Glutamine in sugar beet: where is it synthesized?

Gisela Mäck
Institute for Sugar Beet Research (IfZ), Holtenser Landstr. 77, D-37079 Göttingen, Germany
email maeck@ifz-goettingen.de

Institut für Zuckerrübenforschung

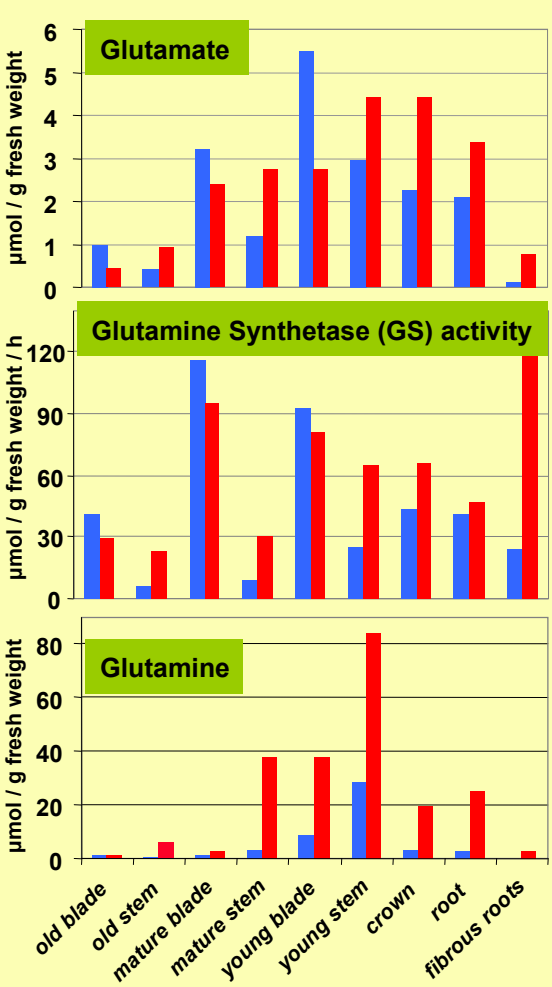
Introduction

Soluble nitrogen compounds (harmful nitrogen) lower the technical quality of the beet. A major aim in breeding is thus to reduce their concentration in the beet. 30-40% of these N compounds are amino acids and amides; glutamine is the predominant amide in the beet. It is assumed that it is produced in the leaves and translocated to the beet (Burba et al., 1984). The aim of the present study was to evaluate the contribution of the different plant organs in synthesis and accumulation of glutamine. Since the N source of the plant has a strong effect on the amino-N content (Mäck and Tischner, 1990), the plants where supplied with either NO_3^- or NH_4^+.

Material and Methods

Seeds were germinated and the plants were grown hydroponically for 40 days in a growth chamber with either 5 mM nitrate or ammonium as N source. All plant organs were harvested and immediately frozen prior to analysis of GS activity and amino acid contents. Synthetase reaction of GS activity was measured as reported (Mäck and Tischner, 1990), amino acids were analyzed with HPLC.

Results and Discussion



Nitrate as N source
Ammonium as N source

- Glutamate, substrate of GS, is present predominantly in the blades of mature and young leaves (NO_3^- nutrition) and in crown and root of the beet (NH_4^+ nutrition).
- GS is active predominantly in the blades of mature and young leaves (NO_3^- nutrition). This activity is primarily due to the chloroplastic isoenzyme (GS 2; Mäck and Tischner, 1994).
- NH_4^+ nutrition results in marked increases of GS activity in leaf stems, fibrous roots and, to a smaller extent, also in the crown. This points to a response of the cytosolic isoenzyme (GS 1) which was detected primarily in the mesophyll of vascular bundles (Edwards et al., 1990). Vascular bundles occur in high density in the crown of the beet.
- From the figures it is evident that synthesis (see above) and accumulation of glutamine do not necessarily occur in the same organ. Most glutamine is found in the stem of the young leaf, but it is synthesized primarily in the blades (NO_3^- nutrition) and in the fibrous roots (NH_4^+ nutrition).
- This points to translocation of glutamine in the plant via phloem export from the blades and xylem export from the fibrous roots.

Conclusion

- Glutamine in the beet is most likely imported from various organs, not only from leaf blades,
- It is also synthesized in the root itself.
- Glutamine which accumulates in the beet is most likely synthesized by both chloroplastic and cytosolic isoenzymes of GS.
- The contribution of the different organs depends on the N source of the plant.

Burba M, Nitzschke U, Ritterbusch R (1984) Zuckerindustrie109: 613-627
Edwards JW, Walker EL, Coruzzi GM (1990) Proc Natl Acad Sci USA 87: 3459-3463
Mäck G, Tischner R (1990) Planta 181: 10-17
Mäck G, Tischner R (1994) Planta 194: 353-359