ChemNet news

RSC ChemNet

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ISSUE 38 NOVEMBER 2009

A taste of Chemistry

Urine: don't flush it away

Article written by Ibrahim Sheriff, winner of our Food Competition

At first glance, we may wonder how we can be running out of food. Our planet is blessed, perhaps uniquely, with a combination of just the right factors for life. Paradoxically, our own success has been our downfall; as we drive for efficiency in agriculture we deplete our soils of essential nutrients. In recent times, chemistry has tried to find a solution.

Fertilisers are chemicals which are added to soil to increase its fertility. They are usually subsidised, but rising prices have caught out developing nations. With starvation on the horizon, it is of paramount importance to place the control of crop yields back in the hands of local farmers. I hope to detail one method in which we can do this.

Nowadays, compounds of ammonia (NH_3) are particularly favoured in fertiliser development. The nitrogen they contain can be used directly by plants to manufacture amino acids, the so-called building blocks of life. In terms of food, using nitrogenous fertiliser promotes healthy growth and higher yields. Usually, the required ammonia is produced in the Haber process:

$$N_{2\,(g)} + 3H_{2\,(g)} = 2NH_{3\,(g)}$$

However, as GCSE chemistry has taught us, the temperature and pressure requirements (450°C, 200 atm, iron catalyst) make this process unviable in small-scale farm production. The method I suggest is comparatively energy-efficient and easy to replicate. For it to work, three cheaply-available inputs are needed: urine, the enzyme urease, and magnesium chloride ($MgCl_2$).

We are all familiar with the pungent odour given off by urine as it goes stale. Microbes hydrolyse the nitrogen-rich urea in urine ($(NH_2)_2CO$), producing alkaline ammonia gas. But this is a slow process, and the gaseous products may take weeks to form. The addition of the enzyme urease (derived naturally) will speed up the reaction considerably :

$$(NH_2)_2CO_{(aq)} + H_2O_{(l)} \xrightarrow{\text{urease}} CO_{2\,(g)} + 2NH_{3(g)}$$

Once we have left the reaction to 'go' for a few hours (the pH should become alkaline), the magnesium chloride then can be added. This absorbs the ammonia, and precipitates the white solid $(NH_3)_6MgCl_2$. Dissolving this solid in water will produce our fertiliser concentrate, which can be diluted further and sprayed onto the crops.

This two-step method contains little advanced chemistry; it isn't meant to. I like to think of it as a farmer's 'DIY process', from building the simple reactor needed to treating the crops. The idea of using urine to grow food may not seem palatable at first, but to feed a hungry world, it is the best chemistry could hope for.

Ibrahim Sheriff, ChemNet member from London

Thanks Ibrahim, I'm not sure that this suggestion is the best chemistry can hope for, but it's one possible solution! – Ed.

Welcome to issue 38

As the RSC gears up for Chemistry Week, this month we have the winning entries from the food competition.

We couldn't really pick an outright winner between them so we've decided to have two winners and have dedicated this edition to showcase their work.

Well done to Ibrahim Sheriff from London and Anna Gerard from Bognor Regis.

ChemNet is hosting a number of Chemistry Week events in November, including a talk on the role of colour in food at The Chemistry Centre in central London on 12 November. There's still time to book your place at this or any of our other events via the ChemNet website: **www.rsc.org/chemnet.**

Don't forget to check out the Chemistry Week website to find other events near to you: **www.rsc.org/chemistryweek**

R. Bowles

Robert Bowles – Editor

Dates for your diary

ChemNet Events:

▶ "Look what chemistry has done for me!" careers event University of Kingston
9 November 2009
A broad range of speakers from industry and academia offer insights into careers in chemistry

▶ Spotlight on scientists at MRC Human Nutritional Research Laboratories, Cambridge
10 November 2009
An insight into the research and careers of the scientists working for the MRC

▶ ChemNet Pizza and Quiz Night at the Unviersity of Bradford
11 November 2009
Answer questions on chemistry and eat pizza! There will also be the chance to talk to admissions staff at the university

▶ ChemNet Lecture at the Chemistry Centre, London
12 November 2009
The first ChemNet event at the newly opened Chemistry Centre in London. A lecture entitled "Food Colourful Food!" from author Tom Coultate

▶ Chemistry of the Senses The Open University, Milton Keynes
1 December 2009

Many other events are running in Chemistry Week by the RSC. Visit:
www.rsc.org/chemistryweek
for the full list

To book a place on a ChemNet event:
E: chemnetevents@rsc.org
T: 01223 432340
or book online and find more info about all the events at:
www.rsc.org/chemnet

Food Spot

Article written by Anna Gerard, winner of our Food Competition

Nanotechnology is the 21st century phenomenon, enhancing everything from racquet sports to cosmetics – but food? It has already infiltrated our lives and, if we put aside the possibility of adverse effects, could hold the key to solving the world's food shortage. Nanoparticles have permeated our food industry from the source through to the packaging.

So what are nanoparticles? They are particles one billionth of a metre in size that are used in manipulating the constituents of products at submicroscopic levels. A thousand nanoparticles together would approximately equal the thickness of one sheet of paper.

Nanocarbohydrates can be added to chicken feedstuffs. In the chicken's gut they bind with bacteria so that they both pass through the chicken before it is processed. By using films (so-called nanobarriers) to prevent oxygen entering food the shelf life can be extended. These edible films are usually double- or triple-layered laminates and the food industry is currently working to produce one that can also exclude moisture. Additives such as colourants or flavours can be incorporated. In fact, some nanoparticles have been developed to allow E coli contamination to be detected by a laser, thus helping to reduce food poisoning. Product life has also been extended by using nanoclays in plastic containers to prevent gas permeability. Other antimicrobial barriers have been developed using calcium and zinc.

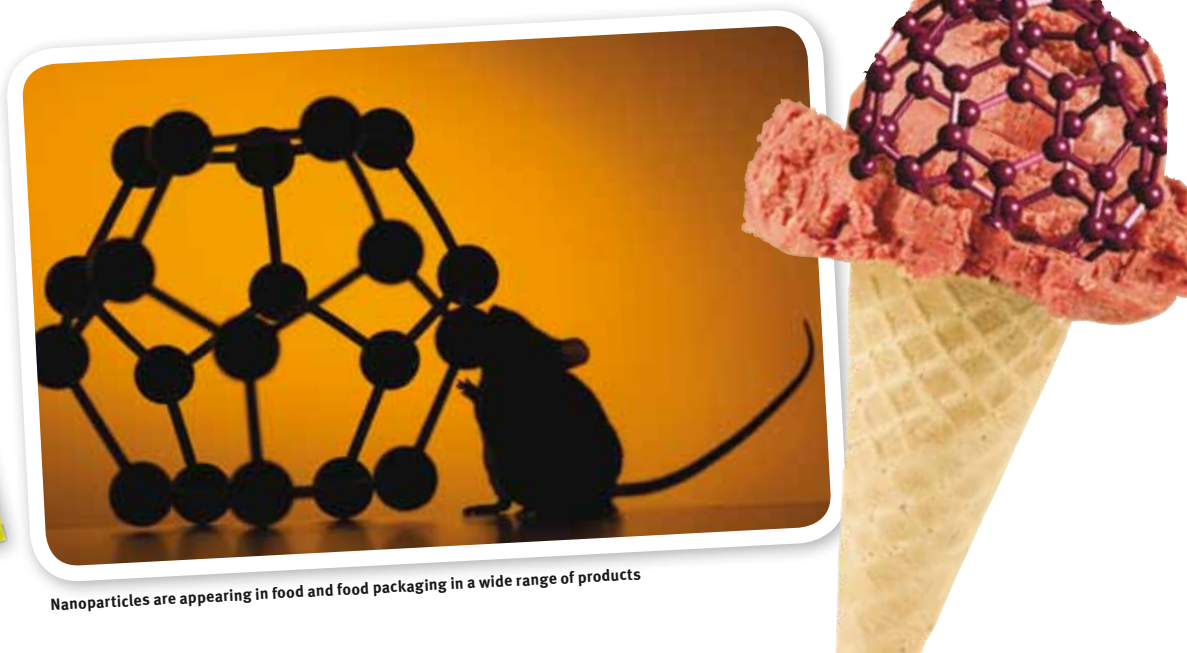
To enhance nutrition, nanoparticles have been designed to encapsulate vitamins, omega oils and antioxidants. Nanocapsules can disguise the taste of some added substances e.g. fish oils. In a similar way drugs could be incorporated to prevent diseases in endemic areas, and vitamins to counteract deficiencies. Preservatives and flavour enhancers can similarly be incorporated by nanodispersion techniques.

Another advantage is that they can be used to enhance flavours. Some have been developed to trick the taste sensors of the tongue by blocking bitter tastes or by enhancing saltiness and sweetness in foods. They have been designed to enhance textures: nanocrystals and lipids significantly increase food spreadability and stability for better low fat food, making healthy food more appealing.

New forms of green packaging have been created using biodegradable nanofibres.

As nanotechnology continues to develop, its applications in the food industry are sure to increase. Its success will depend upon consumer acceptance and regulatory approval. At present the new innovations show a way of increasing food delivery, nutritional value and safety that could help feed the world.

Anna Gerard, ChemNet member from Bognor Regis



Nanoparticles are appearing in food and food packaging in a wide range of products

Careers: Early achiever

Joanne Ayre has combined a talent for science with a flair for working with people to develop a diverse business career. Yfke Hager meets her

Curriculum vitae

Age 32

Work experience

2005-Present
Quality Compliance Manager, GlaxoSmithKline, Barnard Castle

2002-05
Environment Health and Safety Adviser, GlaxoSmithKline, Barnard Castle

1998-02
Process Technologist, GlaxoSmithKline, Barnard Castle

1997-98
Process Technician, GlaxoSmithKline, Barnard Castle

Education

1996
BSc (Hons) Chemistry, University of Leeds

Hobbies
Swimming, camping, travelling

'You have to be passionate about it, because it's not always a popular subject'

Joanne Ayre has found that combining people skills with a passion for science can be the key to an interesting career. As a young scientist joining a large pharmaceutical company, she benefited from an extensive training programme. Ten years and three promotions later, she received the 2007 North East Process Industry Cluster (Nepic) Pharmaceutical Young Achiever Award in recognition of her career achievements.

Ayre attended an all-girls school and was encouraged by her teachers when she showed a natural inclination towards science. When she left school, she opted for a pure chemistry degree at Leeds University. *'I enjoyed my time there, but realised that working in the lab was not for me.'* she recalls.

Lured by the promise of a more diverse career in industry, Ayre joined a scientific recruitment agency. She started her career as a process technician in the Product Technology unit of GlaxoSmithKline (GSK) in Barnard Castle. Joining a large scientific company was a real eye-opener, she says. *'My first job really confirmed for me that I was happier in a broader role. I did not really appreciate the wide variety of opportunities that are available to science graduates until I joined GSK.'*

During her first year at the company, Ayre started exploring her career options. *'I realised there were other roles available that would suit my personality.'* she says. After a year, a permanent position in the unit was advertised. She applied and was appointed as process technologist. She says that the transition to her new role, which led to involvement in strategic projects, was very smooth. *'I shadowed other people and learned from them, so I wasn't starting from scratch.'* As well as receiving on the job training, Ayre took advantage of the numerous corporate training schemes, which covered topics from legislation to standard operating procedures.

Health and safety matters featured heavily in her new role. *'GSK takes health and safety very seriously,'* she says. *'My chemistry background was very helpful, as I had learned a lot about risk assessment as a student.'* She explains that her interest in environmental health and safety gradually grew to a passion. *'You have to be passionate about it, because it's not always a popular subject,'* she laughs.

When the position of environment health and safety adviser became available, Ayre jumped at the chance. Her remit was to ensure that the processes put into place to manufacture drugs are safe. *'The raw materials for certain drugs can be harmful if not handled correctly,'* she says. *'We have to engineer out all potential risks to our staff.'*

Her responsibilities extended to the environment outside the factory. *'We try to minimise risks to our staff, but also to the environment,'* she says. *'This involves thinking about the packaging we use and the waste we produce.'* She points to a corporate responsibility to promote greener ways of working and renewable energy sources. *'It's not just about making sure there's no negative impact on the local community, but also seeing if we can have a positive impact,'* Ayre says. She cites the two (second-hand) wind turbines on the Barnard Castle site as an instance of leading by example.

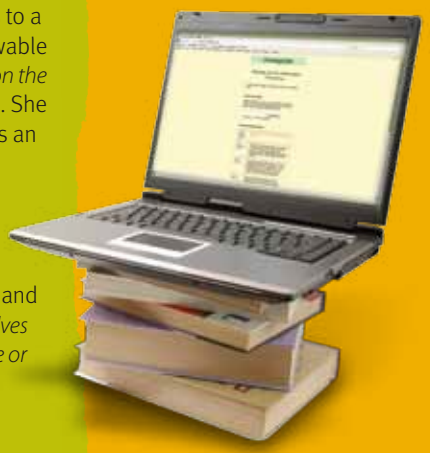
Ayre was recently promoted to site quality compliance manager. She now oversees the site good manufacturing practice (GMP) audit programme, ensuring that external audits from regulators such as the UK Medicines and Healthcare products Regulatory Agency (MHRA) and the US Food and Drug Administration (FDA) are run smoothly. *'This involves meeting with people, discussing audit findings and deciding on any corrective or preventive action that needs to take place,'* she explains.

Chemistry on the web

- The Food Standards Agency has a wealth of information about the safety and nutritional content of food covering topics such and GM foods, and packaging: **www.food.gov.uk**
- The Food Standards Agency's section on the safety of nanotechnology in food: **http://www.food.gov.uk/gmfoods/novel/nano**
- The Guardian has a great section on food and the environment showing just how closely linked they are, with stories such as the effects of climate change on tea and coffee farming: **http://www.guardian.co.uk/environment/food**
- **http://northgatechemistry.blogspot.com/** Northgate High school in Suffolk has created this great blog for their chemistry students, but there's plenty of information and links here for everyone. Well done to Mrs Cook and Miss Hallett for their hard work.

Website of the month:

http://www.chemguide.co.uk/
A great resource to hep you understand more about chemistry. Search by keyword to get more information on the tricky topics and follow the links to exam board specs to give you the edge.



Win stuff

Saccharine was the first artificial sweetener discovered by two chemists in 1878 experimenting with coal tar. But what is it's chemical name?

Send your answer by email to: **chemnet@rsc.org** with your name and ChemNet membership number. Closing date 10 November. Two winning entries will each receive a copy of Elegant Solutions, showcasing 10 of the best chemical experiments of all time.

For a chance to **WIN**, email us at: **chemnet@rsc.org**

Chemistry facts

Dynamite is made with peanuts. Well not all of it, but peanut oil can be processed to produce glycerol, which can be used to make nitroglycerin, one of the constituents of dynamite.

If you want to register to use the discussion board email: chemnet@rsc.org

Cutting-edge Chemistry

Scrubbing out acid rain

US scientists have synthesised an organic liquid that can capture sulfur dioxide. The resulting reversible zwitterionic liquid, the first of its kind, could be used to prevent acid rain.

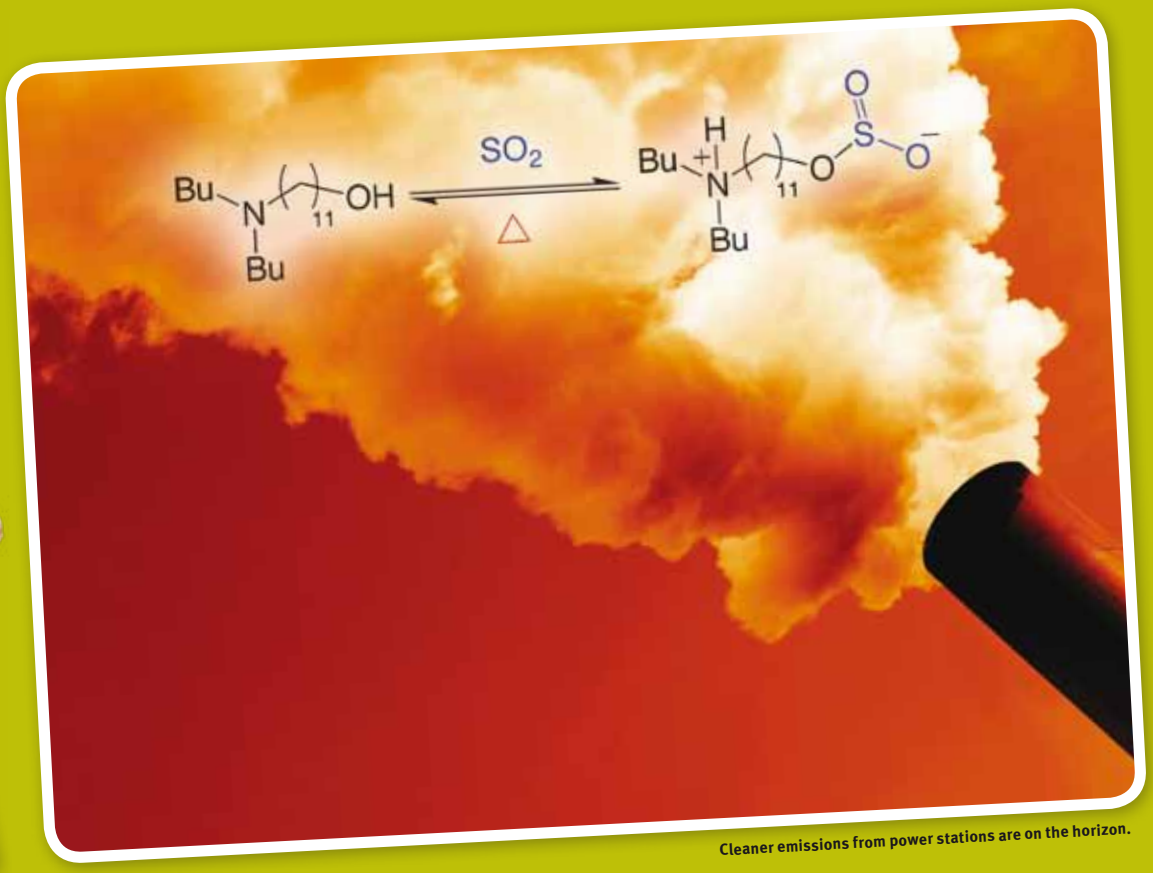
David Heldebrant and colleagues at Pacific Northwest National Laboratory, Richland, made a molecule called N,N-dibutylundecanolamine, which consists of a tertiary amine base and an alcohol separated by a long alkyl chain. When they exposed it to sulfur dioxide, it bound the gas as a liquid zwitterionic alkylsulfite salt. Sulfur dioxide released from power plants is one of the primary causes of acid rain. Most power plants have scrubbers, which are reaction towers containing slurries of caustic soda or lime that bind the sulfur dioxide. But the binding is irreversible, explains Heldebrant, and the resulting sulfurous compounds mostly end up in landfill sites.

"It may be possible to develop hybrid systems capable of capturing sulfur dioxide and carbon dioxide" says Edward Maginn, University of Notre Dame,US.
Heldebrant's zwitterionic liquid binds reversibly to sulfur dioxide - the reactants are regenerated by heating the liquid to 70°C in a vacuum. *'We're doing a chemical capture that allows a reversible release so you could do something else with the sulfur dioxide later.'* he says - the wine and cement industries both use the gas.
Edward Maginn at the University of Notre Dame, US, is an expert in sulfur dioxide capture and says the researchers have made *'an important discovery. This work opens the door for the development of new types of solvents tailored to capture sulfur dioxide.'*

The group intend to use what they have learnt with sulfur dioxide to produce a carbon dioxide-binding zwitterionic liquid. Maginn suggests that these processes could one day be combined, *'It may be possible to develop hybrid systems capable of capturing sulfur and carbon dioxides with either parallel or simultaneous regeneration.'*

Anna Roffey, RSC

For more stories like this featuring the latest research from RSC journals, visit Chemical Technology on the web: www.rsc.org/highlightschemtechnol



Cleaner emissions from power stations are on the horizon.