

## Current Science Reports

### Riboflavin Fluorescence *Optical biomarkers in milk*

Milk is rich in proteins and contains riboflavin or vitamin B12. Riboflavin can bind to different proteins and has fluorescent properties. Any change in milk composition will alter riboflavin's binding properties. And these changes can be estimated using fluorescence spectroscopy.

Gaurav Pandey and Abhijeet Joshi from IIT Indore recently exploited the property as an internal bio-marker to assess milk quality. They collected milk samples from dairy farms near the institute and confirmed the purity of the samples. When checking for the stability of the samples stored at room temperature, the duo found that the pH dropped and proteins in the milk precipitated as the milk curdled. Riboflavin that was bound to the proteins also changed. Thus, pH and riboflavin were both useful indicators of milk spoilage.

The researchers dosed the samples with varying quantities of urea, a common milk adulterant. They found that riboflavin characteristics changed with the concentration of urea in milk. Thus, urea contamination could be evaluated with a good limit of detection, sensitivity and range. The researchers were able to estimate up to 10 times the acceptable level of urea contamination in milk – 70 milligrams per 100 millilitres.

The difference in absorption in fluorescence spectroscopy confirms that natural spoilage and adulteration indeed affect the internal riboflavin components in milk.

'We now need a portable and sensitive fluorescence spectrometer to implement the concept for real-time sensing,' says Abhijeet Joshi.

Using riboflavin as an optical biomarker to monitor milk quality is relatively simple, quick and cost-effective. It can be integrated into processing plants or testing laboratories.

DOI: 10.1016/j.foodchem.2021.129742

### Preventing Shrimp Spoilage

#### *Using lemon and pomelo extracts*

Shrimps contribute to nearly 70% of total revenue from the Indian seafood

export. However, shrimps have limited shelf life and, within a week, undergo melanosis: they turn blackish and release a foul odour. This leads to huge economic losses for the industry.



Image: Pinay06 via Wikimedia Commons

Chemical preservatives can increase shrimp shelf life but are carcinogenic above certain limits.

Preetham Elumalai and team from the Kerala University of Fisheries and Ocean Studies, Kochi recently came up with a natural alternative: the peels of citrus fruits, a rich source of antioxidants.

The team prepared ethanolic extracts of lemon and pomelo peel and screened the extracts to confirm the presence of tannins, saponins and flavonoids – major antioxidant groups. Using gas chromatography–mass spectrometry, they identified 40 different compounds in lemon and 28 in pomelo extracts.

To confirm the antioxidant activity of the extracts, the researchers used various assays and found that the lemon and pomelo extracts could scavenge significant amounts of free radicals.

'Lemons have nearly double the antioxidant potential of pomelo,' says Ajeet Soni, KUFOS, Kochi.

Blackening in shrimps is associated with an enzyme, polyphenol oxidase. Can the citrus peel extracts inhibit the enzyme?

To check, the researchers cleaned and blended frozen shrimps to form a powder. The powder was mixed with buffers to make polyphenol oxidase extract.

Enzyme inhibition was checked by adding varying concentrations of lemon and pomelo peel extracts. The

extracts significantly inhibited polyphenol oxidase activity, thereby reducing the blackening of the shrimp powder. Lemon peel extracts were better than pomelo peel extracts at inhibiting polyphenol oxidase activity.

Next, the team investigated the effect of lemon and pomelo peel extracts on shrimp storage. They took shrimp samples, divided them into four sets and treated them with lemon peel extract, pomelo peel extract or a mix of lemon and pomelo peel extracts, keeping one set as control without any treatment.

The four sets of shrimps were stored for 15 days at 4°C by packaging in polyester laminated with polyethylene bags.

The team analyzed biochemical parameters, such as fatty acid content and peroxide content, to understand changes during storage.

Extract-treated samples inhibited undesirable biochemical changes, preserving the shrimps better.

'The combination of lemon and pomelo peel extracts in a 1:2 ratio gives the best results,' says Praveenkumar Pandiyan, KUFOS.

'Antimicrobial activity is also evident when shrimps are treated with the extracts,' adds Preetham Elumalai, a researcher at the lab.

An expert judging panel assessed melanosis and evaluated the stored shrimps after every three days of storage. The scores for treated shrimps were far better than those for untreated shrimps.

The lemon and pomelo peel extract-treated shrimps appeared good even after 15 days of storage.

Lemon and pomelo peels are waste from the fruit processing industry. Using their extracts can be a cost-effective and easy method for the seafood industry to preserve shrimps longer and to reduce spoilage losses.

DOI: 10.1111/jfpp.15952

### Chitosan Drug for SARS-CoV-2

#### *Targeting viral entry*

SARS-CoV-2 infects by attaching its spike protein to the angiotensin-converting enzyme 2, or ACE2, of cells

in our lungs and other tissues rich in capillaries. Normally, this enzyme protects cells against injury. But it also acts as a binding site for the new coronavirus.

The binding is facilitated by a mediator, a heparan sulphate glycoprotein, located next to the angiotensin receptor on the cell surface. This glycoprotein mediates the binding between the spike protein of the virus and ACE2. Why not target the heparan glycoprotein to inhibit the binding of the virus?

Researchers from NIT, Raipur, BITS, Pilani and NIPER, Hyderabad thought of chitosan derivatives as potential drug molecules to target the heparan glycoprotein. Chitosan, derived from the chitin shells of marine animals or from fungi, has many applications in agriculture and medicine. The natural glucosamine polysaccharide is fairly safe.

The researchers scanned the library of chitosan derivatives. Using heparin as positive control, they shortlisted derivatives with greater binding affinity than that of the virus-receptor. Using molecular docking software, they identified three best performing derivatives: N-benzyl-O-acetyl-chitosan, imino-chitosan and sulphated-chitosan. Computer simulations also revealed that these candidates had desirable drug-like properties.

Next in line will be *in vitro* studies of these potential derivatives. Pharmaceutical research companies may need to keep an eye on further developments on this front.

DOI: 10.1016/j.ijbiomac.2021.07.144

### **Cuttlefish Ink** *Protection for hair?*

Hair loses texture, strength and colour when exposed to prolonged solar radiation. As such, melanin pigments, in the inner cortex of hair, offer natural protection from solar radiation. Melanin also helps maintain structural integrity and resists the swelling of the hair fibre. This enhances strength and elasticity. However, the outer layer, the cuticle, is exposed to UV radiations which cause physical and chemical changes. These adverse effects can be minimized by applying sun-creams. However, synthetic sun-creams con-

tain toxic chemicals that cause side effects.

Cuttlefish ink is a rich source of eumelanin, very similar to melanin in human hair and skin. Why cannot we use it to protect hair from UV radiation, wondered researchers from ICAR-CIFT, Kochi.

To check, they collected cuttlefish ink from a fish processing plant, extracted eumelanin and kept eumelanin coated and uncoated hair in a solar simulator for 100 hours at 30°C. Then they compared the microstructural characteristics of the hairs. Eumelanin coated hair had smooth surfaces and had no breakages. Uncoated hair showed a distinct crack and cuticular exfoliation after UV treatment. The coating also minimized the oxidation of endogenous melanin to oxymelanin, caused by UV radiations.

'Oxidation of melanin causes fading, loss of brilliance and ageing of hair,' says Binsi.

'The cuttlefish ink sac is a part of processing industry waste. And its disposal poses problems. The problem can be solved to the economic benefit of the cosmetic industry. Cuttlefish melanin can be used as a photo protective agent in hair care formulations as a substitute for synthetic melanin,' says A. A. Zynudheen.

'Converting this waste into raw material for cosmetic industries can generate additional income to the fishing industry,' says Muhamed Ashraf, ICAR-CIFT.

DOI: 10.1002/app.51631

### **Non-invasive Monitoring** *Of haematological malignancies*

Haematological malignancies are cancers that affect blood and bone marrow. Treating such cancers with radiation has many side effects. We have no technique to detect such malignancies well in advance, before it gets too late.

Naga Prasad Puvvada from the Indrashil University, Gujarat has been working on nanoparticles to monitor cancer symptoms for more than a decade. Recently he collaborated with Canadian researchers to conceptualize a modified Raman spectroscopy to assess molecular changes in diseases.

Raman effects are very weak in intensity. The researchers worked around the problem using gold nanoparticles. Gold nanoparticles on the surface of cells produce billion times more intense spectra. This makes it very easy to identify spectral lines. This was difficult in normal Raman spectra.

The researchers made gold nanoparticles and mixed them with patient blood plasma samples. They used surface-enhanced Raman spectra to examine the samples at 514 nanometres of visible light.

Comparing the spectral features of samples from patients with and without haematological malignancies, the researchers identified features which could be used to identify potential cancer patients. This is a simple clinical-scale laboratory technique to identify haematological malignancies much before the disease reaches the threshold where it becomes incurable.

'The technique is non-invasive. Useful for identifying potential cancer patients from blood samples. A significant step in clinical biophysics towards rapid and early diagnosis,' claims the young researcher, Naga Prasad.

DOI: 10.2217/nnm-2021-0076

### **Classification of Pneumonia** *Using soft computing*

Identifying pneumonia caused by bacterial or viral infections during COVID-19 is essential for proper medication. The detection and classification of pneumonia using chest X-ray images are complex tasks for radiologists. Computer-aided detection of diseases using chest X-rays has shown promise. But most techniques require long computational time and have high computational load, limiting their application in clinical practice.

Shimpy Goyal and Rajiv Singh from the Banasthali Vidyapith, Rajasthan, have now worked around the problem to propose a method for early detection and classification of lung diseases using X-ray images with minimum computational overheads.

The researchers first enhanced the quality of the raw X-ray by adjusting image features.

Next, they used image segmentation techniques to extract the infected region.

Then the regions with identified infection were used to extract relevant features such as visual, textural, intensity and geometric moment features.

The image enhancement, feature extraction and normalization of the image minimized computational requirements.

The team used conventional soft computing techniques such as Artificial Neural Network, Support Vector Machine Algorithm and K-Nearest Neighbor Algorithm for classification.

They also applied deep learning methods for automatic detection and accuracy enhancement of lung diseases.

The researchers used 70% of the dataset for training and validation and 30% for testing accuracy.

They tested the models with two datasets, and found that the model using recurrent neural network with long short term memory showed the most effective performance.

'We can now distinguish viral pneumonia from bacterial pneumonia, with low computational load,' says Shimpy Goyal.

'Radiologists can make a trial with this method and validate the applicability in clinical settings,' says Rajiv Singh, her colleague.

DOI: 10.1007/s12652-021-03464-7

### **Biodiesel**

#### *From used cooking oil*

Vanadium is a good catalyst for hydrogenation – a reaction that is used for converting vegetable oils to biofuel to replace petroleum. But the catalyst and vegetable oils used in the process are not cost-effective enough for commercial production.

Reusable and eco-friendly heterogeneous catalysts derived from animal bones are more cost-effective and help in waste usage. Chicken bones and fish scales have already showed suitability for use as heterogeneous catalysts.

Now, Piasy Pradhan, Poulami Karan and Rajat Chakraborty from the Jadavpur University, Kolkata add waste duck bone to the list. They obtained waste duck bones and used rice bran oil from the local Jadavpur market.

Washing with hot water helped dislodge any remaining flesh from the

waste duck bones and washing with ethanol removed bone marrow.

After drying, crushing and grinding the bones to make a powder, they prepared a vanadium catalyst by impregnating the powder with ammonium metavanadate.

For biodiesel production, they filtered used rice bran oil to separate suspended solid matter and washed with hot water to remove any dissolved salts. Water and oil were separated later, using a high-speed centrifuge.

After simultaneous esterification–transesterification reactions using the vanadium catalyst on filtered rice bran oil, the solid catalyst was separated using vacuum filtration. The researchers compared the performance of the vanadium-impregnated duck bone powder and commercially available catalysts.

The life cycle assessment of the entire process showed that the naturally derived catalysts were superior to conventional counterparts.

'The catalyst could be reused for up to six consecutive cycles without any significant decrease in biodiesel production,' says Piasy Pradhan.

'The biodiesel and its blend with commercial diesel meet standard specifications,' adds Rajat Chakraborty.

Petrochemical industries can look forward to develop this into a technology for the industrial production of biodiesel from used cooking oils.

DOI: 10.1007/s11356-021-16482-x

### **Lead Nanostructures**

#### *Hydrogen fuel containers*

Hydrogen is the lightest fuel. But, on earth, it rarely exists in pure form. And it is hard to store in a canister. The challenge is to devise efficient ways to store the maximum amount of the fuel and to retrieve it easily when required.

Vivek and Raman Sharma, Himachal Pradesh University and Munish Sharma, Maharaja Agrasen University, Baddi explored the possibility of adsorbing hydrogen on plumbene, a new nanostructure of lead atoms, similar to graphene. They simulated the properties of plumbene using density functional theory, a form of computational modelling, to examine the possibility of hydrogen adsorption on plumbene.

Plumbene has a honeycomb structure and is more stable than graphene.

Out of three possible adsorption sites on the surface of plumbene, hydrogen molecules were most adsorbed at the hollow site, a centre space surrounded by six lead atoms. Adsorption energy values were low and, therefore, were reversible at ambient conditions of temperature.

The team then simulated the binding of more hydrogen molecules on other possible sites. They found that four hydrogen molecules per lead atom could be attached on one side of the plumbene layer.

The researchers successfully accommodated more hydrogen molecules on the other side of the plumbene layer without any desorption from the first side. Thus plumbene could store more than six kilograms of hydrogen per kilogram, which is higher than with other materials.

Simulating the effect of an external electric field on adsorption, the researchers found that a positive field, applied at one side, enhanced adsorption while a negative field leads to desorption. So an electric field can be used to easily switch between hydrogen adsorption for storage and desorption for retrieving the fuel.

Quite a few new technologies for hydrogen production have emerged recently. But storage and transportation still remain bottlenecks.

'Plumbene may be a potential contender for hydrogen storage at ambient temperature and pressure,' says Raman Sharma.

DOI: 10.1016/j.ijhydene.2021.07.159

### **Coping with Negative Emotions**

#### *During COVID-19*

The absence of social interactions during the COVID-19 pandemic has led to stress, depression, anxiety and mental instability at individual and community levels. However, so far, no proper approach has been established to deal with these negative emotions.

So, Vishal Pandey from the Delhi University collaborated with other researchers in India and China to survey how people were coping with the distress caused by the pandemic. Using Google forms, they collected about a

thousand responses from respondents of diverse ages, economic backgrounds, and levels of education.



Image: via pxfuel

The team selected worry, hopelessness and stress as well as outlook on career and economics. They considered variation from normalcy and social life as dependent variables. Factors that help cope – optimism, preparedness, emotional resilience, spiritualism and positive involvement – were also examined.

As independent variables, the team took entertainment, avoidance and social support. Changes in behaviour during COVID-19 were taken as dependent variables.

'Emotional resilience, social support and avoidance were significant factors for returning to normalcy.

Of these, emotional resilience was most important for controlling negative emotions and returning to normalcy,' says Amogh Talan, Delhi University.

'Social support was also crucial for controlling adverse changes in emotions,' says Mandeep Mahendru, State Bank Institute of Leadership, Kolkata.

'Avoiding thoughts and news related to the pandemic was most effective to control negative emotions,' says Vishal Pandey.

Government and non-governmental social welfare organizations may take these results into account while providing services.

DOI: 10.1007/s11356-021-16002-x

### Children in Malda Malnourishment risks

In Malda district, West Bengal, a series of deaths of children below five years was reported in 2013. The report sent shock waves throughout the nation. In 2017, the Government of India implemented the first phase of the National Nutrition Mission in Malda district to eradicate child malnutrition. What is the impact of the programme and what needs to be improved?

To investigate, researchers from JNU, New Delhi conducted a stratified simple random sampling survey in Malda district in 2018. Structured questionnaires were administered to mothers having at least one child aged 3–5 years.

The researchers also measured the height and weight of the children. Children were classified as normal, underweight, stunted and wasted, following WHO child growth standards.

Stunted growth was observed in 40% of children aged below 5. Children in rural areas were more prone to stunting than those in urban areas. Stunted growth was 6% higher in girls.

Babies born prematurely or babies with lower than normal weights at birth were more at risk of stunted growth. Low interval between pregnancies, malnutrition and age of pregnant woman, were found to be the other risk factors. Mother's education and occupation also were major factors that influenced the chances of stunting.

'Among these, low birth weight of a child and mothers who work as bidi workers rank as top risk factors for stunted growth in children,' says Rana, JNU.

'However, we can reduce child growth stunting by increasing breastfeeding duration,' says Rayhan, JNU.

'Increasing the interval between pregnancies can provide required nutrition for growth of a baby and reduce the chances of childhood stunting,' adds Anuradha Banerjee, JNU.

The district still has a high number of stunted children. Malnutrition is the main cause of child mortality in India. Policies related to poverty alleviation, education, health and family welfare need to be put into practice to reach the expected levels, say the researchers.

DOI: 10.1186/s12889-021-11704-w

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ACKNOWLEDGEMENT: NCPOR, Goa for access to scientific databases.

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