

Science Last Fortnight

One-Step Forward

Meteorological forecasting

Much of the uncertainty in weather forecasts is because models miss out on local feedback. Though this feedback is small, it affects mesoscale circulation in the region. Local flows, such as slope winds, impact the atmospheric flow. These local flows are sensitive to radiative changes. This, in turn, influences the boundary layer and regulates the convective system.

Now scientists from the Indira Gandhi Centre for Atomic Research, Kalpakkam, report a study using a numerical model which factors in these local parameters. The team reconstructed the small scale atmospheric conditions of Gadanki, Andhra Pradesh, and examined topographic flows for monsoon and winter 2011.

They used a modelling system that accounts for the influences of local topographic effects. The model showed stronger slope winds in winter and weaker ones in monsoon. And higher prevalence of slope winds at night.

The researchers compared their results with instrumental observations such as the ultra-high frequency wind profiler. The results from the model match simulations from other models. However, since they studied local factors, their results are more detailed.

This high-resolution forecasting system can accurately predict boundary layer features. Since wind systems play an important role in transporting and diffusing pollutants, this model can be useful to forecast air quality over a region.

This high-resolution model can forecast weather down to city level. A small step, but one that makes weather forecasts more reliable and relevant.

Atmos. Res., **185**, 101–117

Aerosol Carbon

Seasonal variations impact health

Air may look immaterial but every breath you take includes tiny solid particles and droplets! These specks of matter, aerosols, have major impacts on climate and health.

Aerosols are complex mixtures of carbon, sulphates, nitrates and minerals. When aerosols increase in the atmosphere, solar radiation reaching the surface and, consequently, crop yield also reduces. Aerosols also lead to persistent haze and fog events, and impact weather patterns and health.

Scientists from the VSSC, ISRO, Thiruvananthapuram, and from the Deen Dayal Upadhyaya Gorakhpur University collected *in situ* aerosol light absorption data from August 2013 to July 2015. They quantified the mass of absorbing aerosols and their potential sources in the Indo-Gangetic plain.

Spectral absorption analysis reveals a four-fold enhancement in absorption at UV wavelengths in winter and post-monsoon seasons. This indicates a proliferation of brown carbon from biomass combustion. During other seasons, spectral absorption at UV is relatively weak, indicating a higher black carbon level in the atmosphere, contributed by industrial combustion. Thus seasonal variation in absorption patterns suggests a shift in fossil fuel to biomass burning at different times of the year.

Wind conditions and the scavenging effect of monsoon rains also influence local seasonal aerosol concentrations.

Long-term measurements of aerosol physicochemical and radiative properties will enhance our understanding of the complex aerosol system over the Indo-Gangetic plain and its climatic implications. The recent Winter Fog Experiment of the Ministry of Earth Sciences will help us predict the effect of aerosols on climate and air quality. This would also be useful to make informed decisions on how best to respond to changing aerosol concentrations.

Atmos. Res., **185**, 13–21

Stable Oil for Deep Frying

Deep frying is a popular method of cooking. It makes food tasty! However, frying changes the oil. It can make it harmful. Oxidative and hydrolytic deterioration takes place. Toxic compounds are generated and accumu-

late in fried foods. This affects their nutritional quality and shelf life.

Rohit and team from IIT Kharagpur, took a chemometric approach to develop a sunflower oil blend which is stable when heated. Sunflower oil is a healthy choice as it has balanced amounts of saturated and mono-unsaturated fatty acids.

The scientists mixed fresh lots of sunflower oil with oleoresin and ascorbyl palmitate in different combinations.

Potato was deep fried in 18 litres of oil. At the end of each day, the oil samples were cooled down to room temperature and covered. The increase in the contents of total polar compounds and polymeric compounds was proportional to frying time.

The researchers checked the frying stability of sunflower oil blends with different levels of oleoresin and ascorbyl palmitate. The chemometric analysis approach gave consistent and reproducible results. About 1300 mg/kg of rosemary oleoresin and 130 mg/kg of ascorbyl palmitate gave the best results. Potato deep fried in the sunflower oil formulation was stable.

Even though the study used sunflower oil, the approach may be applied to develop other edible oils that are stable during deep frying.

Food Chem., **218**, 496–504

Bacterial Products as Food Additive

Microbial exopolysaccharides have applications in the food and pharmaceutical industries. Technologies for microbial production are well developed and, therefore, commercially viable. Studies increasingly focus on bioprospecting new exopolysaccharides and applications. However, we still lack detailed understanding of existing and commercially established exopolysaccharides.

Andhare and Pathak from the P.D. Patel Institute of Applied Sciences, Gujarat, along with researchers from France, isolated an exopolysaccharide producing bacterium, *Rhizobium radiobacter* CAS, from curd. NMR and FT-IR of the exopolysaccharide from

R. radiobacter revealed that it is succinoglycan.

Succinoglycan is already commercially valuable and marketed under various trade names. It is used to thicken, gel, stabilize and emulsify. Its rheological behaviour, therefore, becomes significant for industry. Hence, the researchers investigated the rheological properties of the extracted exopolysaccharide in aqueous solution.

The viscosity of the solution is proportional to exopolysaccharide concentration. An inoculum concentration of 6% was best for producing viscous exopolysaccharide. The product extracted from *Rhizobium radiobacter* CAS showed better viscosity than other commercially available products.

The extracted exopolysaccharide displays pseudoplastic behaviour, typical shear thinning nature and can resist several thermal cycles, temperatures, pH ranges and electrolytes at wide ranges of concentrations. This makes it attractive to food industries.

Rhizobium radiobacter CAS grows fast even in a minimal medium. It is an efficient microbial cell factory for succinoglycan synthesis. The researchers are confident that it will find immediate application in food, cosmetic and pharmaceutical industries.

Food Hydrocolloids, **64**, 1–8

Quality of Barley Flour

Lowered by bioactive compounds

Nearly 1.75 million tonnes of barley is cultivated in India. However, in comparison to wheat, barley has found limited use as food in India. The presence of bioactive compounds and non-starchy polysaccharides should, in principle, make barley attractive to consumers. But unlike wheat flour, which lends itself to the preparation of a variety of culinary delicacies, barley flour finds very few takers.

Last fortnight, Jeessy Moja and Hardeep Singh Gujral, from the Department of Science and Technology, Guru Nanak Dev University, Amritsar, reported a clue to solve the problem. They subjected hullless barley cultivars to roller milling and found that this results in less than 50% of refined flour. This may be due to the influence of non-starch polysaccharides on barley milling behaviour.

They evaluated the bioactive compounds of milled fractions. β -glucan, which plays a vital role in diabetes and cholesterol control, is one of the major attractions of barley. But the presence of greater levels of β -glucan in whole barley flour and bran of high altitude cultivars affected the refined flour inversely.

Cultivars with higher β -glucan and arabinoxylan content displayed greater levels of starch damage during the roller milling process. Higher levels of non-starchy polysaccharides affected the flour yield negatively leading to low flour extraction rates.

β -glucan is distributed throughout the aleurone and endosperm rather than being confined to outer bran. However, non-starchy polysaccharides, anthocyanin and total phenolic contents are higher in the bran fraction. So, removing bran before milling improves the flour yield. But at the same time, it reduces the nutraceutical value of barley.

The scientists found that treatments prior to milling also affect the outcome. Amongst all treatments, conditioning grains to a moisture content of 14% for 30 minutes was found to be the best to improve the flour output from milling.

Food Chem., **218**, 137–143

Safer Renal Transplants

Enterocytozoon bieneusi

Kidney transplantation is the treatment of choice for end-stage renal disease. But infection after transplantation is a major risk. The immunosuppressive therapy carried out among kidney recipients makes them more susceptible to infection. *Enterocytozoon bieneusi* is the most common microsporidia, causing intestinal infection in renal transplant recipients.

Spores of *E. bieneusi* have been detected among animals, birds and humans worldwide. However, the transmission route of *E. bieneusi* among renal transplant recipients in India is still a puzzle.

Sonali and team, from the Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, examined *E. bieneusi* genotypes among renal transplant recipients in India. They analysed the genetic diversity of *E. bieneusi* and inferred the phylogenetic relationships

and the transmission of different genotypes among infected hosts.

The scientists examined stool samples of RT recipients infected with microsporidia for species identification. Using internal transcribed spacer sequencing, they identified eight genotypes, including four new genotypes.

Then they analysed the phylogeny of genotypes and revealed that genotypes Ind1, Ind5 and Ind6 were clustered with zoonotic genotypes D and L. These genotypes could, thus, have been transmitted from animals to humans. This supports the potential of the zoonotic route of *E. bieneusi*.

Genotypes Ind2, Ind3, Ind4, Ind7 and Ind8 showed close sequence similarity to genotypes reported exclusively from humans. Therefore, these genotypes could have been transmitted via the anthroponotic route.

The study throws light on the zoonotic as well as the anthroponotic transmission of *E. bieneusi* among renal transplant recipients through the faecal-oral route. Extreme hygiene may, perhaps, be one method to avoid infection with *E. bieneusi*.

Acta Parasitol., **62**(1), 63–68

In Times of Epidemics

Vaccine + treatment = cost reduction

Ebola, dengue, chikungunya, encephalitis... Epidemics elicit fear. Diseases bring pain, dysfunction and loss, both personal and financial.

There are two strategies to tackle epidemics: vaccination and treatment. Which is better? Anuj Kumar and Prashant K. Srivastava, at the IIT Patna, used a mathematical model, SVIR – Susceptible, Vaccinated, Infected, Resistant – to compare these strategies, alone and in combination.

Using numerical simulations, the researchers tested the impact of each strategy on disease dynamics and associated costs: cost due to disease, cost involved in vaccination as well as cost of treatment and related efforts.

The strategy of combining both vaccination and treatment was most cost effective in lowering disease prevalence during epidemics. It also helps monitor the infective population.

Commun. Nonlinear Sci. Numer. Simulat. **44**, 334–343

Healing with Fish Skin

Collagen for wound healing

Although collagen-based wound dressings have been around for a while, they do have a few drawbacks. Commercially available collagen is mostly derived from terrestrial animals, making it susceptible to prion infections. Moreover, collagen, being proteinaceous in nature, is host to a wide variety of microbial infections.

Recently, scientists at the CSIR-Central Leather Research Institute, Chennai, isolated collagen from starry puffer, a marine fish.



Collagen was homogenized and freeze dried to prepare a collagen 'sponge'. It was then impregnated with ivy gourd extract. Ivy gourd is known to possess antioxidant and antibacterial properties. This combats microbial infections.

The researchers then examined the physiochemical and biological properties of this spongy material. They tested its biocompatibility by allowing keratinocytes and fibroblast cells to grow on it. The spongy material was found to promote cell-cell adhesion and also increased cell viability.

In vivo studies show that the spongy material could accelerate healing by increasing the expression of growth factors responsible for the synthesis of collagen. The dressing substrate was also found to possess requisite mechanical properties. The researchers are optimistic that their work can prove to be the future of collagen-based wound management.

Mat. Sci. Engg C, **72**, 359–370

Genetic Diversity = Host Specificity

The case of Trypanosoma evansi

Trypanosoma evansi is a widespread pathogen. It causes a disease, *surra*, transmitted by insect bites.

Trypanosomes use a transferrin receptor to uptake host iron biomolecules for growth and multiplication. The typical symptoms are fever, anaemia, loss of appetite and weight loss. *T. evansi* infection is responsible for morbidity and mortality in animals around the world and is included in the list of noticeable diseases by the World Organization for Animal Health.

Scientists from the ICAR-National Research Centre on Equines and the Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, examined genetic diversity among *T. evansi* isolates from the Indian subcontinent. The researchers collected *T. evansi* from infected camel, cattle, donkeys and ponies in Haryana, Gujarat, Rajasthan and Uttar Pradesh.

The team observed a variation of about 17% in the nucleotide sequence of the transferrin receptor-encoding region. And up to 31% variation in the amino acid sequence. Analysis of the Indian variants of the region and their respective clade position presented a host-specific distribution. This indicates homogenous parasite population in each animal host species.

Such studies are useful in sub-typing *T. evansi* isolates in India and also for understanding the virulence pattern of the subtypes. Moreover, the sequencing data from Indian isolates might find applications in designing primers for diagnostics.

Acta Parasitol., **62**(1), 133–140

Disability in the Elderly

Functional disability is an emerging concern as the world greys. The inability to carry out daily activities normally affects the quality of life of the elderly. Disability studies indicate that India has the highest prevalence of functional disability among older adults in Asia.

To understand the possible predictors of functional decline among older adults, Arti and Yashoda, from the Pune University, conducted a study in 2011–12 and 2013–14. The study covered 1140 adults, aged 60 and above. The researchers administered a functional ability assessment tool, designed for the purpose, to capture changes in the ability to perform daily living

tasks. The tool assessed lifting, walking, climbing, arising from bed/chair, toilet use, dressing, self-cleaning, eating, squatting, bending, etc.

The respondents were classified into two groups, based on a four-point scale. Simple frequencies and chi-square tests were used to identify the significance of associated factors. The scientists also used binary logistic regression models to extract factors that can explain increased disability.

A follow-up survey showed an increased level of chronic illness from the baseline.

Hospitalization, irrespective of cause and duration, was identified as a major factor for predicting functional disability. The association between disability and chronic illnesses is well established.

Interestingly, there was greater functional decline among females. This may not be just due to biological disposition. Other social factors need to be taken into account to explain this gender disparity.

The results of the research indicate absence of adequate supportive services after hospitalization. The scientists recommend the introduction of affordable transition care services to reduce functional disabilities in older adults.

Arch. Geront. Geriatr., **69**, 151–155

Sugar Spent Wash

Low-cost cleaning technique

High pollution load makes spent wash from cane distilleries a threat to the environment. Physical, chemical and biological methods have been tried for treating spent wash. However, melanoidin, a coloured pigment found in spent wash, is, for example, not easy to remove.



Last fortnight, Dhanapal and Subramanian, from the Bannari Amman Institute of Technology, Tamil Nadu, reported devising a cost-effective biophysicochemical method for the removal of colour and other pollutants. They pre-treated the spent wash using sand filtration. To purify it further, they passed it through a modified chitosan hydrogel grafted banana pseudo stem, which they synthesized for the purpose.

The team then used marine cyanobacteria, *Oscillatoria boryana*, for decolourization and to reduce chemical oxygen demand. Then they removed the final traces of pollutants by electrolysis.

Scanning electron microscopy of the modified chitosan hydrogel showed a bulk distribution of pores that allows maximum adsorption of trace impurities. The researchers achieved a colour reduction of 97.2% in the visible spectrometry. They reported a net reduction of >99% in chemical and biochemical oxygen demand values.



They also studied the adsorption isotherm and kinetics of the adsorbates

and found a maximum adsorption on activated carbon and modified chitosan hydrogel banana pseudo stem.

The researchers claim that the treatment costs only 150 INR/m³ of spent wash to achieve a final COD of <100 ppm. They are confident that the low-cost and eco-friendly method will provide a solution for the safe disposal of spent wash.

J. Appl. Pol. Sci., **134**(9), 44546

Rising Industrial Mercury

Polymer for efficient removal

Mercury is a heavy metal which finds use in many industries. However, its disposal is tricky and a small fraction of the metal may leach and contaminate water bodies leading to severe health problems. Presently, there are many methods to remove mercury from water. But these are expensive and require sophisticated instruments. Recently, Tripathi and team, from the Midnapore College, West Bengal, fashioned Katira gum conjugates that can remove mercury ions from water more economically.

Poly N-vinylimidazole or PNVI hydrogels can complex with metal ions. However, they are insoluble in water and cannot function over a wide pH range. To remedy this, the scientists grafted the PNVI hydrogels to Katira gum – a natural polysaccharide. Next, these gum-hydrogel conjugates were precipitated, washed and complexed with sulphate ions to boost solubility and selectivity for mercury ions. The scientists then assessed the perform-

ance of the sulphated conjugates on mercury ion retrieval at different conditions of pH, temperature and ion concentration.

Electron microscopy shows that each step of chemical modification introduces new structural features in the Katira gum conjugates making them more soluble. The finished sulphate gum-hydrogel conjugates are soluble even in cold water. The conjugates are highly specific for mercury and show maximum activity at 40 degrees and pH 5.0. They take only about 2 hours for removing mercury ions to maximum potential, after which they can be regenerated by treatment with an alkali.

The conjugate can be used for up to three cycles before it loses 30% of its efficiency. Given the nature of synthesis and the low cost of the substrates, the scientists are confident that their polymer conjugate has potential to be developed as a low cost tool to remove mercury from water.

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