AN013

Measuring $\delta^{18}O$ and δD for Commercial Apples and Oranges

A quick screening method of using stable isotopes to distinguish the true origin and/or composition of natural food and beverage products

Keywords:

Material: Apples, oranges, apple juice, orange juice, food, cereal, fruit, fruit juice, vegetables, wine, olive oil, honey, food stuffs, petfood,
Process: Stable isotopes, $\delta^{18}O$ and δD, delta-18O, delta-D

Summary and Relevance:

Many parties in the agricultural, food and beverage industries can benefit from a technique to rapidly distinguish between similar raw and processed food products with very different provenance. Stable isotopes can provide this fast screening because every fruit, leaf or vegetable product will have ^{13}C, D and ^{18}O isotope ratios unique to the plant type and local growing conditions (groundwater, temperature and amount of sunshine). Indeed, it has long been known for example, that these ratios can be used to determine whether premium products such as honey and olive oil were genuine or treated[1]. Yet in spite of growing public pressure to unequivocally verify and certify the origins and authenticity of foodstuffs, stable isotope ratios are still rarely used for this purpose. This is because of the high cost, complexity and time required to make these measurements using traditional instrumentation, as well as the level of special expertise required. Fortunately, this has now completely changed with the advent of simple-to-use, turnkey instruments which can quickly provide these ratios on a wide range of samples, often in seconds or minutes, and for a fraction the cost of traditional instrumentation. These instruments are based on a proven technology called WS-CRDS (wavelength scanned cavity ring down spectroscopy). In this application we demonstrate the simplicity and discriminatory power of measuring $\delta^{18}O$ and δD for two different apple types and for oranges grown in two different regions.

Picarro Analyzer Used:

L1102-*i* equipped with autosampler option

Process:

Two types of apple, one labeled as a Pink Lady and the other as a Granny Smith, and two types of orange, one labeled as grown in California and the other labeled as grown in Florida, were obtained from a supermarket. Juice was extracted from each fruit by peeling the fruit and then grinding the remaining flesh in a plastic cup. Six juice samples from each fruit were then pipetted into the caps of 5 ml vials. The vials were then screwed onto the cap in the upside down position, and the sealed vials were placed upside down in a heated sand bath at 80°C overnight. The vials were then carefully turned right side up and the condensed liquid water removed with a standard pipette, and added to a 2 ml vial with an insert and septum cap. These vials were added to the autosampler of the Picarro L1102-*i* and run using a series of five injections for each vial with an analysis time of ca. 8 minutes per injection. The first value for each vial was then discarded to mitigate any memory effects.

Results:

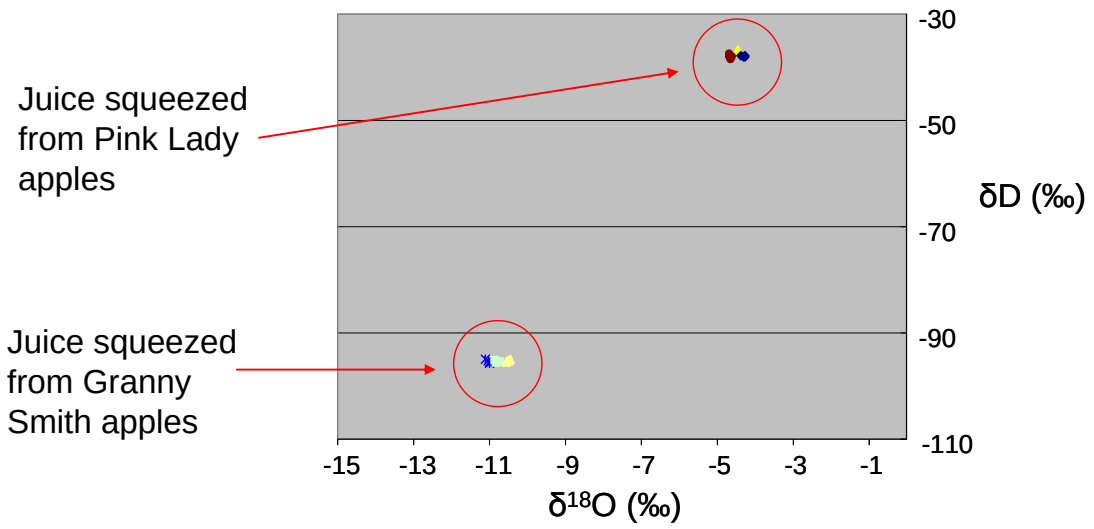

Fig. 1. Data for Granny Smith and Pink Lady apples. Each color represents an individual sample and is a superposition of multiple injections. Note the excellent precision for each sample and the clear differentiation shown by the tight grouping.

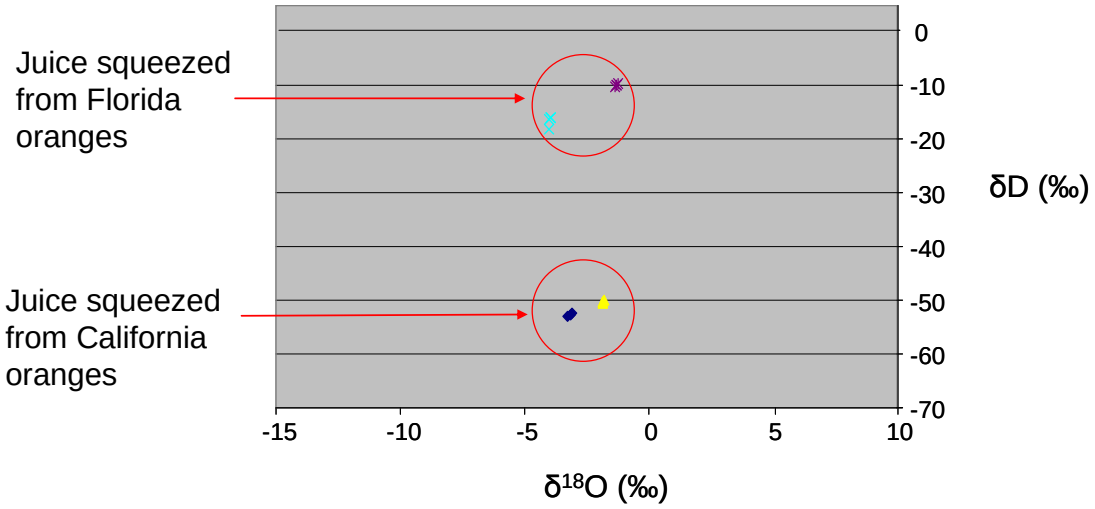

Fig. 2. Data for oranges grown in California and Florida. Each color represents an individual sample and is a superposition of multiple injections. Note the excellent precision for each sample and the clear differentiation shown by the tight grouping.

As shown in Figures 1 and 2, each apple type and each orange growing region provides a distinct profile, significantly different from the other, especially in δD. This result is even more compelling when the huge simplicity of the method is taken into account. Also visible is the exceptional precision for each vial. The precision for δD was as low as 0.13 permil and that for $\delta^{18}O$ was a low as 0.008 permil. The data precision for every vial was always lower than the guaranteed performance specifications for the L1102-*i*. Isotope standards were measured before, during and after the run and, although the values are calibrated against this VSMOW standard, at no point during the run did the standard data drift by more than 0.1 permil for $\delta^{18}O$ and 1.6 permil for δD.

Comments:

WS-CRDS instruments now provide simple access to stable isotope ratios for the three life elements (C, H, O). Once the growing, harvesting and/or processing of natural products is complete, these ratios leave a permanent and characteristic signature that can be easily read and used to screen these products, e.g. to tell whether a wine is from South America or France, or to confirm whether orange juice is from Brazil or Florida.

References:

See for example: Ghidini et al, Stable Isotopes Determination In Food Authentication: A Review, *Ann. Fac Medici. Vet di Parma* (Vol. XXVI, 2006), 193-204 and references therein