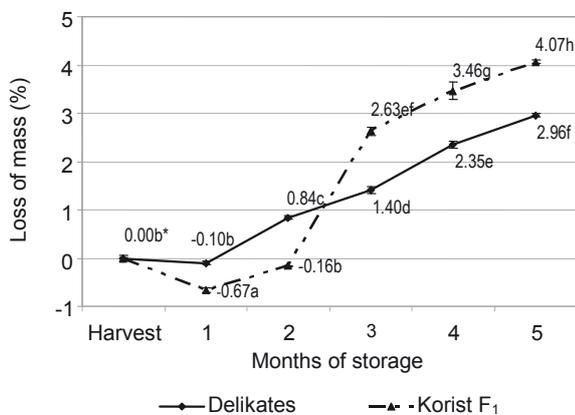
Similar tendencies were observed in both years of the experiment, thus means for both years are presented. Kohlrabi natural mass losses were relatively small and after five months of storage were about 4% in

‘Delikates’ and about 3% in ‘Korist’ F<sub>1</sub> (Fig. 1). Kohlrabi skin, thick and containing large amounts of cutin, effectively protects it against excessive water loss and for this reason mass losses in this vegetable during storage were exceptionally low in comparison with root vegetables, for example.

A comparison of both cultivars with respect to the contents of the analysed components is more favourable for ‘Delikates’, which at the outset of the experiment contained 20% more dry matter, 15% more sugars, over 80% more L-ascorbic acid and over 15% more isothiocyanates than ‘Korist’ kohlrabi. These differences lasted until the end of the storage period (Figs 2-5).

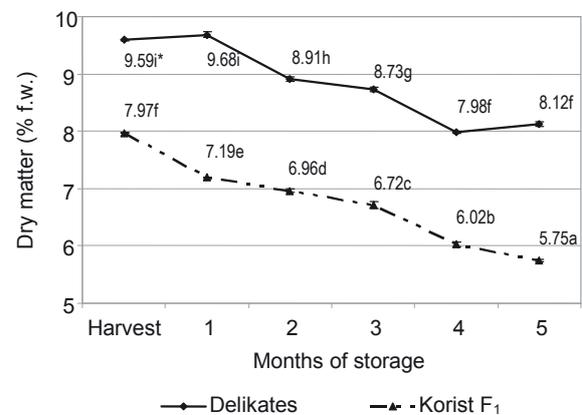
Dry matter content decreased quite regularly during storage and at the time of the experiment’s completion, it was 15% less in ‘Delikates’ stems and 17% less in ‘Korist’ F<sub>1</sub> stems (Fig. 2).

The dominant sugars of kohlrabi are glucose and fructose; it also contains a lot of sucrose. During storage, sucrose quickly decomposes, and then increases the content of simple sugars (Escalona et al. 2007 a). The level of soluble sugars increased in the first month of storage in the flesh of both cultivars, by 8% in ‘Delikates’ and by 11.6% in ‘Korist’ F<sub>1</sub>. In the successive months their contents decreased to about 50% of the initial content in stems of ‘Delikates’ and to about 68.2% in ‘Korist’ F<sub>1</sub> stems (Fig. 3). The increase in soluble sugar content at the initial period of storage is typical for many vegetables and is connected with the mobilisation of starch reserves some time after harvest. Later they are slowly broken down. Escalona et al. (2007 c)



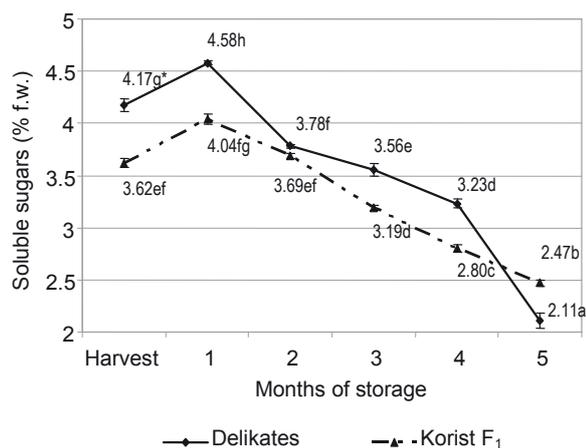
\*Values marked with the same letter do not differ significantly at  $\alpha = 0.05$ . Significance interval marked by vertical bars

**Figure 1.** Changes in mass loss of stored kohlrabi cultivars



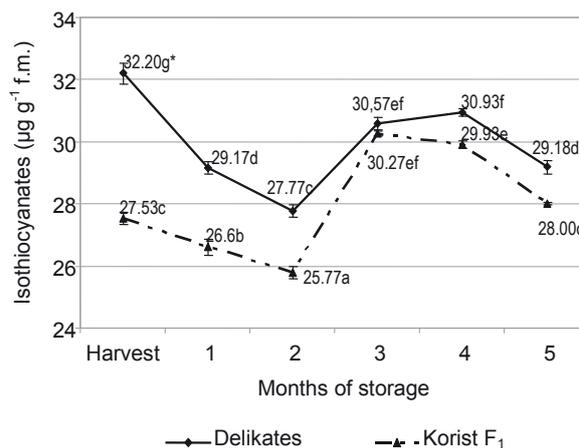
\*Explanations: see Fig. 1

**Figure 2.** Changes in dry mass of stored kohlrabi cultivars



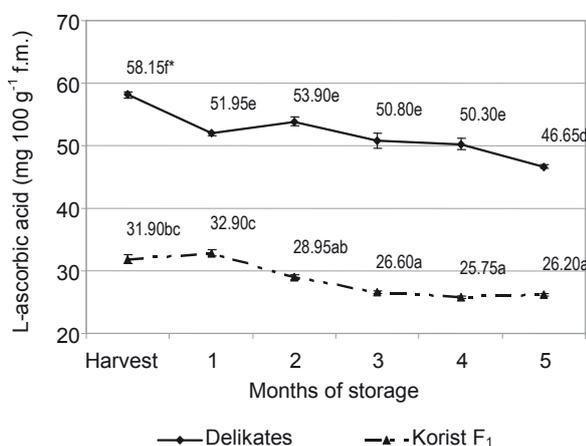
\*Explanations: see Fig. 1

**Figure 3.** Changes in soluble sugars in stored kohlrabi cultivars



\*Explanations: see Fig. 1

**Figure 5.** Changes in isothiocyanates in stored kohlrabi cultivars



\*Explanations: see Fig. 1

**Figure 4.** Changes in L-ascorbic acid in stored kohlrabi cultivars

made similar observations when kohlrabi was stored in a modified atmosphere.

The ascorbic acid content determined in kohlrabi corresponds to the data in the research of Gerendas et al. (2008). ‘Delikates’ kohlrabi had 10.8% less ascorbic acid after the first month of storage, but in the subsequent months the losses of this compound were small. In ‘Korist’ F<sub>1</sub> kohlrabi, a decrease in this component occurred after two months of storage and reached 9.2%; only slight changes were observed until the end of the experiment (Fig. 4). The degree of ascorbic acid preservation in the kohlrabi proved very high, which identifies this vegetable as a good source of vitamin C during the winter.

Changes in the content of isothiocyanates in stored brassica vegetables depend on the species, variety and storage conditions (Hodges et al. 2006,

Kosson and Horbowicz 2007). Isothiocyanate content in ‘Delikates’ kohlrabi diminished by 13.8% after two months of storage. An increase in the contents of these components occurred in January, and in February there was only 4.0% less than at the beginning of the experiment. Again the isothiocyanate level decreased in the final period of the experiment. The isothiocyanate content in ‘Korist’ F<sub>1</sub> kohlrabi declined over the two first months of storage, whereas close to a 10% increase in comparison with the initial content was registered in the subsequent period. After the completion of the experiment, this kohlrabi contained a similar amount of isothiocyanates as at the experiment outset (Fig. 5). Similarly, the changes of glucosinolates in seed-sprouts of kohlrabi in cold storage were very small (Force et al. 2007). As was stated in a paper by Jones et al. (2006), proper storage conditions, including a particularly low temperature and high relative humidity, allow the maintenance or even an increase in the glucosinolate content in vegetables abundant in these compounds, because well-preserved cell integrity does not allow for their contact with the myrosinase enzyme, thus preventing their decomposition.

## CONCLUSIONS

1. Kohlrabi kept in cold storage preserved dry matter and L-ascorbic acid content well; mass losses were very low.
2. During five months of storage, the content of soluble sugars decreased by half in the ‘Delikates’ cultivar and by one third in the ‘Korist’ F<sub>1</sub> cultivar.

3. Isothiocyanate content changed little and the kohlrabi remained a good source of these compounds throughout the storage period.

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## JAKOŚĆ KALAREPY (*BRASSICA OLERACEA* VAR. *GONGYLODES* L.) PRZECHOWYWANEJ W CHŁODNI ZWYKLEJ

Streszczenie: Kalarepę zieloną dwóch odmian: 'Delikates Biała' i 'Korist' F<sub>1</sub> przechowywano w chłodni zwykłej w temperaturze 2°C i wilgotności względnej 95%. W odstępach miesięcznych mierzono naturalne ubytki masy oraz analizowano zawartość suchej masy, cukrów rozpuszczalnych, kwasu L-askorbinowego i izotiocyanianów. W czasie pięciu miesięcy przechowywania stwierdzono jedynie nieduże ubytki masy kalarepy. Spadek suchej masy wyniósł w tym czasie 15-18%. Zawartość cukrów rozpuszczalnych, po chwilowym wzroście, obniżała się w czasie przechowywania i w marcu w miąższu kalarepy 'Delikates' stwierdzono 50%, a w miąższu kalarepy 'Korist' 65% początkowej zawartości cukrów. Kwas L-askorbinowy wykazywał znaczną stabilność w przechowywanej kalarepie i po zakończeniu przechowywania pozostało go około 90% zawartości początkowej. Zawartość izotiocyanianów mało się zmieniała i warzywo to cały czas przechowywania pozostawało dobrym źródłem tych związków.

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