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Application note 020

Ginseng authenticity testing by measuring carbon, nitrogen and sulphur stable isotope compositions that differ based on cultivation, land and organic fertilizer type

Introduction:

China, Korea, Canada, and the USA produce more than 99% of the global ginseng harvest. The quality of ginseng production is affected by various physical, chemical and microbial properties of the soil. Continuous cropping of ginseng is discouraged because the soil fertility is highly decreased. Therefore, management of the soil quality is paramount in the production of a large yield and high quality of ginseng. In Korea, production of ginseng is falling due to a lack of new fields to use for this purpose, this has led to increased research into alternative ways of increasing the quality of yield and tackling pathogen based disorders such as *cylindocarpon destructans* caused by intensive ginseng cultivation. The stable isotope signature of ginseng can be used to analyse the environmental conditions that a particular crop of ginseng has been cultivated in. This can then be used as evidence of the quality of the ginseng in question.

Method:

For this study, six year old (Jagyeongjong variety) ginseng roots were used to grow seedlings. The roots were provided by the Department of Herbal Crop Research, Rural Development Administration (Korea), in varying conditions during 2009. The two cultivating locations included upland traditional ginseng fields and rice paddy-converted fields, three types of organic fertilizers were used in both locations; 1. Cattle manure, 2. Food waste and 3. Rice straw compost. Each fertiliser was applied at 1 ton/1,000m^2, 2 tons/1,000m^2 and 4 tons/1,000m^2.

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The ginseng samples were prepared by being lyophilised at -45°C for three days before being pulverised in preparation for IRMS analysis. 5 mg of ginseng powder was used for C and N stable isotope composition and 20 mg for the analysis of S stable isotope composition. Once prepared the C and N stable isotope compositions (δ^{13}CVPDB and δ^{15}NAIR) in ginseng were analysed using a PDZ Europa ANCA-GSL elemental analyser interfaced to a PDZ Europa 20-20 IRMS. The S stable isotope ratios (δ^{34}SVCT) were analysed using Sercon's pre-concentration unit interfaced with an elemental analyser and a continuous-flow Sercon 20-22 IRMS. Replicates of laboratory standards which had previously been calibrated against international standards from USGS and IAEA and which were compositionally similar to the ginseng samples were repeatedly analyzed for quality control. The analytical precision was ± 0.1‰ for δ^{13}CVPDB, ± 0.1‰ for δ^{15}NAIR, and ± 0.2‰ for δ^{34}SVCDT.

Results:

It was discovered that in a traditional upland location the type and amount of organic fertiliser applied to the ginseng crop has an effect on the stable isotope ratio of C, N and S. The mean ^{13}C values of ginseng cultivated by using rice straw compost was higher than the control (with no application of organic fertiliser). On the other hand the mean ^{13}C values of ginseng grown using cattle manure and food waste were lower than the control. The ^{15}N isotope composition in ginseng appears to be correlated to the amount of organic fertiliser applied to the cultivated area. Similarly, the ^{34}S isotopic values increase in line with increasing amounts of rice compost. On the contrary to these discoveries there is no observed pattern between the C, N and S stable isotope ratios and the fertiliser types/amounts applied to rice paddy fields, other than a reduction in the ^{15}N with increasing amounts of rice straw compost. Figure 1 shows the combination of ^{13}C-^{15}N revealing the relationships mentioned previously.

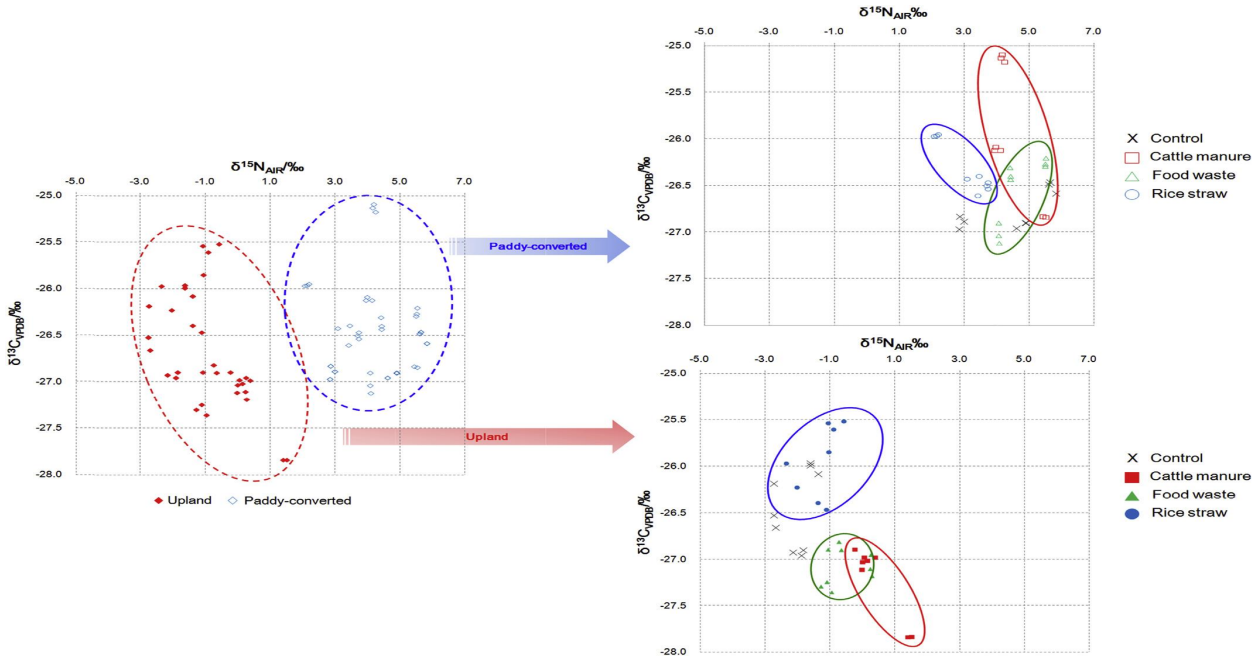

Figure 1: Variability of the combined C & N stable isotope ratios in 6-year old ginseng roots depending on the type of cultivation, land and organic fertiliser.

Conclusion:

It may be possible to interpret the conditions/ location that the crop was grown in using the variability of ^{13}C stable isotope. It is possible to discriminate between agricultural practices (types of organic fertiliser used on a ginseng crop) using N stable isotope composition. For example manure is known to be susceptible to N isotopic fractionation through nitrification/denitrification processes. The S ratio is more likely to isotopically fractionate due to the physical geology of the region instead of being biologically controlled. in future the S stable isotope ratio could be used to verify the geographical authenticity of the ginseng crop.

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