Science Last Fortnight

Nano-Cauliflower to Detect Arsenic

Cheaper, faster technique

West Bengal, Jharkhand, Bihar, Uttar Pradesh, Assam and Manipur have reported arsenic contamination in groundwater. Above permissible levels of arsenic contamination – 0.01 mg/l as per WHO – are found in the Ganga and Brahmaputra rivers which flow through these states. Arsenic toxicity causes many serious health issues such as cancer, hypertension, dermatitis, kidney and lung diseases.

Detection of arsenic in water is the first step to tackling the problem. Analytical methods like high-performance liquid chromatography, atomic absorption spectroscopy, and spectrofluorimetry are used to detect arsenic levels in water. The difficulties in sample preparation, time taken to detect arsenic and the cost involved are major deterrents to using these techniques in field conditions.

A group of researchers, from the SASTRA University, Tamil Nadu, has now developed a cheaper, rapid detection sensor for detecting arsenic levels. The sensor has a cauliflower morphology which facilitates high diffusion and mass transport of reactants. This enhances the detection capacity of the sensor. But preparing such a sensor is a great challenge.

The researchers developed fluorine doped cadmium oxide sensing electrodes by spraying a cadmium acetate dehydrate precursor along with ammonium fluoride onto the pre-heated glass substrate. This process produced a thin nanolayered cauliflower shaped non-toxic fluorine doped cadmium oxide sensor. This sensor can detect arsenic rapidly and is more sensitive than currently available sensors.

Arsenic contamination in drinking water threatens more than 150 million people globally. It is urgent to detect even low quantities of arsenic in drinking water. And these nano-cauliflowers may form the basis of technology that can be produced cheaply on a large scale to detect arsenic in water efficiently and rapidly.

Sensors and Actuators B, **234**, 426–434

Beat the Weeds

Cross resistance sparks old methods

Even with improved agronomic practices, farmers may still need to use age-old practices to fight weeds. That's the lesson to be drawn from the latest development of resistance to the weed fighting herbicides applied to wheat fields. A weed, locally known as *gehunsa* (*Phalaris minor*) is not much to look at. But the farmers in Haryana have a hard time controlling it.

Having evolved the ability to withstand Clodinafop, a major herbicide, it has developed genetic defenses to survive herbicides. Even increasing the dosage could not control the weed. According to a team, led by Dharam Bir Yadav, a scientist at the Haryana Agricultural University, Karnal, their resistance is metabolic in nature. The more they are exposed to herbicides over the seasons, the more resistant they become. The team warns that herbicide resistances can lead to total crop failure from unchecked growth of the weed.

Yadav notes that it is difficult to identify a specific tolerance trait. The weed population has high molecular diversity. So a multipronged strategy has to be adopted. Cultural methods like crop rotations, along with manual/mechanical weed management are still effective. He suggests that the weed should be attacked using a combination (sequential or tank-mix) of weedicides. This reduces the chances of development of weed resistance strains. However, there still remains a pressing need to develop new herbicide molecules for managing the weed.

Crop Protection, **89**, 239–247

Bitter Pill Kills

Destroying the dengue vector

A study[1] in 2013 reported that India contributes to 34% of global dengue infections. The mosquito-borne viral infection may cause mild asymptomatic illness or develop into a lethal haemorrhagic fever. There is no specific treatment. So the only option is to control the vector.

Last fortnight, researchers from the Manonmaniam Sundaranar University, Tamil Nadu, came up with a suggestion: an ayurvedic medicinal plant as anti-vector drug[2].

Andrographis paniculata, known as *kalmegh* or *mahatiktha* in India, is used as traditional medicine for the treatment of sore throat, common cold, respiratory tract infections and as antidote against snake or insect venom. The plant extracts have shown anticancer, antibacterial, antiviral, anti-inflammatory and antimicrobial properties. But the efficacy of the plant to control the vector had not previously been evaluated.

The research team extracted a compound, 'andrographolide', known for its pharmacological effects, from the leaves of the plant. They tested it against the dengue vector, *Aedes aegypti*.

In adult females, the drug reduced the number of eggs laid and the hatchability of the eggs. The survival rate, in the first four larval stages, showed that mortality rates are directly proportional to andrographolide concentration. Within 24 hours, the growth of mosquito larvae and pupae is inhibited by up to 90%. Histological and morphological observations reveal a breakdown in the mid-gut section of the larval intestine.

This research offers a clue for developing harmless larvicides. Transforming this bioactive compound into a cost-effective product, however, remains a challenge.

[1]*Nature*, 2013, **496**, 504

[2]*Acta Tropica*, 2016, **163**, 167–178

Bacteria for Better Soils

Solution inherent in the problem

In 1971, Ananda Mohan Chakrabarty engineered a new strain of bacteria that could degrade crude oil and aid bioremediation of oil spills, saving millions of dollars and precious marine life. A lobby of scientists argued that it was genetically modified, and that its long-term environmental impact is unknown. Scientists across the globe have ever since been searching for naturally

occurring microbes and organisms that can degrade pollutants.

Heavy metals and polycyclic aromatic hydrocarbons are increasingly polluting our soils. Released by burning fossil fuels, industrial wastes, coal and tar processing, these pollutants settle down in the soil. Are there microorganisms that can tackle this pollution? This is the question that researchers at the Krishnadevaraya University, Anantapur, Andhra Pradesh, asked themselves.

They collaborated with universities from Australia and South Korea to isolate bacteria that were present in polluted soil samples from various sites. They identified these organisms by pyrosequencing: a next generation sequencing technique. Using the data of 16S ribosomal RNA, the researchers classified them into 16 different phyla using bioinformatics tools.

They found that about 80% of Proteobacteria and Actinobacteria are tolerant to metal toxicity and capable of degrading polycyclic aromatic hydrocarbons.

Mass producing these naturally occurring bacteria and using them for soil bioremediation can be an environmental-friendly and sustainable solution, enabling the transformation of polluted areas into cultivable land.

J. Hazardous Materials, **317**, 169–179

Pollution-free Cotton Dyeing

Dyeing of cotton is done in two steps. First, the fibre is 'exhausted' using dyes. This requires a large amount of salts like sodium chloride. Secondly, the dye has to be fixed using alkalies like sodium hydroxide. If the exhausting step is inefficient, the leftover dye leaches into the waste. This leads to water pollution, a serious challenge in tertiary effluent treatment processes. Another problem is salt leaching into groundwater making it saline and unfit for consumption.

Researchers at the Anna University, Tamil Nadu, have now devised a novel and efficient method of exhausting cotton fiber that uses 100% of the dye. Nothing is leached out in the wastewater. In this method, the fabric is first treated with an alkali, followed by CHPTAC, a cationic etherification agent, in a mole ratio of 1 : 2.

Apart from utilizing the complete dye, this deviation from tradition consumes 20% less time and saves almost 30% water. And what's more, the new method of dyeing cotton fabrics is salt-free!

The great success of industrial trials of the method needs to be brought to the attention of knit processing industries in India for immediate implementation.

Carbohydrate Polymers, **152**, 1–11

Better Brooms for Algal Mess

Water bodies are often covered with algal blooms. They exploit the nutrients and oxygen in water and suffocate aquatic life. This algal mass can be clumped by flocculation using chemicals which makes it easy to remove. But this is not popular because the chemicals used are expensive and end up polluting water.

Dharani and Balasubramanian from the University of Madras, Tamil Nadu, now report a novel flocculant that is inexpensive, eco-friendly, easy-to-make and highly efficient. The highly water-soluble flocculent is a copolymer of two monomers: DMC and MACPPC. The polymer is grafted on a modified acryloyl chitosan moiety. The resulting flocculent is named AC-g-P (DMC-MACPPAC).

The researchers tested it on a common species of microalgae, *Chlorella vulgaris*. The material is found to be highly efficient: it can flocculate approximately 73% of algae when used at concentrations as low as 20 parts per million.

This gives us an effective agent that can be used for algal biomass isolation at a mass scale. The properties of the isolated biomass remain unchanged. Thus, this flocculant works both as a method to generate cattle feed and as source of biofuel.

Carbohydrate Polymers, **152**, 459–467

Video Coding for Internet Security

Steganography: blow to hackers

A team led by Ramakrishna Hegde, at the SDM Institute of Technology, Karnataka, found a new way to convey secret data by concealing its existence using multimedia as a carrier.

The secret data is encrypted using Elliptic Curve Cryptography. This is convenient as it reduces storage and transmission requirements, enhancing processing speed.

The encrypted cipher is again embedded in the H.264 video format. The pixels in the video are optimized by using an optimization algorithm called, Artificial Bee Colony, to reduce the distortion of the encrypted data.

The digital media acts as cover media or host for transferring highly confidential data with minimum cognizable degradation. The digital medium can be a text, audio, video or image, depending upon the size of the message to be transferred. The secret message is invisible and inaudible.

This technique proved its robustness when implemented on Matlab and MPEG video files. Steganography, using video format, brings a revolution in terms of security levels, carrier capacity and embedding efficiency of the classified data. It is a challenge to internet hackers.

Computer Standards & Interfaces, **48**, 173–182

Reports by: **Pavithra P. Nayak, Bhavya Khullar, G. Sharath Chandra, Manish Kumar Tekam** and **S. Puspanjali**

ACKNOWLEDGEMENT. Science Media Centre, IISER Pune for access to databases.

scienceandmediaworkshops@gmail.com