Food forensics

Simon Kelly and Jurian Hoogewerff of the Institute of Food Research, and Paul Brereton from the Central Science Laboratory examine new methods for tracing the origins of food.

The globalisation of food markets, and the relative ease with which food commodities are transported between continents, means that consumers are increasingly concerned about the origin of the foods they consume. The reasons for this vary. Consumers often lack confidence in the quality and safety of commodities produced outside their local region. Some are concerned about animal welfare and ecologically sound production methods, while others simply want to be patriotic about the food they eat.

Recent food scares involving BSE, foot and mouth, and chicken flu have increased public awareness regarding the origin of foodstuffs. A number of research articles have already been published which detail the use of natural chemical fingerprints as geographic tracers to determine the provenance of 'protected' regional foods. These investigations are mainly based around the systematic global variations of hydrogen, oxygen and strontium isotope ratios, in combination with elemental concentrations, and other bio-geochemical indicators.

Labels do not always describe the precise origins of food

True origins

The information given on a label can be fraudulent, so there needs to be an analytical method to test if any claims of origin are true or false. The Institute of Food Research is investigating the link between the food product and its regional climate, or geology. The climate indicators used are the isotopic composition of hydrogen and oxygen. Due to the way clouds are formed by the evaporation of seawater, and its subsequent precipitation as rainwater, rainwater and soilwater have systematically different isotopic compositions. Hydrogen (chemical symbol H) has two natural occurring isotopes ^{1}H (protium) and ^{2}H (deuterium). The latter is twice as heavy as the former. With sensitive analytical instruments called mass spectrometers, the exact isotopic composition of hydrogen and oxygen in water can be determined. Rain clouds have a relatively lighter isotopic composition than seawater, as the heavy isotopic forms of the water molecule do not evaporate as easily as the lighter ones.

Rain check

The difference between the isotopic composition of H and O in the cloud's water vapour and the seawater is expressed in parts per thousand (relative to standard seawater). If the cloud produces rain, the rain will be slightly isotopically heavier then the cloud. As more rain leaves the cloud, the cloud becomes isotopically lighter. Normally, clouds form over the oceans and then drift inland. Therefore, the rain that falls further inland will always be isotopically lighter than the rain falling closer to the coast. This effect is also reflected in the soilwater.

As a consequence, if a type of plant takes up the soilwater near the coast it will have a different isotopic composition than an inland plant. In this way, the Food Institute can deduce the geographical origins of identical types of plants. The H isotopic composition of rainwater in Europe shows a west-east trend, and may be used to determine if vegetables, fruits and, in principle, meat come from certain regions.

Geological traces

The geology of countries can be highly variable, but is demonstrated by systematic differences in the trace element composition of the overlying soils. Additionally, there are two types of isotopic variation that can be related to geological environments. Firstly, every element with more than one isotope can fractionate their isotopes. The second type of isotopic variation is caused by radioactive decay at low levels.

There are no clear east-west or north-south trends, but many areas have unique elemental and natural isotopic signatures. So the H and O isotopes deliver the ability to differentiate between large areas of up to 100km, and the elemental and isotopic analysis can provide discrimination on scales of up to 10km.

Proof positive

The big challenge at present is to prove that similar food products from different regions can be isolated by the climatic and geological fingerprints they have inherited from the geographical source region. In an attempt to develop food forensics, the UK FSA has commissioned the Institute of Food Research (IFR), together with the University of East Anglia (UEA), to undertake two applied research studies: one on beef and one on poultry. In cooperation with the Central Science Laboratory (CSL) and UK Port Health Authorities, poultry samples entering the UK are first analysed by CSL for veterinary drug residues, and the elemental and isotopic composition is then determined at IFR.

The EU has recognised the potential of the proposed methods, and negotiations are now underway to establish a very large project, involving more then 50 European partners, which will be coordinated by CSL. In this project, food products such as mineral water, olives and olive oil, wheat, honey, and meat will be collected from 20 different 10x10km test regions throughout Europe. The test regions will represent different climate and geological zones. If the project proves that it is possible to differentiate between different geographical source regions for common food products, then predictive models will be developed. The latest developments of the technique will allow researchers to study the origin of individual compounds. In the future, scientists hope to be able to take a slice of parma ham and tell you where the pig was reared, where it was salted and even where it was smoked. ●