Food science

Snack food polyphenols

Snack foods, like popcorn and many breakfast cereals, are an unexpected source of polyphenols, according to research conducted by a team of researchers at the University of Scranton, Pennsylvania. The team was led by Joe Vinson, whose work on polyphenols in chocolate is widely known.

Hot and cold whole grain breakfast cereal have been recognised as having healthful fibre content, but Vinson has shown they also contain 'surprisingly large' amounts of polyphenols. 'Early researchers thought that the fibre was the active ingredients for these benefits in whole grains, the reason why they may reduce the risk of cancer and coronary heart disease,' he said. 'But recently, polyphenols emerged as potentially more important. Breakfast cereals, pasta, crackers and salty snacks constitute over 66% of whole grain intake in the US diet. Whole grains provide around 10% of daily per capita polyphenol intake in the US diet.

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Healthy snack?: plain popcorn

'We found that, in fact, whole grain products have comparable antioxidants per gram to fruit and vegetable. This is the first study to examine total phenol antioxidants in breakfast cereals and snacks, whereas previous studies have measured free oxidants in these products, he said, adding that ferulic acid is the major phenolic acid in grains. 'We have shown that they are six to ten times better than vitamins C and E in protecting lipoproteins in our "heart disease in a test tube" model. Whole grain extracts are also better antioxidants than the vitamins.'

The wholegrain cereals with the most antioxidants, by serving size, are oat-based and have similar amounts to corn, while wheat has lower quantities followed by hot oat cereals, which have much more than rice-based cereals. Vinson said raisin bran has the highest amount, with 524mg/serving, but this is primarily due to the raisins. Plain bran cereals are similar to wheat but have more fibre. Snacks made from whole grains have slightly lower antioxidants/gm, except for popcorn, which has much higher levels.

These amounts compare with average US per capita consumption levels of 691 mg/day in coffee, 302 mg/day in tea and 103mg/day in dark chocolate, said Vinson.

Analytical chemistry

Sweet tasting electronic tongue

The race to develop an electronic 'tongue' has tested researchers around the world, but a team from the University of Illinois at Urbana-Champaign has achieved a major step with an inexpensive visual lab-on-a-chip sensor that can quickly and accurately identify sweetness.

'We take things that smell or taste and convert their chemical properties into a visual image,' said team leader Kenneth Suslick. 'This is the first practical "electronic tongue" that you can simply dip into a sample and identify the source of sweetness based on colour.' Suslick said the device can provide a simple quality control test for food processors, to ensure consistent, predictable flavour.

Many food processors use high-pressure liquid chromatography to monitor sweetness, involving expensive instrumentation for a process that is relatively slow: up to 30 minutes/sample. The new device is small, disposable and produces results in around 2 minutes.

The device comprises a transparent container with 16 to 36 printed dye spots less than 1mm in diameter immobilised in an organically modified polysiloxane, or ormosil. The spots contain an activator derived from boric acid. The reaction between the sugar and the activator, which is contained within the porous silica glass, changes the pH, which is then identified and quantified by the colour and its intensity using common pH indicators. Fifteen different monosaccharides, disaccharides and artificial sugars have been differentiated with 100% accuracy.

A variation of the original display has been used to differentiate 14 natural and artificial sweetners at millimolar (mM) concentrations, in addition to detecting ingredients in complex mixtures, such as in sweetener sachets. Limits of detection at pH 7.4 for glucose were less than 1mM, which is below physiologically important levels, according to Suslick, who believes that that modified versions might be able to monitor blood glucose levels in diabetics, and even identify toxic substances in the environment.

The new device is seen as just the first step in the development of a fully functional electric tongue, said Christopher Musto, a student in Suslick's team. 'To be considered a true electronic tongue, the device must detect not just sweet, but sour, salty, bitter and umami [meaty or savoury] – the five main human tastes.'

Adhesive secrets of a marine worm revealed

Despite 30 years of research into mussel adhesives, no adhesives based on natural products have been used in medical applications such as the repair of shattered bones.

Scientists at the University of Utah, US, believe that this situation is likely to change with their development of a water-based adhesive based on the adhesive that sandcastle worms (*Phragmatopoma californica*) use to build their homes from sand and sea shell particles.

The challenge was to produce a biocompatible, biodegradable adhesive that remains insoluble in wet environments; is able to bond wet surfaces within a specific period of time; and does not swell by water absorption, thereby disrupting bone alignment.

Sandcastle worm adhesive comprises oppositely charged proteins, and calcium and magnesium ions.

The protein chemical groups, including phosphates, amines and catechols, assist in binding to a variety of materials sufficiently strongly to displace water, while the oppositely charged proteins themselves associate electrostatically into a dense cohesive fluid that is not miscible with water. Hardening is triggered within 30 seconds by the pH difference between the worm's secretory system and seawater.

The research team therefore substituted synthetic polymers for the natural compounds. When mixed in water, the oppositely charged mimetic polymers associate and separate out into a dense fluid state called a complex coacervate, which performs in the same way as the natural adhesive but is twice as strong.