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Determination of the Geographic Origins of Grains with Strontium and Lead Isotope Ratios and Multielement Concentrations

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Introduction

The importance of food authenticity is increasing due to expanding global trade and economy. Nowadays geographical identification of food materials are labeled in many countries because the information is very important to consumer. Geographical identification can be useful not only to help consumers in their selection of foodstuffs but also for branding strategy purposes. However, such identification has sometimes been fraudulently labeled for financial gain. Therefore, techniques to prevent consumers or producers from suffering financial damage are required.

The techniques determining the geographical origin of raw materials of food or foodstuff itself have previously been developed. However, conventional methods have defects that an enormous database for each target food item is required, and cannot avoid some level of discrimination error. So, we examined to develop a more reliable technique, which improves these defects, utilizing isotopic ratios of Sr and Pb. As features of these isotopic ratios, plant-available Sr and Pb in soil are absorbed by plants without isotope fractionation. Thus, the geographical origin of a crop can be estimated from these isotopic ratios in soil and vice versa. Since crops grown under the same soil and water conditions at the same area have the same isotopic ratios of these elements, a large database is not required for each target item, which makes it possible to determine the geographical origin of a new crop. Furthermore, since Sr and Pb isotope ratios feature small variations in the same production area less than factors used in other techniques, this technique possesses high reliability.

We applied the method determining Sr and Pb isotopic ratios in cereal grains[1),2)], including polished rice of very low Pb concentration, to determination of their production countries. Multielement concentrations were also used for this purpose to achieve sufficient origin determination.[3)]

Samples

Cereal grain samples were rice (*Oryza sativa*), barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), and buckwheat (*Fagopyrum escul*

Method1),2)

Sample was digested by acid using a sample digestion system (SCP Science) and dissolved in 0.05 M HNO_3. Strontium and Pb in the solution were separated and concentrated by extraction chromatography with Sr resin (Eichrom Technologies). $^{87}Sr/^{86}Sr$ and Pb isotopic ratios in the sample solutions were determined with a double focusing inductively coupled plasma mass spectrometer (ICP-MS) (Element2, Thermo Fisher Scientific). Uncertainties of this method were around 0.06% for $^{87}Sr/^{86}Sr$ and 0.2% for Pb isotopic ratios ($^{204}Pb/^{206}Pb$, $^{207}Pb/^{206}Pb$, $^{208}Pb/^{206}Pb$) as 1s. Multielement concentrations were also determined with the same instrument.

Results

Many of $^{87}Sr/^{86}Sr$ values of grains grown in Japan were within 0.703-0710 with some outlier samples and tended to be lower values than other countries intended in this study. The grains in northeastern region, around Izu Peninsula, and Oita prefecture in Japan tended to have lower values than other regions in Japan. The grains grown around Lake Biwa tended to have higher values than other regions. Different grain species grown in the same area had almost the same $^{87}Sr/^{86}Sr$ values. We made a $^{87}Sr/^{86}Sr$ map of grains, which will be applicable to other agricultural products, using obtained data. Lead isotope compositions of Japanese grains were within a small area. Each country showed a specific isotopic composition. Some grain samples grown in certain countries could be determined the countries by only the isotopic compositions, but other grain samples could be determined the countries by using multielement concentration data as well.

1) M. Shinozaki, K. Ariyama, A. Kawasaki, T. Hirata, Kunseki Kagaku, 2010, 59, 1003.
2) M. Shinozaki, K. Ariyama, A. Kawasaki, Y. Ishida, Anal Sci., 2011, 27, 709.
3) M. Shinozaki, K. Ariyama, A. Kawasaki, J. Agric. Food Chem., 2012, 60, 1628.

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