

Boron isotopes - a new tracer for the origin and authenticity of food

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Introduction

- Boron and its isotopes have been used for a long time in geo- and environmental sciences to study mixing and fractionation processes as well as sources of anthropogenic contamination.
- The authentication of food using isotopic compositions of specific reservoir- and process-sensitive elements is a relatively new and growing application in isotope-chemistry.
- Unlike some well-established stable and radiogenic isotope systems (H-C-N-O-S-Sr-Pb) the use of boron isotopes for food authentication is almost unexplored.
- However, due to the essential role of boron for embryonic development and organogenesis in plants and animals and the enormous range of isotope compositions found in nature boron potentially is a very interesting isotope system to verify the origin and possible cultivation methods of various types of food.

Objective

To investigate the potential of boron isotopes as tracer for food authentication and to demonstrate it for the first time.

Experimental

Analytical Procedure

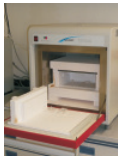
Decomposition:

Dry ashing: Microwave ashing system (MLS)

Quarz glass cups

300-500 mg freeze-dried food

Duration of 170 min; max. 600°C (120min)



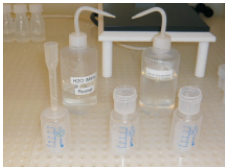
Boron/matrix separation: Miniaturized 3 step ion-chromatography

I. AG50 W-X8 (0.5ml)

II. AMBERLITE IRA 743 (0.1 ml)

III. AMBERLITE IRA 743 (0.1 ml)

Procedure blank 10-20 ng B



Thermal ionization MS:

Cs₂BO₂⁺ graphite methode

VG Sector 54

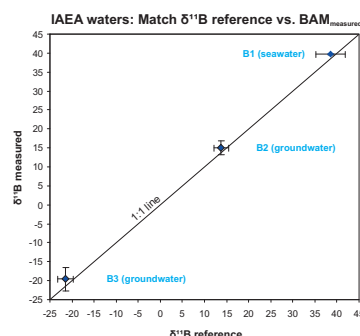
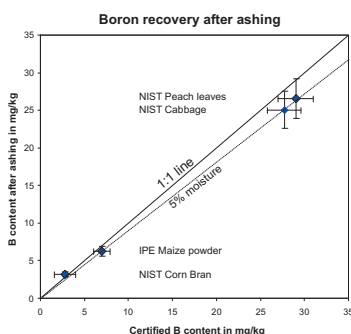
Dynamic single collector on axial faraday

Reproducibility 0.3 to 1.5‰ (2SD)

Accuracy < 2‰



Validation of the analytical procedure



- Considering the moisture content of the CRMs the dry ashing gives 100% recovery. No boron is being lost by volatilization
- The determined δ¹¹B values agree perfectly with the reference values of the IAEA water RM. No unexpected fractionation occurs.

Results and Discussion

δ¹¹B to trace the origin of food

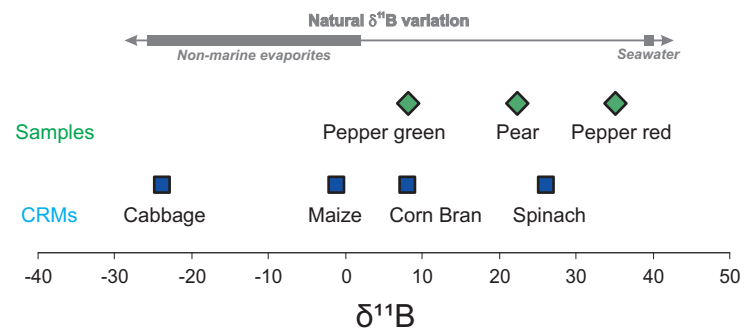
➤ Natural variation in boron isotope composition is reflected in food

- geological (bedrock)
- environmental (soil, local hydrosphere)
- anthropogenic (fertilization, irrigation)

fingerprints can potentially be distinguished by δ¹¹B of crops

Boron concentrations and δ¹¹B of food

Boron concentrations of food reference materials and pepper, corn and pear samples range between about 40 to 0.4 mg/kg. The determined δ¹¹B values fall between -24 and +35 ‰ and cover almost the whole range of natural boron isotope variation.



Preliminary Interpretation

Most of the food samples show typical geogenic δ¹¹B values falling in the middle of the natural range of boron isotope variation. The δ¹¹B values of the two isotopically most extrem samples can be related to as follows:

- Irrigation with waters derived from the Dead sea (+55 - 58 ‰ δ¹¹B; Vengosh et al. [1]) for the red pepper (+35‰) from Israel
- Fertilizers coming from non-marine evaporite deposits [2] could be responsible for the extremely negative δ¹¹B value of the NIST cabbage (-24‰) as boron is an essential micronutrient for cabbage and some other boron-loving crops.

Outlook

- Further optimization of the analytical procedure for further food types
- Transfer of the procedure to a potentially faster and simpler technique such as ICPMS or IRMS
- Determination of δ¹¹B values in well-characterized food sample series such as wheat from the TRACE project
- Studying the function and transport mechanisms in biological systems as boron isotope fractionation during incorporation, transport and integration in the plants is almost unexplored [3]

Acknowledgement

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Literature

- [1] Vengosh A, Starinsky A, Kolodny Y, Chivas AR, Geochim. Cosmochim. Acta, 55 (1991) 1689-1695
- [2] Barth S, Geol. Rundsch., 82 (1993) 640-651
- [3] Takano J, Noguchi K, Yasumori M, Kobayashi M, Gajdos Z, Miwa K, Hayashi H, Yoneyama T, Fujiwara T, Nature, 420 (2002) 337-340