Current Science Reports

Lunar South Pole
Pre-sampling identifications

The lunar south pole is a targeted site for exploration missions. ARTEMIS, a NASA programme, plans a series of missions and human landings by 2024. The rim of the Shackleton crater, located at the lunar south pole, is an ideal site for exploration missions. The high regions of the crater have permanent exposure to sunlight to power solar systems for energy requirements. Moreover, there are deep craters, permanently shadowed regions, which are possible cold traps of water and other volatile materials. Imagine using solar power and water on the moon!
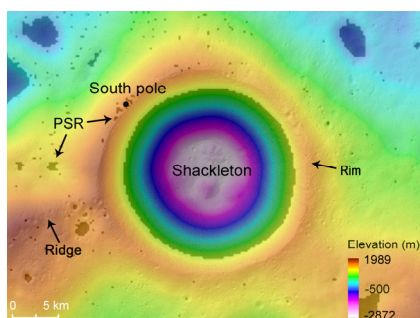

Image: Harish

But spending time on the moon, outside the spacecraft, is difficult. So the samples have to be collected within a short period. This requires detailed geographic and geologic information about the south polar regions.

A. V. Satyakumar from the National Geophysical Research Institute, Hyderabad and Harish from the Physical Research Laboratory, Ahmedabad have been collaborating with researchers from various universities and institutes in the US, the UK and Canada and now provide detailed information for potential exploration.

For topographic analysis, they used the Lunar Orbiter Laser Altimeter, which gave a detailed topographic map of five-metre resolution. The near-angle camera data from the Lunar Reconnaissance Orbiter provided a photogeologic interpretation of the Shackleton crater and its surrounding areas in the south pole.

There are large rocky exposures of up to 900 metres in the Shackleton crater close to the south pole, just below the crater rim and above the permanent shadow zone. These exposures are ancient crustal material. The opposite side has 10 to 50 metre thick-layered sequences. These sequences are the deposits of old materials, thrown out during crater formation. The high light-reflecting materials in the wall of the Shackleton crater are also good sampling sites.

The researchers identified small craters formed by the impact of materials ejected from the Shackleton crater. Some had intriguing features. The rock exposures are 20 to 200 metres in size and are good sampling sites. Boulder fragments from large rock exposures will also be easy to sample.

Using ArcMap software, the researchers generated hillshade and hill slope maps. They found that the average slope along the rim from the south pole to the ridge was 14.3 degrees, whereas the average slope along the ridge was 10.6 degrees. The researchers also measured the distance and climbing heights required to collect samples in the ridge.

'So, in a way, we can now reasonably estimate the time and effort needed by lunar explorers four years from now to collect the right kind of samples', says A. V. Satyakumar, NGRI, Hyderabad.

Plant–fungal Interaction
Cross-kingdom gene regulation

Plants and fungi have various types of relationships. While saprophytic fungi try to feed on live plants and become pathogens, plants slowly develop the molecular machinery to resist. Some fungi are important collaborators in plant growth and productivity, and some are even protectors of plants from pests.

To evolve such a diversity of interactions, plants and fungi must be able to modify and regulate the expression of each other's genes. How do the microRNAs of plants and the fungal equivalent, milRNAs, which normally regulate genes within a species, interact across kingdoms?

Such reports of trans-kingdom microRNA conservation prompted Narendra Kundoo and his group from NCL, Pune to predict milRNAs across fungal genomes and their possible targets with the help of bioinformatics.

A homology-based approach helped identify milRNAs in thirteen different fungi. Based on similarities reported between milRNAs from other fungi and microRNAs of plant and animal origin, they identified 262 milRNAs across these fungal species.

Of these, 209 milRNAs were highly conserved. But there were 15 milRNAs similar to those from plants, 36 similar to those from animals, and two similar to those from a virus. This implies the possibility of milRNA-mediated trans-kingdom regulation of gene expression.

What genes do these milRNAs target in their host? To identify the targets, the researchers compared gene sequences from the plant host with those of the milRNAs. Upon analysing the targets for fungal milRNAs, they found that these are required for fungal growth and development.

Do the microRNAs of the plant modify gene expression in fungi? The researchers computationally predicted potential targets of plant microRNAs in fungal transcriptomes. Plant microRNAs seemed to target genes responsible for fungal virulence.

The researchers followed up these findings by validating their prediction through expression analysis. First, they checked the expression of two chickpea microRNAs and their four targets in fungi. They found that the genes had a negative correlation, indicating that these genes contributed resistance to fungal pathogens. The expressions of plant microRNAs that target fungal genes further corroborated the idea of microRNA-mediated trans-kingdom gene regulation.

The team then checked a fungal milRNA and its six targets in chickpea using quantitative RT-PCR. They

found that all target genes showed either direct or indirect involvement in defence against pathogens. These genes might play a role in providing resistance against the pathogen, and might be regulated by the microRNAs.

These new insights into understanding microRNA-mediated plant-fungal interactions can lead to the development of microRNA-based disease-resistance approaches, say the researchers.

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Microalgal Extracts for Tomatoes
Seed treatment or foliar spray?

Chemical fertilisers and growth stimulants help increase agricultural output, but they have a negative impact on the environment. Recently, microalgal extracts have been reported to stimulate agricultural productivity, providing potential alternatives to chemicals. But which is the best technique – seed priming or foliar spray?

Researchers at NIT Rourkela reasoned that a consortium of microalgae would work better than individual ones. They experimented with a mixed consortium of microalgae containing *Chlorella* sp., *Spirulina* sp., *Scenedesmus* sp., and *Synechocystis* sp. collected from wastewater ponds. This algal consortium was grown in dilute human urine, and air-dried to get algal biomass.

The team dissolved the dried biomass in deionized water and ultrasonicated it to make microalgal extracts of varying concentrations containing bioactive metabolites. They soaked tomato seeds in these microalgal extracts for 24 hours, considering deionised water as control.

The team then germinated the seeds in pots containing coco peat. After three days, it was evident that all seeds treated with 20%, 40% and 60% microalgal extracts germinated whereas, in the control, germination was only 80%.

To check the effect of foliar spray, the researchers took tomato plantlets and sprayed microalgal extracts of varying concentrations on the leaves. To prevent confounding experimental parameters, they ensured that no droplets fell on soil.

After 20 days of incubation, the researchers compared plants grown with treated seeds with those whose leaves had been sprayed. Seed treatment proved better than foliar spray, they found.

Image: Karon Magwood

'Treating seeds with 40% algal extract is best. For foliar spray, 60% is optimum', says K. V. Supraja, NIT Rourkela.

'Nutrient-enriched microalgal biomass grown in wastewater can be used to improve agricultural productivity', says Bunushree Behera, her colleague.

'Unlike chemical fertilisers, microalgal extracts help increase crop yield without harming the environment or posing health risks', adds P. Balasubramanian, their supervisor.

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Processing Peanuts
Protection from aflatoxins

Peanuts are often contaminated by aflatoxins. To degrade the aflatoxins, different processes are applied. In India, peanuts are either roasted, fried or pressure cooked. Which is best for reducing the impact of aflatoxins on human health?

Manisha Dhanshetty and Kaushik Banerjee from the ICAR-National Research Centre for Grapes, Pune in collaboration with a researcher from the UK investigated the effectiveness of the three methods. They collected three naturally contaminated samples from a local market. The samples were fried in oil, pressure cooked and roasted using home appliances. Additives such as citric acid and salt were added during the processing.

The researchers standardised advanced chromatographic techniques to analyse the aflatoxins. This method helped them analyse aflatoxins in fresh and processed samples with high sensitivity. Two of the three cooked samples had lower aflatoxin content than the maximum permissible levels.

Among processing methods, roasting was most effective. Additives such as salt and citric acid further reduced the levels by 80%. Pressure cooking with these additives was also an effective decontamination technique.

The team carried out sensory analysis of the processed products. Again, roasting was ranked the highest.

So next time you pop a peanut, make sure it is well processed.

DOI: 10.1007/s13197-020-04761-3

Preterm Birth
Group B Streptococcus infection

Out of the 27 million babies born in 2010 in India, 3.5 million were premature. About 10% of preterm infants die in the first month after birth – accounting for nearly 40% of deaths before five years of age! So, infant mortality can be reduced by reducing risk factors of preterm birth.

A group of scientists and doctors from the Indian Council of Medical Research and the MGM Medical College in Mumbai investigated the role of Group B *Streptococcus* infection as risk factor for preterm births.

They analysed previously published works on Group B *Streptococcus* infection and preterm births in India from 1981 to 2019. Thirty-six papers fulfilled the criteria for a meta-analysis.

The papers contained data on more than 9700 pregnant women, and the incidence of streptococcal infections reported was nearly 8%. Compared to the incidence in other countries, infection rate appeared to be low among Indian women.

The low rate reported may be due to poor or even lack of compulsory screening for the infection, the researchers say. Among the 36 papers analysed, there were different techniques used for screening: traditional culturing, culture after enrichment, immunological detection, and detection by molecular techniques. While

the culture method detected 14%, the molecular technique showed a prevalence of more than 60%! So the method of detection also influences the reporting of the infection.

Even if fewer cases of infections are reported presently in India, it is not a reason to be complacent. The associated risk of preterm delivery is about 7 times higher than in those without infection.

The infection remains clinically asymptomatic in most women. However, the risk of preterm delivery and infection transfer to the baby during delivery are possible even in asymptomatic women. The babies are then at risk of neonatal sepsis, pneumonia, meningitis or seizures, and high mortality rates.

Image: Sathish Suganvanam

The screening of pregnant women for Group B *Streptococcus* and other vaginal microbes will allow rational usage of antibiotics as treatment during pregnancy. This is necessary to prevent antibiotic abuse and reduce antimicrobial resistance which is getting common in the population. At the same time the screening will help minimise the transfer of infection from mother to new-borns resulting in sepsis.

The Ministry of Health may take the cue from the meta-analysis and make sensitive screening for reproductive health feasible at all primary health centres as a step to reduce infant mortality in the country.

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Vitamin B12 Deficiency
Dietary habits

Vitamin B12 plays an essential role for nerve tissue health, brain function, and the production of red blood cells. Deficiency causes neurological and cognitive deficits even in adults.

In growing children, it leads to lifetime complications.

Bentu Kalyan from the Chacha Nehru Bal Chikitsalaya, Delhi and colleagues investigated the linkage between diet and the prevalence of vitamin B12 deficiency among children aged between 6 months and nearly two years. They tested the vitamin B12 levels of around 200 healthy children.

More than 37% had vitamin B12 deficiency. Even breastfed children were deficient in B12. This may be related to maternal vitamin B12 levels, say the researchers.

Early initiation of animal milk had a positive effect on the vitamin B12 status of the children. Fish, meat, poultry, eggs, milk, and milk products are major sources of this water soluble vitamin. Plant sources lack the vitamin, making deficiency a high risk for vegetarians.

Food habits are influenced by cultural, social, religious, economic and environmental factors. But consuming fortified foods and supplementation can easily prevent unfortunate consequences.

The researchers emphasise the need to start supplementing vitamin B12 among mothers and children during the weaning period to prevent any possible neurological consequences.

Concerned ministries and departments may need to formulate a systematic nutritional policy to address the issue.

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Bacteria-Textile Adhesion
Curbing nosocomial infections

Clothing of healthcare workers and hospital linens are sources of secondary infections. Nosocomial or hospital infections are a major concern due to increasing antibiotic resistance in microorganisms. Can the right textile for hospitals restrict such infections?

Shilpi Sharma, Deepti Gupta and team at IIT Delhi recently evaluated factors affecting the binding of bacteria on textiles. They selected and characterized six different fibres: cotton, polyester, viscose, wool, polypropylene and silk.

Initially they determined the nano-roughness of the fibres using atomic force microscopy. They found viscose fibres had the highest nano-roughness followed by polyester, cotton, wool, polypropylene and silk. Scanning electron microscopy revealed crevices in fibres where bacteria can adhere.

For determining the properties influencing bacterial binding on textiles, they selected four non-pathogenic strains of *Staphylococcus aureus*, *Acinetobacter calcoaceticus*, *Escherichia coli* and *Pseudomonas aeruginosa.*

Hydrophobicity, surface charge and biofilm formation influence the binding of bacteria. Based on bacterial adhesion to hydrocarbons and contact angle measurements, the researchers found that *Escherichia coli* exhibited the lowest hydrophobicity. Greater surface charge on bacteria discouraged adhesion on fibres.

By determining the bacterial load on the fibres after a dislodging step, they confirmed the lower adhesion of *Escherichia coli* to the fibres. *Pseudomonas aeruginosa* showed strong adhesion, attributable to its greater biofilm forming ability.

'Textile texture and bacterial characteristics both influence the adhesion pattern', says Swati Varshney, IIT Delhi.

'Our results indicate that silk should be preferred in hospitals, instead of cotton that is most commonly used now', says Shilpi Sharma. However, the economics of shifting from cotton to silk has to be worked out.

DOI: 10.1007/s12088-020-00903-5

Covid-19 Pandemic Lockdown
Online learning

The closing of educational institutions due to the COVID-19 pandemic created an unprecedented impact on the educational system. Teachers had to use online platforms. This was a sudden change in methods. What was the impact on students?

Researchers from the University of Gour Banga, West Bengal and Jawaharlal Nehru University, New Delhi assessed and analysed the impact of lockdown on undergraduate and postgraduate students from various colleges and universities in the region.

They used a Google form as questionnaire to survey students from 1 to 8 May 2020. Analysing the responses from 232 students, they found that around 70% were involved in e-learning during the lockdown. Most used platforms such as Zoom, Team, YouTube live, Skype, Google Meet/Hangout, Google Classroom and Whatsapp, on mobile phones.

The team found that the students suffered stress, depression, and anxiety due to the lockdown. Students from remote areas and marginalized sections were affected by lack of electricity and poor internet connectivity. Some also faced unfavourable study environments at home.

'Poverty aggravates problems in digital learning', says Ankita, University of Gour Banga, West Bengal.

The researchers advocate adopting open-source digital learning systems for online classes and a uniform academic plan. Adequate funding and infrastructural facilities must be provided to educational institutions for digital teaching and learning, they say.

Roadblocks for Solar Power
Delhi as case study

India has ample access to sunlight and thus the potential for developing solar power. Yet the uptake of the technology remains poor. Why?

Besides subsidies for solar energy from the Central Government, the State Government of Delhi launched a scheme in 2016 to promote rooftop solar systems, especially in housing societies with enough space to install solar panels.

The scheme has two models. In the first, residents of a housing society invest the entire capital expenditure for the installation: 2–6 lakhs after government subsidies, with free maintenance for 5 years from vendors. Solar power not consumed by users can be fed into the grid. The return of investment takes 4–5 years, depending upon the use of power.

In the second model, the company that installed the solar panels and equipment bears all costs with a documented financial assurance from consumers. Here the company retains the right to sell residents the power generated at a fixed rate for up to 25 years.

Theoretically, Delhi has the potential to generate 2 gigawatts of solar power using only about 1.6% of available roof space. Yet, despite the government's enthusiastic assumption and subsidies, there were very few installations, resulting in only 5 megawatts of solar power in the fiscal year. Why?

Image: Ale Spa

Dwarkeshwar Dutt from IIT Delhi took up the task of finding the factors. He did a thematic survey using a semi-structured interview with vendors, residential association members and officials involved in the scheme.

Dwarkeshwar found that the first problem was the cost associated with the scheme. In the first model, the high investment with low returns did not appeal to residents. The housing societies found the lack of finance from banks for the investment a second obstacle. Practically no bank was ready to back loans for solar power schemes. Vendors also voiced their concerns about the low cost of bidding which was not very profitable for them.

Not surprisingly, most housing societies expressed interest in the second model as there was zero investment. However, the issue of money remained a major block, albeit in a different manner. Here the residents pay for solar electricity at a fixed rate for 25 years. If the government reduces the conventional electricity cost for some reason, residents would be paying a comparatively higher amount. The notion that solar power is cheaper is lost in such cases. Thus, the second model also failed to take off.

The third factor was the lack of transparency and information dissemination between all three major players – consumers, vendors and government officials. Residents felt that vendors were not providing clear technical information. Vendors felt that the government should promote the various schemes widely. Vendors and consumers found the process for the subsidy very cumbersome.

'The responsibility falls mainly on government officials', says Dwarkeshwar Dutt, IIT Delhi.

Officials can instruct nationalized banks to finance solar projects in housing societies participating in the government scheme. That would resolve the issues. The officials can also provide timely platforms for consumers and vendors to discuss subsidy, bidding and paperwork. The government needs to clarify the scheme through media outlets so that people become conscious of their choices.

In any case, the government has to leverage on the available evidence to tweak the schemes and policies to promote solar energy uptake by housing societies.

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