Application note 004

The Application of Isotopic and Elemental Analysis to Determine the Geographical Origin of Premium Long Grain Rice

Introduction

Rice samples cultivated in the USA, Europe and Basmati regions have been analysed using Isotope Ratio Mass Spectrometry (IRMS) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Nine key variables ($\delta^{13}C$, $\delta^{18}O$, boron, holmium, gadolinium, magnesium, rubidium, selenium and tungsten) were identified by canonical discriminant analysis as providing the maximum discrimination between rice samples from these regions.

High levels of boron (>2500 ppb) were associated with rice samples from America and notably high levels of holmium were found in rice samples from the state of Arkansas. European rice samples generally contained relatively high levels of magnesium and Indian/Pakistani samples were characterised by relatively low oxygen-18 (^{18}O) abundance.

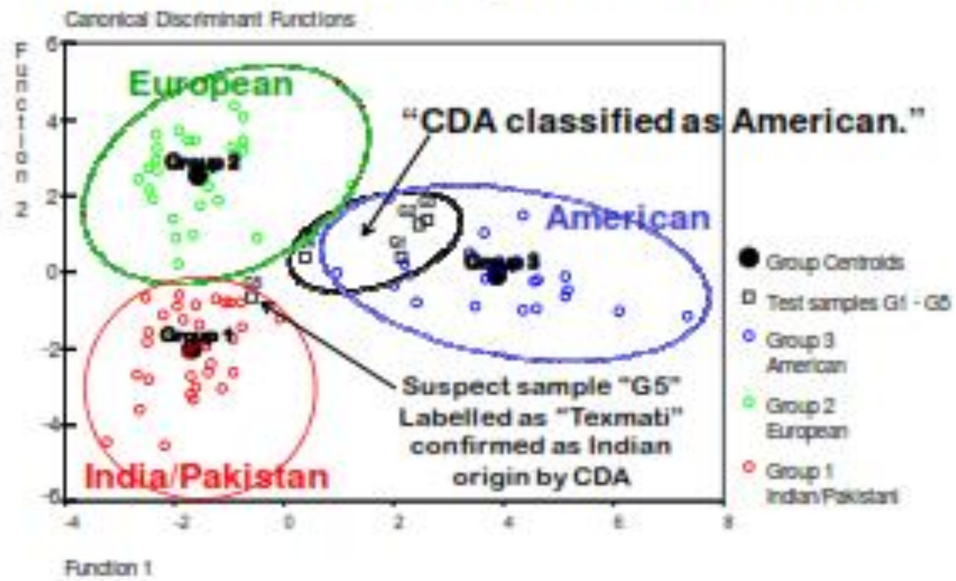
KEYWORDS: Rice, authenticity, geographical origin, $\delta^{13}C$, $\delta^{18}O$, trace elements.

Multivariate statistical analysis of stable isotope and trace element data from authentic rice samples (Figure 1)

Canonical Discriminant Analysis is a supervised patter recognition technique, which allows the user to find a linear combination of the stable isotope and trace element data that maximises the separation between countries of origin.

CDA may be used to identify which variables provide the means to classify any sample into a pre-defined group that it most closely resembles because of its stable isotope and trace element 'fingerprint'. Figure 1 below shows the first to discriminant functions for the separation of premium long grain rice from Basmati regions, Europe and the U.S.

Figure 1: A graphical representation of the canonical discriminant analysis of rice isotopic & trace element data



Identification of suspect "Texmati" sample using stable isotope and trace element data (Figure 1)

Five retail samples of a new variety of 'basmati-like' rice grown in Texas and marketed as "Texmati" were profiled using molecular biology techniques. One of the samples G5 had a DNA profile typical of a true Basmati and it was suspected that it had been mislabelled.

When the $\delta^{13}C$ and $\delta^{18}O$ stable isotope and trace element data had been analysed by canonical discriminant analysis it revealed that the rice possessed a signature typical of Basmati cultivated in India.

Results and discussion

The values of nine variables - $\delta^{13}C$ and $\delta^{18}O$ (Fig. 2), selenium (Fig. 3), magnesium (Fig. 4), boron (Fig. 5), rubidium, gadolinium, holmium and tungsten - have been identified, by canonical discriminant analysis, as providing the best information for differentiating between rice grown in Europe, the United States of America and the Basmati regions of India and Pakistan. This has permitted an empirical model to be developed to establish the geographical origin of unknown samples.

The concentration of specific elements such as boron and magnesium can be used exclusively as reasonable indicators of the geographical origin of rice. The role of the other elements in this empirical model is more complex but contributes significantly to the overall discrimination of country of origin. The stable isotope ratios of oxygen and carbon have been shown to be significantly correlated with the geographical origin of rice samples.

However, because the determination of origin is comparative and these variables are altered by seasonal variations, it will always be necessary to have an up-to-date supply of commercially sourced authentic rice samples to assess accurately unknown samples. The trace element composition of rice is less likely to be affected by seasonal variations and in this respect provides a more robust indicator of geographical origin.

This set of results clearly indicates that the trace element composition of rice samples due to topographic or soil factors and/or possible input from production processes is a powerful tool for characterisation of the geographical origin of rice. In addition, the measurements of ^{18}O values in rice carbohydrate are applicable to the characterisation of the geographical origin. This is clearly demonstrated by the effect of irrigation with Himalayan waters on the fractionation of these isotopes in rice grown in the Basmati region.

Figure 2: Radar diagram of rice $\delta^{18}O$

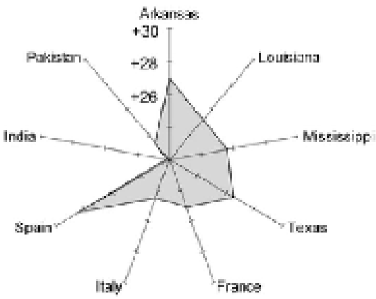


Figure 3: Radar diagram of selenium(ppb)

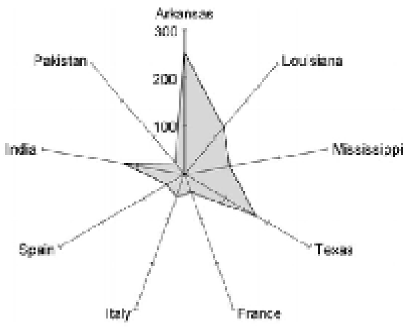


Figure 4: Radar diagram of magnesium(ppb)

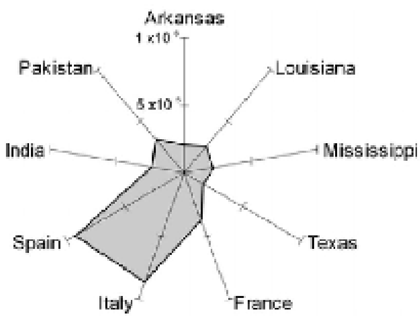
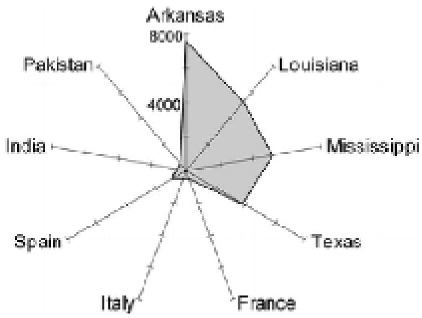


Figure 2: Radar diagram of rice boron(ppb)



Sercon

Equipment
CF 20-20 IRMS
Integra CN

References

S D Kelly, M Baxter, S Chapman, C Rhodes, J Dennis and P Brere-ton (2002) 'The application of isotopic and elemental analysis to determine the geographical origin of premium long grain rice' European Journal of Food Research and technology, 214: 72-78

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