Loss of vitamin C (L-ascorbic acid) during long-term cold storage of Dutch table potatoes

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Summary

Loss of vitamin C (L-ascorbic acid) from Dutch table potatoes during storage at 5–6 °C over 8 months from November to July, was studied in two seasons. L-Ascorbic and dehydroascorbic acid were analysed by HPLC. The amount of dehydroascorbic acid was negligible. Total loss of L-ascorbic acid varied between 21 and 60 %.

Some potato lots lost L-ascorbic acid rapidly in the first four months, others more gradually over the whole storage period. The L-ascorbic acid levels detected were 75–150 % higher in the period March–June, but 35 % lower in the period December–February than those indicated by the step-wise decreases in the Dutch Food Composition Table.

Introduction

Tubers of potato (Solanum tuberosum L.) can be a major and cheap source of vitamin C in the human diet but its levels decrease during storage as do those of other nutrients (Woolfe, 1987). The most rapid losses occur during the first months of storage (Augustin et al., 1978; Finglas & Faulks, 1984; Mareschi et al., 1983) and losses may range from 40 to 60 % (Augustin et al., 1978; Faulks et al. 1982; Mareschi et al., 1983). The high initial rates of loss decrease to become small by the end of storage. Temperature as well as time may affect losses and below 10 °C storage losses are higher than between 10 °C and 20 °C; indeed ascorbic acid content was found even to increase in tubers stored between 16 and 28 °C for 12 weeks (Linneman et al., 1985).

The data on loss of vitamin C in table potatoes in long-term cold storage in the Netherlands is too limited to use for reliably estimating dietary intake of this important nutrient. Modern analytical techniques enable vitamin C to be determined precisely. Separation and determination of (dehydro)ascorbic acid by high performance liquid chromatography (HPLC) gives more precise data than older colorimetric methods. This study presents such data on vitamin C loss during modern long-term cold storage of Dutch table (ware) potato lots of different cultivars and from different sources and compares them with those in the Dutch Food Composition Table (Nederlandse Voedingsmiddelentabel, 1987).

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Materials and methods

**Potatoes.** Potatoes of cvs Bintje, Désirée, Eba, Eigenheimer, Hertha and Irene were grown on clay soil on the experimental farm De Eest, Nagele in the Netherlands in 1982 and 1983. Tubers of cv. Bintje were also collected from four other sites. Samples of 20 kg (size 35–50 mm) were cured for two weeks and then stored from November to July at 5–6 °C and 95–98 % r.h. with C(IPC) powder as sprout inhibitor, and once a month 2 kg samples (about 20 tubers) were analysed.

**Determination of L-ascorbic acid and dehydroascorbic acid.** Tubers were hand-peeled, divided in quarters, and one quarter of each tuber cut rapidly in cubes. A 50 g sub-sample of cubes was homogenized immediately in a mixture of 50 ml 9.5 % oxalic acid and 50 ml methanol (Ultraturrax). The resultant slurry was diluted to 500 ml with water and filtered through fluted paper (Schleicher & Schull 595½). Ten ml of the filtrate was diluted with water to 25 ml and then partially purified by passing it through a SEP-PAK Florisil column (Millipore). Ten μl of this filtrate was then injected into a Waters HPLC-system using a Model U6K injector and a Model 2000 pump. The ascorbic acid was analysed according to Rückemann (1980), but on a radially packed #Bondapak C18 column (5 μm) (Waters). Column effluents were monitored at 251 nm with a Pye Unicam LC UV-vis variable wavelength detector and peaks integrated and calculated with a Hewlett Packard HP 3390 integrator.

Dehydroascorbic acid was calculated from total ascorbic and L-ascorbic acid values. For total ascorbic acid determination, dehydroascorbic acid in the potato extract was reduced to ascorbic acid with homocysteine by the procedure of Dennison et al. (1981), modified by adjusting the pH of 10 ml filtrate to 7.0 with 2 M KOH (pH 5.0) followed by 0.05 M Tris buffer (pH 7.0); the volume of this filtrate was made up to 25 ml of which 1 ml was treated in the dark for 15 min with 1 ml 8 % DL-homocysteine solution. After ultrafiltration (Millex 0.45 μm filter, Millipore), 10 μl was injected into the HPLC-system and analysed as described for L-ascorbic acid.

Extraction and determination of L-ascorbic acid were done in duplicate and the results are presented as mean values. The standard deviation of L-ascorbic acid analysis was 0.44 mg/100 g (4 %) at an average value of 11.3 mg/100 g fresh weight (f.w.) (n=8).

**Results**

Only L-ascorbic acid values are presented because total ascorbic acid contents were only slightly higher (0–10 %) than those of L-ascorbic acid; typically, 4 % early in the storage season and 7 % later. The levels in the lots of six cultivars and in the four lots of cv. Bintje in the two seasons are shown in Fig. 1A/B and 2 A/B respectively. During 8 months at 5–6 °C, levels decreased steadily in all lots, but the initial level and the loss patterns differed between lots and seasons. The differences were larger between lots of the six cultivars (Fig. 1A/B) and smaller between the lots of cv. Bintje potatoes from different locations (Fig. 2A/B). Towards the end of the storage period, the L-ascorbic acid level had increased in most lots and, most notably, as storage continued until the end of July 1984 by which time several tubers had small, thick sprouts.