Science Last Fortnight

Ginger Extract in Biofuel

Traditionally, ginger is used in many dishes. It is also consumed in beverages such as tea. According to folklore, ginger is good for us. Research appears to support some of these claims. Many studies focus on its antioxidant properties: it counteracts the effects of stress.

A team of scientists from the Tezpur University now report that the antioxidant property of ginger extract could be useful in the production of better biofuels.

Biodiesels are renewable, and biodegradable. But their oxidation stability poses a problem. The scientists used the antioxidant activity of ginger extract to increase the oxidation stability of *Pongamia pinnata* biodiesel.

The antioxidant activity of ginger extract is due to the presence of phenolic compounds. Scientists identified these compounds using standard techniques. They tested the antioxidant activity of different concentrations of ginger extract on Pongamia biofuel.

The results show that a minimum doping of 250 ppm of ginger extract in Pongamia biodiesel improves oxidation stability and meets standard specifications. Lower water content and a higher proportion of non-polar compounds in the ginger extract increased miscibility in biodiesel and improved performance.

Ginger extract is a low-cost and easily available additive to enhance the oxidation stability of biodiesel. Ginger, it seems, is as useful to the fuel in engines as it is to our body.

Fuel, **187**, 306–314

Nanosensor to Detect Milk Spoilage

Milk is highly perishable. Milk spoilage is difficult to measure with accuracy as there are no rapid methods for the precise detection of spoilage. The only rapid method which is available is called as clot on boiling method, which is widely used. However, the method detects the milk spoilage when the milk is already spoilt and it cannot be used anymore.

In the last fortnight a research team in the Pondicherry Central University reported development of a method based on silver nanoparticles to detect milk spoilage. Researchers used the lactic acid concentration in the milk produced by spoilage bacteria and acidity leading to spoilage as an indicator.

The team used silver nano particles bio-functionalized with cysteine as the sensor. Cysteine acts as a conjugating agent for nanoparticles and lactic acid. In the presence of lactic acid, cysteine induces aggregation of AgNPs leading to a change in colour of the AgNP from yellow to orange red to purple.

This method can be used as a rapid method for the detection of milk spoilage at pre-spoilage point. Other available methods like dye reduction test take at least two hours. Further they cannot be conducted under field conditions.

This method does not need expertise in handling and gives instant results. It can be developed into a portable kit. An Indian patent application is pending on the invention.

LWT-Food Sci. Tech., **75**, 702–709

Kudos for Kodo Millet

Kodo millet – *Paspalum scrobiculatum* – is an annual grain grown in India, the Philippines, Vietnam, Indonesia and West Africa. It is extremely hardy and drought tolerant. It can survive well on marginal soils where other crops fail. Scientific study of kodo millet's nutritional values and health benefits is, however, very meagre.

In the last fortnight, Sakshi Sharma and colleagues from the Dr Yashwant Singh Parmar University of Horticulture and Forestry, Himachal Pradesh, reported their study that overcomes the problem. The researchers collected grains from different districts of Himachal Pradesh and used chemical tests and chromatographic analysis to determine the percentage nutritional values of kodo millet grains. They also tested the antimicrobial activity of some of the chemicals present in the grains.

Researchers find that kodo millet grains are nutritionally rich. They contain more carbohydrates than wheat, rice and barley. The grains have total phenols, 18 times more than wheat and barley. The antioxidant activity of the grains is greater than that of wheat, rice and barley. Moreover, the grains are rich in minerals like magnesium and potassium as well as fibre content. As kudo millet grains are gluten free, food articles made with them can also be used by celiac patients who cannot consume wheat and barley.

The crop is only cultivated in a few states of India such as Himachal Pradesh and Tamil Nadu, and is consumed locally. Promoting large scale cultivation will ensure greater availability of this nutritious millet. It would also benefit farmers in rainfed areas.

Food Chemistry, **214**, 162–168

Jackfruit Peel
Promising pectin

The humble jackfruit – *Artocarpus heterophyllus* – is one of the most common fruits in India. Hailed as the 'poor man's fruit', the jackfruit is a popular ingredient in pickles, candies, ice creams and various other desserts. An average fruit weighs more than 20 kilograms, but a large part of this consists of the inedible husk and peel. The peel often goes as waste, as no efforts were made till date to create value added products from it. This is what sparked the interest of Prakash Maran and his team from Tamil Nadu. The researchers tested and optimized a process to extract pectin from discarded jackfruit peels.

Pectin, a polysaccharide, finds uses in many industrial processes. It is a major component of jams and jellies, many drug capsules and also acts as soluble dietary fibre.

A steady supply of waste jackfruit peel was available from the local fruit centre. The team washed, cleaned and processed the peel before milling it to a fine powder. The powder was then mixed with distilled water before exposing it to ultrasonic waves. This Ultrasound Assisted Extraction procedure is fast and efficient.

The team optimized the process by determining the best temperature, pH, sonication time and the ideal liquid to solid ratio so as to maximize the yield. Extraction at optimal conditions gave a pectin yield of 14.5% in dried weight.

Pectin is currently extracted industrially from the peels of citrus fruits and apple pomace, both of which are by-products of the fruit juice manufacturing industry. As jackfruit peel is ubiquitous and locally available, its effective utilization can create more income for farmers and food processors while cutting down on wastage.

Ultrasonics Sonochemistry, **34**, 525–530

Sericulture Silk

Polyamines promotes production

Silk is the cynosure of all eyes, especially for women. The triangular structure of the fibre gives it a glittering appearance. Silk is hydrophilic and amphiphilic – both water and fat loving – very similar to human skin. So it is biocompatible. Its oxygen and water vapour permeability promotes its wound-healing capacity. Given the demand from various quarters, scientists have come up with new ideas for sericulture.

Many attempts have been made to increase silk production by feeding the larvae with compounds such as royal jelly, a secretion of honey bee, cowpea, a legume. Juvenile hormones that regulate the physiology of the insects have also been used for promoting growth. Now, a group of scientists from the GITAM Institute of Science, Andhra Pradesh and the Centre for DNA Fingerprinting and Diagnostics, Hyderabad, suggest that treating the larvae with polyamine is a cost effective way to increase silk production.

Polyamines are aliphatic amines without aromatic carbon rings. Polyamines transfer protons to bind DNA and RNA under physiological conditions of the cell. Polyamines can thus regulate cellular protein synthesis and promote growth of the larval cells.

Polyamine-treated larvae show better gain in body weight, shell weight and hence more fibre production in the cocoon. Parameters such as crystallinity, percentage elongation and fibre diameter of the silk fibres also increased. Moreover, moisture regain capacity of the fibre was comparatively less.

The results imply that polyamine regulated growth of silk larvae would be beneficial for sericulture farms and textile industries.

Biopolymers, **107**(1), 20–27

Silk Bandages

Chitosan-silk for wound dressings

Silk scaffolds promote cell proliferation and tissue regeneration. For this reason, scientists are exploring silk as wound dressings. Among the available varieties, Tasar silk is most efficient in promoting tissue regeneration. But to date, non-woven silk matrices of Tasar silk could not be developed. Recently Purwar and his research team from the Delhi Technological University, devised a method to create non-woven Tasar silk matrices and combine it with chitosan to serve as wound dressings.

The researchers used silk from cocoons which were degummed, chopped and treated with formaldehyde to produce non-woven mats. Next, they washed the mats to remove salts before combining them with different concentrations of chitosan. Chitosan is a biodegradable polymer possessing antimicrobial activity. It also promotes blood clotting and cell adherence. By combining non-woven Tasar silk with chitosan, the researchers created a film bearing ideal properties for wound dressing. They tested the film for these properties using diverse techniques.

Results show that addition of chitosan did not affect the crystalline nature of silk fibers – which is necessary for tissue regeneration. In fact, it could increase the tensile strength three fold. The developed films had adequate porosity, water permeability and water retention capacity. The chitosan-coated films were biocompatible and more efficient in promoting cell proliferation than silk fibroin alone.

Due to the promising results obtained, the scientists now plan to study the effect of their chitosan–Tasar silk dressing and compare it to the commercially available wound dressings to evaluate its suitability in clinical settings.

J. Appl. Polym. Sci., **134**, 44341

Wound Dressings get a Makeover

Bamboo-silver nano-constructs

Tissue regeneration thrives in the presence of moisture and gaseous exchange. Therefore, scientists are experimenting with substances that can retain moisture to create new age wound dressings. Recently Yadav from the Institute of Himalayan Bioresource Technology, Himachal Pradesh, in association with scientists from the Academy of Sciences and Innovation Research, New Delhi, and the Center for Innovation and Applied Bioprocess, Mohali, tested bamboo cellulose nano-constructs for wound healing.

For constructing cellulose nanocrystals, the scientists used two varieties of bamboo plants – Tama bamboo and the Indian thorny bamboo. The leaves of these plants were treated with chemicals to rid them of non-cellulose contents. These were then reduced to a smaller size by mechanical means to

produce nano-cellulose crystals. Next, silver nanoparticles were synthesized and combined with cellulose. Silver nanoparticles have antimicrobial action and make wounds sterile. The Tama bamboo variant was found to contain silver nanoparticles of about 16 nm while the rough Indian bamboo featured 22 nm silver nanoparticles.

The nanocrystalline cellulose embedded with silver nanoparticles was then tested in both ointment form as well as hydrogel dressings. The tests evaluated the preparations on the basis of antibiotic potential, skin toxicity and wound healing in mice. The scientists found that addition of nanoconstructs could induce bacterial cell death within 6 h by promoting silver nanoparticle permeation within the bacterial cells. This was verified using sophisticated microscopic colorimetric and microbiology approaches.

The variant from Tama Bamboo was found to have a more potent antimicrobial action due to the presence of slightly smaller silver nanoparticles. Both the varieties were found to be non-cytotoxic on skin cells and could promote wound healing in less than 14 days by favouring collagen deposition, cell differentiation and angiogenesis.

The scientists are confident that their system is a promising candidate for developing new age wound dressings. Further testing in clinical settings may make bamboo leaves a valuable raw material for health industries.

Carbohydrate Polymers, **155**, 152–162

Heartbeat in Gelatin

Cardiovascular tissue engineering

Research on heart disorders essentially requires beating heart cells – a factor that has restricted innovation in this sector. Many scientists have used varying approaches to maintaining heart cells outside the body, but they seldom remain functional past two weeks. In the last fortnight, a team of research scholars from the Sri Ramachandra University, Chennai, have found a way to extend the *in vitro* heart cell survival to about a month.

Elamparithi and her team used gelatine nanoconstructs as matrices for heart cell culture. Gelatin is biodegradable, cheap and closely related to collagen – the protein which serves as cell matrix in hearts. The scientists prepared gelatin matrices by electrospinning a solution of gelatin in organic solvents. The fibres were collected and crosslinked with a carbodiimide to increase scaffold stability. The crosslinked matrix was then sterilized, characterized and assessed for cell culture suitability in 2D and 3D.

Even though initial cell adherence was slightly delayed in the 3D culture, the 3D gelatin constructs could support primary cardiomyocytes for over 27 days. However, in the 2D models, the cells stopped beating after 17 days. This was further verified by the marker for heart cells – troponin – and marker for contractility function – desmin.

The scientists found that these gelatin matrices could be stored for two months without any loss in morphology as assessed by electron microscopy. They are confident that the long-term 3D cell culture using cross-linked gelatin base can be employed for drug discoveries and *in vitro* physiological studies for assisting research.

Int. J. Polym. Mater. Polym. Biomater., **66**, 20–27

Arsenic Poisoning

Zebrafish model

Arsenic poisoning is one of the leading causes of death today. Even trace amounts are harmful. Arsenic can cause various conditions such as melanosis, keratosis, hyperpigmentation, etc. It is a potential carcinogen. But we have limited knowledge about the mechanism of action – which genes and proteins in our body are affected.

Last fortnight, scientists at the University of Delhi proposed zebrafish as a model to study arsenic poisoning. As a beginning, they assessed changes in the immune system and related genes due to arsenic poisoning.

They exposed zebrafish to increasing concentrations of arsenic for a month. After the exposure period, fish were infected with a pathogenic bacteria – *Aeromonas hydrophila*. Pathogenicity was 11–15 times more in arsenic poisoned fish. The kidneys of exposed fish were severely damaged.

The researchers measured the expression of genes related to the immune system. They saw that the genes were either over or under expressed compared to the controls. These genes code for proteins which are critical signalling molecules and mediators in immune system functioning.

Zebrafish and humans have a similar genetic makeup. Thus they can be used as a model system to understand the mechanism of action of various heavy metals, toxins and drugs. This research has taken one more step towards understanding the mechanisms behind arsenic poisoning and has given valuable information about the proteins affected in the immune system.

J. Hazardous Mater., **321**, 121–131

Wild Edible Fruits

Nutraceutical potential

The Himalayan region is breathtaking. However, the lack of agricultural biodiversity, crucial to food security, is of concern. Harsh conditions and extreme altitudes prevent the use of many standard crops in this region. So, identifying crops that can adapt is a challenge for farmers.

Bhatt and his group from the National Institute of Himalayan Environment and Sustainable Development, Uttarakhand, studied the nutraceutical properties of ten Himalayan plant species. They reported that the wild edible fruit plants of the region are rich sources of various antioxidant compounds. Myrobalan, Indian gooseberry, *Morus alba*, *Ficus palmata*, Nepalese firethorn, *Berberis asiatica* and Bayberry are the richest sources of phenolics, flavonoids, ascorbic acid, β-carotene and anthocyanins. Phenolic compounds varied among species. Myrobalan and Indian gooseberry had the maximum. The antioxidative property of these plants helps reduce free radicals in the body, thus preventing diseases such as cancer, scurvy, etc.

These fruit trees are naturally adaptable to the Himalayan climate and can supplement the dietary needs of the people. Thus they help overcome nutritional insecurity in the Himalayan region. The nutraceutical properties make the trees attractive to drug industries. Thus these trees provide an additional opportunity for a livelihood. Scientists advise planting them in the bunds of agricultural fields as well as in wastelands.

Food Chemistry, **215**, 84–91

Economic Inequality

A new measure

Economic inequality has a negative effect on human potential, well-being and happiness. Quantifying inequality is vital in measuring the success of schemes designed to reduce it, and in comparing societies to find ones worth emulating.

Economic inequality is usually measured using the Gini index, which is a number varying from 0 (perfect equality) to 1 (complete inequality). Germany, for example, had a Gini index of 0.301 while India had 0.351 and South Africa 0.634 (income data from World Bank, 2011).

Though widely used, the Gini (g) index has some disadvantages. It is difficult to calculate. We need to know the total assets of all the individuals in a society. Moreover, even small errors in the input will inevitably skew the result.

Researchers from the Saha Institute of Nuclear Physics, Kolkata and the Aalto University, Finland, have developed an easy way to measure inequality. This Kolkata (k) index is the fraction of total wealth that is held by (100-k) per cent of the population. It varies from 0.5 to 1.

This makes calculations easier. We need to know only the wealth of the richest person, the number of people in the community and the assets of certain, usually middle-class, individuals. These are easier to obtain or estimate than the assets of poorer people, which are rarely recorded. Moreover, errors in all but a few data points have no effect on the final result.

Roughly, the Gini and Kolkata indices are related by the equation $k = 0.5 + gc$, where $c = 0.365 \pm 0.005$ and $g < 0.7$.

The scientists point out that the Kolkata index of inequality is not limited to wealth, but can be used to make sense of various other types of data, such as citations per paper and city populations.

The usefulness of indices like this will be based on the contribution they make in reducing economic inequality to the low levels seen in countries like Norway and Slovenia.

PHYSICA A – Stat. Mechan. Appl., **466**, 583–595

Elephant Foot Yam

A food preservative?

Elephant Foot Yam – *Amorphophallus konjac* – is a perennial, tropical tuberous root crop grown in Asian countries. It has a bland flavour and is considered a cheap vegetable with good nutritional values. *A. konjac* corms are rich in starch, vitamins, minerals and glucomannan.

Glucomannan extracted from the *A. konjac* tuber is a water soluble polysaccharide which functions as storage macromolecules. It swells and forms a gel. It is a low caloric dietary fibre and has important health benefits. It is a naturally occurring low glycemic carbohydrate source and has many favourable features for the food industry. A review of literature in the field, published last fortnight, covers the applications of glucomannan from elephant foot yam.

Konjac starch is superior to potato or maize starch. Crude Konjac flour is a low-calorie food supplement with several therapeutic applications.

Konjac glucomannan as a food preservative draws the attention of researchers as it is cheaper, convenient, and has obvious advantages over conventional food preservation methods.

To improve the quality and acceptability of glucomannan, yam goes through bioprocessing. Processed konjac foods are popular in Asian markets. They are used as fat analogues in various meat products including fresh pork sausages and merguez sausages.

The review identifies the gaps in our understanding. *A. konjac* is a major vegetable (tuber) crop. It belongs to the Araceae family with 170 member species, mostly wild. Only a few are edible and are domesticated. Research directed to uncovering the relative nutritional and other merits of the members of the group may yield more useful results.

Food Rev. Int., **33**(1), 22–43

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