

Science Last Fortnight

Viral Outbreak

Haematopoietic necrosis in goldfish

The introduction of alien fishes into local aquatic systems as part of aquaculture trade and ornamental fish culture has often alarmed scientists, indicating the threat posed by exotic species to native fishes. Many scientific studies have been done on the impact of exotic ornamental species on native aqua diversity. Along with the domination of exotic species in local water bodies, experts are also concerned over the possibility of parasites and pathogens getting introduced into the native environment. But, no studies have reported any parasitic outbreak or the presence of any pathogens in Indian water bodies.

For the first time, in India, P. K. Sahoo and a group of experts, report on a recent viral disease outbreak in freshwater aquaculture, in Serampore, West Bengal. The virus, called goldfish haematopoietic necrosis herpes virus (cyprinid herpes virus-2), was detected in association with multidrug resistant *Aeromonas hydrophila* infection in goldfish, *Carassius auratus*.

The virus causes destruction of cells of blood forming organs (haematopoietic necrosis) in goldfish and it is diagnosed by large scale haemorrhages on the body, fins and gills, lepidorthosis, necrosed gills, protruded anus and shrunken eyes. White nodular necrotic foci in spleen and kidneys were also noticed along with necrosis and fusion of gill lamellae.

Transmission electron microscopy revealed the presence of mature virus particles. And it was confirmed using polymerase chain reaction.

Scientists isolated a bacterium from the internal organs of the affected fish which they found to be *Aeromonas hydrophila*. According to the scientists, this could be a secondary infection. The primary etiological agent responsible for this outbreak is cyprinid herpes virus-2 itself.

Experimental infection trials failed to reproduce the disease in co-cultured rohu and koi carp. Since it is the first virus outbreak report in Indian waters,

the study bears further investigation, they added. It is better to take precautions rather than be sorry later.

Acta Tropica, **161**, 8–17

Methane from Landfills

Tapping trash

India's cities are rapidly growing in population. Per capita income is increasing, as is per capita consumption of resources, which in turn, leads to generation of waste. We are often greeted by the sight of scattered open dumps in cities. Most municipalities take these to landfills, the dump yards for solid waste. In the landfill, organic waste is anaerobically decomposed. The microbes consume the organic matter and produce methane, a gas that has significant global warming impact, second only to carbon dioxide.

Last fortnight, a team of researchers, headed by Sunil Kumar, from the National Environmental Engineering Research Institute, Nagpur developed a model framework to measure methane emissions. The team monitored emissions at Shillong, Kolkata and Jaipur. They utilized LandGEM, a commonly used model for projecting methane emission. They modified the model for Indian climatic conditions and formulated correction factors. They report that the methane concentration shows a correlation with the temperature fluctuations.

When methane emissions rise, the concentration of the pollutant ozone, in the troposphere, also rises. It is well known that methane does not yield its secrets easily. Its residence time in the atmosphere is short. Thus, a reduction of methane will be an effective solution in reducing its impact. Waste minimization and recycling are the way to go.

Waste management must translate into resource management. Trapping the methane from landfills for energy needs is the next step. We need to develop robust systems to do this. With these new insights, we can explore alternative approaches to dealing with waste.

Bioresource Technology, **216**, 981–987

One Good Fuel Supports Another

Pongamia and Calophyllum biodiesel

Alternative sources of fuel have always attracted researchers. Biodiesel, one such alternative, has caught the eye of many. This has the potential to replace fossil fuels. But high viscosity and density impedes its use as sole fuel. However, in combination with fossil fuels, its efficiency improves.

Combustion, gaseous emissions and oxidation stability are important factors contributing to the efficiency of biodiesel. These depend on the properties of the fuel and, subsequently, engine performance.

Ramalingam and team from Tamil Nadu tested the efficiency of calophyllum biodiesel using plant extracts as additive and emission suppressants. They tested a 20% blend of calophyllum biodiesel on a Kirloskar SV1 four-stroke engine. Varying concentrations of ethanol extracts of pongamia were used as fuel additive. Addition of leaf extract increased the oxidation stability of the biodiesel.

The scientists assessed the performance, combustion and emission characteristics of the blends. CO and hydrocarbon emission of the blends was lower than that of pure diesel. Smoke emission reduced with increase in additive in the fuel.

Smoke emission increases with increase in load on the engine. The highest reduction in smoke was at 80% load. The presence of 15% leaf extract additive reduced the NO_x emission by about 20%.

Currently, synthetic fuel is added to blend biodiesel for use in diesel engines. The team's efforts to explore the possibility of using plant-based antioxidants are a welcome move, as these increase the stability of biodiesel and reduce NO_x emissions. One more step towards an eco-friendly future...

Fuel, **180**, 263–269

Eco-friendly Concrete

Using waste ferrochrome ash

Demand for concrete is increasing in India. Concrete is a composite material

composed of coarse to fine aggregates joined together by a cementing material. Lime powder was used as a cementing material in many historical monuments. Now-a-days, ordinary portland cement is widely used in general concrete construction. Limestone and clay are the major raw materials in producing portland cement.

In the recent years, industrial wastes and by-products such as fly ash and ground granulated slag are used as a supplementary cementitious material in making concrete. This reduces the use of portland cement and is also an effective way to make use of the industrial waste.

Researchers from the KIIT and the VSS University of Technology in Odisha are now suggesting the use of ferrochrome ash as a supplementary cementitious material for concrete. Ferrochrome ash is a dust generated as a waste material from the gas cleaning plant of ferro alloy industries. The researchers experimented with a nominal mix proportion of 1 part portland cement, 2 parts of fine aggregates and 4 parts of coarse aggregates, with a water to cementitious materials ratio of 0.45. Cement part was substituted with ferrochrome ash ranging from 0% to 40% and 7% lime, partially replacing the portland cement up to 47%. They also checked the mechanical properties and durability of cement mixtures with varying proportion of ferrochrome ash for periods ranging from one month to three months.

The mechanical properties and durability of the samples improved with increasing ferrochrome ash compared to control concrete sample. Microscopic examination of concrete samples further substantiated these findings.

The researchers also tested the effect of possible groundwater pollution on these mixtures since the ash materials were likely to contain large quantities of chromium and other toxic materials. Results show the contaminant levels are much lower than prescribed limit and will have no adverse impact on environment.

Thus concrete made with this mixture and lime can be a good alternative to reduce the dependence on portland cement while using up industrial waste.

J. Cleaner Production V, **131**, 237–246

Going Zero Waste

Recycling Sunflower By-products

Sunflower is one of the most cultivated crops around the world. While sunflower seeds represent the fourth major source of vegetable oil in the world, the heads, stalks, and leaves remain unused. After harvesting the seeds, they are burnt, usually, under not well-controlled conditions. This produces atmospheric pollution. About 5 tonnes of dry matter waste residue is produced from every hectare of sunflower fields. Thus, the attention of the scientific community is now oriented to the revalorization of wastes after sunflower harvesting. A research team from the Mahatma Gandhi University, Kerala joined hands with scientists in Italy and Spain to propose that sunflower stalks could be an economical source for cellulosic materials.

Cellulose nanofibrils are extracted from sunflower waste by steam explosion. And cellulose nanocrystals are extracted by hydrolysis. The nanocrystals, 150–200 nm in length and 10 nm in diameter, could be extracted with a high yield of 21%. Chemical characterization revealed that cellulose nanocrystals had a cellulose II structure and nanofibrils were cellulose I.

Scientists made gluten nanocomposite films with the nanofibrils and crystals by solvent casting. Investigations highlighted that gluten based bio-nanocomposites showed a homogenous morphology. The different morphology and consequent dispersion of the cellulosic materials into the gluten matrix also affected the barrier properties of the composite.

The presence of carbon nanocrystals was more efficient in reducing the permeability to gases, due to their ability to increase the path of gas molecules. But the presence of some nanofibril agglomerates, as shown by optical microscopic images of Gluten-CNF based systems, negatively affected the barrier properties of these formulations, especially with oxygen.

The study proposes recycling sunflower waste since sunflower stalks exhibit encouraging potential as nanofillers for polymer matrices.

Carbohydrate Polymers, **149**, 357–368

Ashes and Plastic

New recipe for shaping plastics

Plastics can be molded into any shape upon heating. To improve the efficiency of this process, fillers are frequently added to molten plastic which help shaping it. Scientists are now studying different additives for their shape changing ability. Among the available fillers, fly ash is an attractive option since it is inexpensive and readily available. But it requires surface treatment before incorporating in polypropylene. Besides, not much is known about polypropylene–fly ash composites.

Last fortnight, Mahanwar from the Institute of Chemical Technology, Mumbai, reported success in improving the properties of plastic using coconut treated fly ash.

Coconut water has been used to generate nanoparticles in the past. In their study scientists used it to reduce the size of the filler. Fly ash was soaked in coconut water for 24 hours before it was compounded with different quantities of polypropylene at high temperature. Both treated and untreated fly ash was used to form pellets which were characterized by spectrometry and X-ray diffraction to examine any structural changes.

The scientists then studied the melt properties of the pellets – the viscosity of samples was determined over a wide range of shear rates and angular frequencies. These were compared with polypropylene composites containing titanium nanoparticles.

Results reveal that coconut water treatment is able to generate fly ash particles of the order of 2 μM that could be easily dispensed in the polymer matrix. The coconut water treated variant demonstrated abrupt change in complex viscosities even as the untreated fly ash composite displayed gradual rise in viscosity.

The study suggests that surface treatment of fly ash promotes better coupling between the filler and the polymer which can effectively reduce the melt temperature. This would reduce costs involved in molding plastics and also make the process more efficient.

J. Applied Polymer Sci., **133**(36), 43900

In Search of Cysteine

Thiols are sulfhydryl-containing molecules which participate in several environmental and biological processes. Selective detection of thiols is vital in basic research and diagnosis of diseases. Cysteine, for example, is a thiol-containing amino acid. It takes part in essential metabolic pathways in biological systems and serves as a precursor for many biological molecules. Most importantly, it plays a special role in maintaining the structure and function of proteins. It is no wonder then that cysteine is associated with several cardiovascular diseases, neurological disorders and so on.

Abraham John along with Kirthika Rani from Gandhigram Rural Institute, Tamil Nadu synthesized a fluorescent probe for the selective and sensitive detection of cysteine over other biothiols. The probe is based on a pyrene molecule containing α,β -unsaturated carbonyl moiety. The fluorescent probe exhibited optimal absorption at 374 nm and emission at 467 nm. Adding 2.5 nM of cysteine enhanced the emission intensity.

The fluorescent probe was able to detect cysteine in the presence of a 250,000-fold higher concentration of other common interferents. The minimal cysteine required for detection is 10 pM/L ($S/N = 3$) with response time less than 1 minute.

The study is carried out under physiological conditions for diagnostic applications. The probe detected cysteine in blood serum samples. Cell permeability and selectivity of the probe are confirmed in HeLa cells.

Biosensors and Bioelectronics,
83, 237–242

Designs for Phenolics Extraction

Extraction of secondary metabolites

Extraction, quantification and isolation of compounds of interest are major processes in pharmaceutical industries. Inefficient extractions lead to large quantities of waste. This issue demands attention in today's context, where raw material availability is often a limiting factor. Smarter resource management would enable efficient use of the available stock.

There are various factors that influence the extraction processes. The procedure of addressing one factor at a time, is time consuming. The interactions between the factors often go unnoticed.

Tarun Belwal and colleagues from G.B. Pant Institute of Himalayan Environment and Development tested designs to optimize the extraction of phenolics of *Berberis asiatica* fruits.

They adopted a design termed Response Surface Methodology to achieve optimization. This method uses different experimental parameters to maximize responses. It defines effects of independent variables, and also the interaction effects.

They selected varying temperature, time, solvent ratio, pH and solvent dilution as variables and analysed the concentrations of compounds under different conditions. The scientists then fitted the results into linear, quadratic and interaction models.

They find that the quadratic model fitted well for all the responses. Temperature, solvent ratio and solvent dilution affect the responses. The optimal conditions for obtaining high yield of phenolics are a solvent ratio of 1 : 50; pH 3.0; 80% methanol heated at 80°C for 30 minutes. The predicted values matched the experimental results!

This methodology thus has improved accuracy in predicting models and optimizing extraction conditions for phenolics. It adopts a strategy of simultaneous maximization of many parameters to minimize loss of material. An increase in yield during extraction is the goal for large-scale industrial applications. This could find use especially in Traditional Systems of Medicine which heavily rely on extraction of compounds from medicinal plants.

J. Food Chem., **207**, 115–124

Sensor for Pesticide Detection

Antibodies for parathion

Parathion – a commonly used insecticide – is toxic to humans. At high concentrations, it can meddle with the nervous system and cause headaches, nausea, muscle twitching and shortness of breath. Such instances are becoming more common due to its unregulated

use and its tendency to persist in the environment. Most methods used for its detection are cumbersome and not suitable for field applications. Deep from Central Scientific Instruments Organisation, India partnered with the Hanyang University, Korea, to develop a cost efficient method for on-site detection of this insecticide.

Deep and his team made use of screen printed electrodes as starting material for their sensor. They coated the electrode with graphene sheets which were later functionalized with 2-amino benzyl amine to introduce free amine groups. These free amine chains were used to link the insecticide specific antibody to the sensor. The design is such that the fixed component of antibody is used for linking while the variable portion is free to interact with the insecticide.

After the electrode was thus modified, it was used to detect parathion in test samples over a wide concentration range. To check for interference from other biomolecules, the scientists spiked fruits and vegetables with parathion and used the sensor to detect its presence in their blended supernatants. All results were validated through gas chromatography to check the quantification efficiency.

The study shows that the sensor can detect extremely small quantities of parathion. It can also maintain specificity for the target even in the presence of other common insecticides. Since the sensor is cheap and easy to use it can serve as a vital tool for regulating the use of parathion in agriculture. Scientists are confident that a similar strategy could also be extended for the detection of other toxicants for field applications.

Biosensors and Bioelectronics,
83, 339–346

Recovering Gold from Electronics

Gold is an inert metal with high electrical conductivity which makes it an important component of electronic circuits. The large build-up of electronic wastes can, therefore, serve as a secondary source for this precious metal. However, methods for gold extraction are non-selective and can cause leaching of other metals. Even partial

separation of gold from the leachate requires cost intensive techniques. Recently Chhavi Aggarwal, a researcher from the Bhabha Atomic Research Centre, has devised a way to separate gold from this mixture by using ion exchange membranes.

The scientists used a method called Donan exchange which involves the use of salt for ionic separation. But instead of using commercially available ion exchange membranes, the researchers constructed pore-filled membranes to promote the transfer of target ions. For this, the researchers grafted monomers onto a micro-porous host membrane which was tested for selective transport of gold ions between two compartments – one housing ionic gold solution and the other containing sodium chloride. Once the experiment was set up, the scientists drew liquid from each compartment at regular intervals to quantify the amount of gold present in each chamber. The ion transport was studied both as a function of time and concentration across the membrane. To assess the efficiency of this method the researchers examined ion transport in the presence of copper and also by using actual metal solutions of electronic boards.

As much as 96% of the total gold ions present in the feed could be recovered through this method. Even

though the initial concentration of gold does not influence the ion exchange, the process could be made more efficient by increasing the salt concentration up to 0.5 M.

The process was unhindered even in the presence of 500 fold copper, suggesting that the method is highly selective. This method can serve as a low cost technique for the recovery of gold from electronic wastes.

J. Membrane Sci., **514**, 210–216

Digital Technology

Environmentally sustainable practices

Environmental sustainability of industries has been in the limelight for some time now. In the past few years, developments in the ICT sector have harmful effects on the environment. ICT industries are involved in environmental problems like natural resource depletion, greenhouse gas emissions and global warming. But are the people working in this sector aware of the issues?

A team of researchers led by Chugh from Central Queensland University, Australia studied the awareness level among Indian Information and Communication Technology professionals about environmentally sustainable practices and measures employed by their organizations.

They administered a web-based questionnaire to elicit data on demographic information, environmental sustainability awareness, environmentally sustainable practices and any interruptions in sustainable ICT practices.

They find that respondents aged 35 or more are conscious about renewable energy and had a greater understanding about e-waste. They are more concerned about their liability towards environmental issues. Organizations with more than 1000 employees are more aware and acquainted with environmental sustainability practices rather than smaller ones. Female professionals possess more knowledge on issues like greenhouse gas emissions, renewable energy and e-waste.

Improving awareness about sustainable information and communication technology practices can assist organizations implement different policies. This will lead to an increase in efficient environmentally sustainable work environments.

J. Cleaner Production, **131**, 435–446

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