Current Science Reports

Himalayan Caves

Traces along pre-historic silk route

In the cold and rugged topography of Ladakh nestle natural caves. In seven of these caves, researchers noted that a black, shiny material had coated the roofs. One cave, especially, was well covered with this charred, sticky, resinous matter.

The region once connected India to the ancient silk route – to China and Central Asia. These caves could have acted as refuge from the cold and the wind for shepherds and travellers ever since the glaciers there retreated more than 10,000 years ago. But when did this charred material get deposited?

Researchers from the Birbal Sahni Institute of Palaeosciences investigated the coating. They scraped off samples from the cave to analyse. They confirmed that the host rock was sandstone type. But the black charred material had graphitic carbon.

The material was mainly composed of sulphur and oxygen with a small percentage of sodium, silica, aluminium, calcium and carbon. Various aliphatic and aromatic compounds of carbon were also present.

Isotopic values established that the sulphur was from sulphate that came from human activities. The carbon came from plant sources.

'Polyaromatic hydrocarbons are released from small scale biomass burning under sub-optimum combustion conditions,' explains Amritpal Singh Chaddha.

Using carbon dating, the team found that the coating was more than 1800 years old. This may be when humans last used those caves.

'People must have burned wood and oil lamps in those caves,' says Anupam Sharma, BSIP, Lucknow.

The team also found pottery – a small Buddhist stupa and an earthen diya – in the cave.

Due to the challenging terrain, it must have taken days to go from one settlement to another.

'These caves probably provided shelter on the journey to the silk route,' says Binita Phartiyal, BSIP, Lucknow.

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Wettest Place on Earth

Cherrapunji? No more

Cherrapunji in Meghalaya was considered the wettest place on earth for a long time. A team from IITK, labs under the Ministry of Earth Sciences and researchers from the UK now say that the wettest place has shifted to Mawsynram, kilometres away from Cherrapunji.

They collected data from 16 rain gauge stations spread over seven states across northeast India and analysed 119 years of rainfall, from 1901 to 2019. The data included Cherrapunji and Mawsynram, separated by 15 kilometres.

Pre-monsoon rainfall starts here by March and peaks during the summer monsoon. The amount of pre-monsoon rainfall is about half that of the monsoon. But 1973 witnessed a shift. Most stations showed negative trends in rainfall. The biggest decline in rainfall was during the summer monsoon and the smallest in winter. So the researchers considered this an epoch year for further analysis.

They assessed various factors that could be responsible. Indian Ocean and Arabian Sea temperature and moisture were major drivers, they found. During the monsoon, Atlantic and Indian Ocean temperatures decide the amount of rainfall. Equatorial winds mainly suppress rainfall. The Pacific and equatorial Indian Ocean surface temperatures also play a major role in influencing annual rainfall.

The researchers then looked into human influence on rainfall change, using satellite-derived land-use and land-cover data. Area covered by vegetation in this region has been decreasing by more than a hundred square kilometres per year in the last two decades.

'This could be a major contributing factor for the shift in rainfall patterns,' says Jayanarayanan Kuttippurath, IIT Kharagpur.

While natural forces are not yet easy to control, policies to regulate land use and land cover in the region are easy to implement.

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Maize Grain Quality

Balancing fertilisers and minerals

India is a major producer of maize. However, productivity is almost half the global average of 5.5 tonnes per hectare. Can we improve maize quality and productivity with a balanced application of various fertilisers? Would the benefits be sustainable?

There is a 46-year long-term experiment at Palampur, Himachal Pradesh where various fertilisation protocols are being tested on maize–wheat rotation. Soil there is slightly acidic and using lime was found to improve wheat production. A perfect opportunity for Anjali Thakur and other researchers from the CSK Himachal Pradesh Agricultural University, Palampur to test how different combinations of fertilisers, farmyard manure and lime affect maize quality and yield.

After harvest, the grains were dried to a constant weight so that water content variations do not impact results.

As expected, the lowest yield was recorded in plots where no fertiliser was applied. Adding lime with nitrogen, phosphorus and potassium increased yield by 37%. The team recorded 48% higher yield with highest starch content in grains when the recommended doses of nitrogen, phosphorus and potassium were used with farmyard manure. Using fertilisers with organic manure or lime significantly influenced total carbohydrate content over the sole use of fertilisers.

Omitting sulphur and potassium produced significantly lower crude protein, fat, and fibre content while applying nitrogen with sulphur increased their contents. Applying nitrogen, phosphorus and potassium, with zinc and lime separately, increased calcium and zinc content in maize grains.

'To improve the nutritional quality and yield of maize, use inorganic fertilizers with farmyard manure,' advises Anjali Thakur, CSK Himachal Pradesh Agricultural University.

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Pruning Coffee Cultivation Costs

Cyclic or rock-n-roll?

Coffee is a highly labour-intensive crop. Paying workers for planting and pruning comes to more than 60% of the total cultivation cost. The pandemic lockdowns further worsened things.

Recently, researchers from the Central Coffee Research Institute, Kerala came up with simple changes to tackle the problem.

Coffee plants are spaced for better sunning. Traditionally, decaying and thin branches are removed throughout the season.

The team experimented with modified pruning combinations for nine consecutive seasons. In modified pruning, the apex is first trimmed.

The researchers then tried a cyclic method where, after the plant reaches 12 inches, one sucker per year is allowed to grow at most three branches for three years. The first sucker of the first year is trimmed and allowed to grow a new sucker in the fourth year, leaving one branch to grow for a year and the cycle continues.

The team also tried a rock-n-roll model, growing plants in nine rows. When the plants grew to a minimum of 12 inches, they clipped suckers in the 1st, 4th and 7th row in the first year, allowing only 2–3 suckers per plant.

The researchers pruned plants from the 2nd, 5th and 8th row in the second year and the 3rd, 6th and 9th in the third year. From year four onwards, they went back to trimming rows from first year plants.

Cyclic and rock-n-roll pruning required less skill than traditional methods. The principle is to use vegetative young branches, chopping them off to create a better canopy for sunlight to penetrate.

High density planting with modified bush management reduced the need for skilled labour. And yet, it resulted in high yield. Are coffee growers listening?

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Ultraviolet on Turmeric

Enhancing medicinal properties

Ultraviolet radiations from the sun trigger stress in plants, affecting plant growth and yield. However, plants respond to ultraviolet rays by producing secondary metabolites to protect themselves. Can we use the radiations to improve benefits from medicinal plants?

Scientists from Banaras Hindu University, Varanasi tried short wavelength ultraviolet radiations on yellow and black turmeric.

One month after germination, one row of each species was exposed to light from UV lamps. And the team recorded transpiration rate, stomatal conductance, internal concentration of carbon dioxide and water-use efficiency.

In both species, physiological activities decreased due to UV rays. But when they checked the yield of essential oil from fresh rhizomes of both treated and untreated plants, they found an increase of about 16% in black turmeric and 9% in yellow turmeric.

Now, the team looked for the most active compounds in both plants. UV rays on black turmeric induce aromatic compounds. Yellow turmeric had more anti-cancerous compounds.

'Stress induces changes in secondary metabolites, altering the content and composition of the essential oil,' explains Deepanshi Jaiswal, BHU.

'Knowing how ultraviolet radiations affect plants can help increase industrial application,' adds S. B. Agarwal, her colleague.

Pharma industries can now help farmers improve the pharmacological properties of the raw materials.

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Green Cardamom

Drying, colour and aroma

The Food Safety and Standards Authority of India set standards for green cardamom in the Indian market: moisture level should be 12%, volatile oil 30 milligrams per kilo and surface colour should be green.

Conventionally, hot air convectors are used for drying. But what are the best conditions to retain the aroma and colour of green cardamom? Jatindra K. Sahu and team from IITD investigated.

'We plotted moisture diffusivity against temperature. The minimum energy required to initiate the drying process was nearly 35 kilo-joules per mole,' says Sushreesmita Mishra, IITD.

The fastest way to reach the standard moisture level was drying at 60°C, for 34 hours. But colour and aroma reduced.

To achieve standard surface colour and aroma, the team found 38 hours at 50°C best.

On hydro-distillation, they found that 1,8-cineol and α-terphenyl acetate are the major compounds that provide the typical cardamom smell. During drying, the amount of 1,8-cineol decreased whereas α-terphenyl acetate increased.

'Aroma increased with drying time due to the release of a large number of volatile components,' says Nitya Sharma.

'But with any further increase in drying time, the brightness of cardamom decreased,' says Nikita Sanwal.

'To achieve the recommended quality standards, and better price, farmers can dry cardamom for 38 hours at 50 degrees centigrade in a convective drier,' says Jatindra K. Sahu.

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Fermenting Pears

Kefir grains?

Pears, crisp and juicy, are powerhouses of phytonutrients and antioxidants. Juice from the fruits during seasonal glut can solve the problem of fruit spoilage. Storing pear juice, however, reduces the nutritive value due to chemical changes.

A search for different techniques to preserve the nutritional value of pears led researchers from the K. S. Rangasamy College of Technology, Tamil Nadu and colleagues from Lincoln University, New Zealand to kefir grains.

Kefir grains are a mixture of probiotic bacteria and yeast. Drinks fermented with kefir grains, especially milk, are consumed for their nutritional enrichment. Can fermenting pear juice with kefir grains help prevent the loss of nutrients?

The team extracted juice and whole fruit puree from fresh pears. They added equal amounts of water, mixed

in kefir grains and left the mixture to ferment for three days.

Usually fermentation changes the acidity and alcohol content. But the team found no such change in either fermented juice or puree.

Protein and mineral content decreased, but there was an increase in carbohydrates in fermented pear juice. Fermented puree, on the other hand, had increased carbohydrates and minerals.

Trained volunteers tasted the fermented juice and puree and found the juice more palatable than the puree.

The team then assessed antioxidant capacity and found that antioxidants decreased after fermentation. Phenolic compounds, such as flavonoids, terpenes and other phytonutrients, decreased in the fermented extracts.

Want the full benefits of pears? Eat or drink them fresh.

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Custard Apple Juice

Pectinase and algorithms

Extracting juice from custard apples is challenging. The juice is trapped within pectin, making it impossible to extract with a mechanical press. Why not use the pectinase enzyme to break up the pectin and liberate the juice, thought researchers from the Institute of Chemical Technology, Mumbai.

They added the enzyme to custard apple pulp at different concentrations and temperatures for different incubation times. After heating the puree to inactivate the enzyme, they filtered the clear juice.

Encouraged, they used two algorithms to optimize the juice for maximum yield and taste: response surface methodology and artificial neural networks coupled with a genetic algorithm. Artificial neural networks with the genetic algorithm predicted the best model. With an enzyme concentration of 3%, incubated for four hours at 50°C, custard apple yielded the maximum juice with good clarity and glucose equivalents.

Though juice from the optimised process had less vitamin C, it contained enough phenolic compounds and antioxidants.

Trained volunteers evaluated appearance, aroma, taste, mouthfeel and consistency. Most chose the juice from the optimised conditions but with a score of 6 out of 9.

'A lower score than we were hoping for. That may be due to the high temperatures used to inactivate the enzyme,' says Nikita Sanjay Bhatkar, ICT Mumbai.

'Our next step is to check custard apple juice shelf-life and improve the taste,' says Snehasis Chakraborty, her mentor.

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Neuroinflammatory Diseases

Agmatine for memory defects?

Some pathogens produce endotoxins like lipopolysaccharide, a potent inflammatory agent, that cause nervous system injury. Neuroinflammation in the hippocampus in the brain leads to learning and memory defects.

Agmatine, a metabolite of arginine, an amino acid, is known to cross the blood-brain barrier when given orally. And it reduces neuropathic pain. Can it reduce memory deficits caused by inflammation?

Researchers from three pharmaceutical institutes in Maharashtra teamed up to experiment. They gave lipopolysaccharide injections to groups of mice for one, three and seven consecutive days.

Seven mice from each group were then made to do the novel object recognition test. They had to explore objects in a box and remember them. Then, one object is relocated while another is replaced.

Mice with good memory spent time exploring new rather than familiar objects. But mice injected with lipopolysaccharide for 7 days scored low. Those injected for one and three days had no significant memory loss.

The researchers then used a set of seven mice for the Morris water maze test. The mice had to swim to platforms to get out of water and remember the route. One day, the platform was removed. Mice with good memory swam along a path to reach the platform. But memory, the researchers found, was affected in mice with the 7-day lipopolysaccharide dose.

Those mice were injected with agmatine and their memory improved in four days of treatment.

The team co-administered lipopolysaccharides and agmatine to another set of mice. Damage to nerves was reduced and the mice had better memory retention.

'Agmatine can help reduce learning and memory deficits caused by bacterial toxins,' says Shruti I. Dongare, Gurunanak College of Pharmacy, Nagpur.

'Agmatine at 40 milligrams per kilogram of body weight was better than lower doses,' adds Kishor R. Danao, Dadasaheb Balpande College of Pharmacy, Nagpur.

'But we need clinical trials before clinical application,' cautions Sachin P. Borikar, RC Patel Institute of Pharmaceutical Education and Research Shirpur.

This would be a necessary step since nearly 30 million people in India suffer from neurological disorders.

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Drug-induced Liver Damage

Coconut oil with phospholipids

Drugs, such as paracetamol, prescribed for fever and pain, are toxic to our liver. Phospholipids are hepatoprotective and are used for liver damage caused by alcohol. Virgin coconut oil has also been found to be hepatoprotective. The oil is made by cold pressing fresh coconut meat instead of copra. And oil is then extracted from the milk thus obtained. A patent has recently been filed for a product consisting of phosphatidylcholine and virgin coconut oil as a medicine for liver damage.

Researchers from the St Thomas College, Pala, Kerala, IISc Bengaluru and Glowderma Pvt Ltd, Mumbai tested this combination on paracetamol-induced liver toxicity in rats.

The researchers treated one group of rats with paracetamol, and another with paracetamol and the combination of phospholipids and virgin coconut oil.

After thirty days, they collected blood samples and analysed liver functional marker enzymes. Paracetamol-treated rats had higher levels

of the enzymes than rats treated with paracetamol and the combination.

Rats treated with the combination, they found, survive, regenerate and maintain liver cells even when challenged with liver damaging substances.

Thus the patent also survived tests with animal experiments.

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Osteoarthritis in India

Responses of rural patients

Osteoarthritis occurs when flexible tissue at the ends of bones wears out. It affects millions worldwide. There is no cure but symptoms can be eased.

Patients in urban areas can easily access medical care but in rural settings that is not possible. How do they cope, wondered Gitanjali Jethliya and Subhash Khatri from the Pravara Institute of Medical Sciences, Loni. So, they collaborated with researchers from Sweden to explore approaches used by patients in rural settings.

Using semi-structured interviews and questionnaires, they collected data from patients with the condition from around Pravara University Hospital and ten adjacent primary health care centres. The questions were open-ended and follow-up questions took details on how osteoarthritis impacted daily life and how the sufferers coped.

The researchers found that the disease is more common in women and prevalence increases with age. Quality of sleep was affected due to sudden locking of the knee and there was morning stiffness.

Medication temporarily reduced pain. Many turn to regular calcium intake or Ayurveda. Breaks during work and not sitting cross-legged helped.

Physiotherapy and exercises provided relief to some. So, physiotherapists can educate patients regarding best-practices to manage the disease and empower them to take positive action, say the researchers.

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Mental Health During Lockdown

ASHA brings hope to Ramanagara

After the onset of the COVID-19 pandemic, the people of Ramanagara district, Karnataka did not have easy access to health services due to lock down and travel restrictions. In such situations, the continuation of mental health services was disrupted.

Can community health services help people with mental illness during the pandemic, wondered C. N. Kumar from NIMHANS, Bengaluru. His team collaborated with the Department of Health and Family Welfare and Accredited Social Health Activists – ASHA – to tackle mental health issues in Ramanagara.

ASHAs are local women, trained to act as health educators and promoters in their communities. They provide information on health, nutrition, basic sanitation and hygiene. During the lockdown, these health activists, in coordination with the District Mental Health Program, made a list of 80 patients with mental illness.

They made medications available in primary healthcare centres. For those who could not travel, the brave women ensured the medicines reached them with adequate COVID safety measures. They counselled patients and, in some cases, connected patients with psychiatrists for consultations.

For these ladies, the pandemic meant more hours of work and personal risk. Yet, they rose to the challenge. However, some challenges remain. Overburdening these women may diminish the quality of services provided. The researchers suggest providing them adequate training in mental health, enabling them to use technology and mobile apps to liaise with doctors and specialists when the need arises.

Creating monitoring and evaluation systems for community health workers can help bridge the treatment gap and reduce the burden of mental illness, say the researchers.

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Removing Manganese and Fluoride

Using activated carbon from waste tyre

Manganese affects the central nervous system and fluoride can cause fluorosis. High concentrations of these elements in water are harmful. Adsorption using activated carbon has been tried for individual ions, but not for magnesium and fluoride together.

Saswata Bose and Tirathkar Mukharjee from Jadavpur University had a bright idea: make activated carbon from waste tyres piling up in cities. It will be highly porous. And, if we incorporate iron, it will convert manganese of high-oxidation number to low-oxidation number manganese, which will be easily adsorbed by the activated carbon. But the reactivity of iron is low. That can be overcome by adding cobalt to improve catalysis.

Mehabub Rehman got tyres shredded, removed fibres and metals and carbonised the product at high temperature. The team impregnated the resulting material with hydrated ferrous sulphate and cobalt dichloride to prepare bimetallic activated carbon.

Adsorption studies using 1.25 grams of the material per litre revealed that nearly 100% of manganese and more than 85% of fluoride can be removed in about half an hour, if the pH of the solution is about 2.

Tireless research makes even waste tyres useful!

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