Problem solving in Food Science

Six young women sit around the table – all fourth year students in Food Science at Otago. The research projects they’re working on cover a huge range – analysing existing food products, solving problems for food producers, or trying out completely random ideas ….

**Hayley** is working on the rate at which biofilms in milk powder plants grow and release spores.

“I’m working with *Geobacillus* spores that survive pasteurisation. They don’t create a health problem, but they do affect the quality of the milk powder produced, so the producer will get a lower price for it. It’s a costly process, so the producer is keen to maximise the profit! I’m growing these biofilms under simulated factory conditions, and counting how many spores are formed; the work will eventually impact on cleaning regimes in milk treatment plants.”

**Valentina** is exploring the levels of folic acid in existing products such as supplements and fortified milk powder.

“We’re looking at how much folic acid is in these products, and also how stable it is. The stability impacts on how long the folic acid remains in the product; if something sits on a shelf for months, does it still contain the same level of folic acid as it did when it left the factory? That’s the kind of thing we’re looking for. Because the traces of folic acid are quite small, I get to use the HPLC (High Pressure Liquid Chromatography) to detect it. It’s really cool!”

**Leith** is working with Emersons Brewery, solving a problem caused by their huge success as a boutique brewer of fine beers.

“Emersons needed an improved method of evaluating their clarification techniques prior to filtering their beer. Due to the variations in batch brewing sometimes there is more or less yeast in suspension dependant on raw material and brewing variations. Isinglass (a product made from the swim bladders of Thai catfish, no less!) is used prefiltration to settle out the yeast. We’ve been working on different pH levels, time periods, concentrations, temperatures, to see if we can improve the filtration.”

**Alice** is working on a low sodium processed cheese, finding alternatives that will deliver the same results as the emulsifying salts used at present.

“I’m exploring a low sodium alternative, because sodium is a risk factor in heart disease and in diabetes. So if we can make a processed cheese that has the same texture, but less sodium, that’s going to be better for people. I’ve been trialling carrageenan and alginates from seaweed, and also pectins. I’m working on texture and firmness … I’m having a few problems with mould – so I haven’t actually tasted the cheese … Flavour might be next year’s project.”

**Lauren** is also working on cheese – adding antioxidants extracted from kiwifruit, grape seed, and apple. Does this result in long-life cheese? Extra health benefits?

“We’re looking to see whether the antioxidants will reduce the oxidation of fats in the cheese. It’s a bit random because it’s the oxidation of fats that produces flavour in cheese, but then eventually it can also make the cheese rancid. My supervisor was happy to pursue it just as a random experiment to see what happened! Of course the antioxidants will add nutritional value, but unfortunately I don’t have time to look at that or how they will affect flavour. At the moment the cheese that has the grape seed extract added to it has purple spots through it, so no, I haven’t tried mine either!”

**Carrie** is also dealing with splashes of purple – from black currant juice extraction.

“We’re adding pectinase to black currants to break down the pectin in the skins. This means that it’s easier to extract the juice, and the yield of juice is higher. It also means that more of the purple pigment is released from the skins when the fruit is pressed, and it’s this pigment that contains the anti-oxidants so that’s important too. We’re also testing for sugars, vitamin C and viscosity.”
Isotope and Trace Element research

Pinpointing the place of origin for something takes a layered approach. The ratios of light isotopes such as hydrogen, oxygen or carbon can narrow the field to within a hundred kilometres. An analysis of the trace elements can fine this down to within tens of kilometres. Isotopic ratios from trace elements such as heavy metals take this even finer… it's like using a sieve then a cheese cloth then a filter paper.

With the combined power of the Community Trust of Otago Centre for Trace Element Analysis and Isotrace Research, University of Otago researchers can track a wide range of things – from stolen diesel at Rainbow Ski-field to the origins of the solar system.

Dr Stirling, director of the Trace Element Analysis lab says “We have a Marsden-funded research project looking at the origin of the solar system, checking out competing hypotheses by analysing metal isotopes, especially Uranium. Some theories depend on the decay of Uranium being stable but recent research shows this is not the case, so those theories could be out by millions of years! We’re looking at the decay of Curium which is an obsolete metal – a metal so heavy it can only be generated by something like a supernova. It decays to a ‘daughter’ form of Uranium, so now we are looking at high concentrations of that to find out about the origin of the solar system.”

Associate Professor Russell Frew’s Isotrace Research lab has been called on for forensic work, for example proving the origin of diesel believed to be stolen from Rainbow Ski-field. “Almost all of the diesel in NZ comes from Marsden Point Refinery, but fine definition in the hydrogen and carbon isotopes can give a history of old diesel – e.g. if it’s been left to sit and then other newer diesel has been added to it; the blend of old and new creates a unique fingerprint and we were able to provide evidence that two batches (ski field and suspect’s) had the same source.”

Some of the research undertaken uses one facility or the other, but often it’s the combined power of trace element analysis and light isotopes that give the best results.

Researchers from Anatomy have used both the Isotrace Research lab and the Trace element analysis facility to track migration patterns of early groups travelling through Micronesia and into the Pacific: “The strontium isotopes in the teeth give us the geological information, and oxygen isotopes (analysed in the Isotrace Research lab) give an indication of local rainfalls. We could use laser tracking across the tooth to work out chronologically when people were in the different locations, or how long they spent in each area, but we haven’t done that as yet.”

Tina Summerfield – cyanobacteria

There are unknown numbers of different cyanobacteria – in the soil, in fresh water and in the sea. Simple organisms that capture sunlight for their energy supply via photosynthesis: the perfect “lab rat” of the plant biochemistry lab.

As well as harvesting energy for themselves, cyanobacteria produce hydrogen and small amounts of ethanol and in these energy-conscious times these ubiquitous energy factories are of particular interest to us. Tina Summerfield of the Botany department has been working on cyanobacteria and their photosynthesis processes for some time, investigating which strains of cyanobacteria are the highest producers of hydrogen.

“There’s a balancing act between oxygen production through photosynthesis and the production of hydrogen. Oxygen inhibits the enzyme that generates hydrogen, but both are products of photosynthesis. So there’s a tipping point where more oxygen is produced, cutting off the production of hydrogen. This varies from one strain to another.”

While working on this Tina found something extraordinary: one strain had a different response, producing alternative forms of key proteins in photosynthesis.

“These alternative proteins are increased under low oxygen conditions, we will investigate how they alter photosynthetic performance and whether this alters the ability of the cyanobacterium to produce hydrogen. These changes may enable the hydrogen production to continue for longer.”

The other puzzle is the enzyme itself, hydrogenase, which produces hydrogen but also consumes it. Summerfield is exploring what triggers this switch as well.

“ There are so many different kinds of cyanobacteria, and they do different things – some produce hydrogen, some fix nitrogen; there’s so much metabolic potential in the different varieties. The ones that live in hot springs would be very interesting to explore…”

At present Summerfield is working on one of the more commonly used “lab rat” strains, but investigating others around NZ is a part of future work.