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Fractal dimension of protein–protein interactions

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In this issue

Forensic DNA Technology
Its history in India

DNA fingerprinting technology was invented in Britain in 1984. The first forensic DNA examination in India was done in 1989 by CSIR-CCMB. In 1991, evidence from the technology was first used in a legal case in Kerala.

A General Article in this issue outlines the history of the growth of the forensic use of DNA fingerprinting technology in India and interweaves the story of the evolution of the technology and the advances in science that drove the changes in technology. The accuracy and reliability of forensic DNA technology have improved and the time and costs have reduced considerably.

The uptake of forensic technology in India is equally impressive. India has the National Forensic Science University and the Rashtriya Raksha University for the capacity building of the personnel required; it has 7 central, 32 state and 80 regional forensic science laboratories, and 529 mobile forensic units.

And yet, in India, about seven to eight hundred thousand cases are pending in the forensic science laboratories across the country.

What needs to be done to address the issue? Turn to **page 1424** for answers.

Wound Healing
Diabetes delays

The healing of wounds is a natural process. But in people with diabetes, the wounds persist and fester. What are the mechanisms involved in normal wound healing? How do the metabolic changes in diabetes interfere with it? What are the traditional methods for treating various types of wounds in diabetic patients? How has our understanding of the biological processes changed the way we deal with the problem? What is in store in the scientific establishment as future treatments?

A Review Article on **page 1438** in this issue provides answers to such questions and more.

Cancer-related Proteins
Higher fractal dimension?

Many complex geometric patterns in nature are self-similar across different scales. Unlike traditional geometry which considers only one, two or three dimensions, fractal structures have fractional dimensions. The fractal dimension is used as a measure for representing the complexity of an object.

Researchers at the Rajagiri School of Engineering and Technology, Kochi recently analysed the topological properties of proteins implicated in cancers in the protein–protein interaction network focusing on their fractal dimension. In a Research Article in this issue they report that cancer proteins have a fractal dimension above the average fractal dimension of the network.

In a dataset of 39,167 protein interactions among 9465 proteins, they homed in on 941 proteins implicated in cancer and about 8524 non-cancer proteins. They selected 500 cancer proteins and 500 non-cancer proteins by random sampling. More than 85% of the cancer proteins had a higher fractal dimension than proteins not involved in cancer. They are more connected to the protein–protein interaction network and interact more strongly.

The topology of proteins is, of course, intimately connected to their functions. So the article on **page 1454** will keep cancer biologists pondering on the results for days to come.

Managing Genetic Diversity
Melipona mandacaia

Melipona mandacaia is a stingless bee abundant in north-eastern Brazil, where its role in pollination is appreciated. So farmers breed these stingless bees for economic reasons, with an ecologically useful outcome. But rational breeding of organisms can often lead to reduced genetic diversity. Is this reduction in genetic diversity happening in the case of *M. mandacaia*?

Researchers collected samples of the rationally bred stingless bees from three distinct areas and samples of natural populations, extracted their DNA and separated 32 inter-simple sequence repeats (ISSRs) as markers of genetic diversity. Using twenty-eight of these ISSR markers which were polymorphic, they came to the conclusion that genetic diversity can even increase in rational breeding under certain conditions. For insights on bee breeding without loss of genetic diversity, read the Research Article on **page 1479** in this issue.

A Furnace for Farmers
Optimising design

In this issue, researchers at the Nimbkar Agricultural Research Institute offer the design of a furnace for farmers. They had designed the furnace to produce syrup from sweet sorghum juice, using the biomass left behind in sorghum cultivation. The parameters for the design were that the heating rate of the furnace should be controllable, that it should produce minimum smoke and particulates, that it should be low cost and simple in design.

In a Research Communication on **page 1501**, they now provide data on using other commonly available biomass in the furnace. The furnace of 170–670 kW thermal capacity can be used to concentrate sugarcane and fruit juices, dehydrate the pulp of fruits and vegetables, such as bananas, melons, guavas, mangoes, papayas and tomatoes, and increase their shelf-life and facilitate their handling, transportation and off-season supply.

Though rich farmers can make use of the design to their benefit, for smaller farmers, the institute plans to design a furnace that can be mounted on a truck which can be taken to the farm site to further decentralize dehydration and food processing and to reduce the wastage of heat energy used in biomass burning.

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A low-cost multi-fuel biomass furnace for food processing in rural areas

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A low-cost, multi-fuel biomass furnace of about 170–670 kW (thermal) capacity for food processing has been developed for rural areas. The biomass combustion in the furnace is clean, with very little smoke. Such small, clean biomass-burning furnaces are not available in India; hence, their development will fill the need gap. Details of the development are presented in the present communication.

Keywords: Food processing, loose biomass furnace, rural areas, sweet sorghum syrup.

MANY plant-based raw materials such as stalk juices, fruits and vegetables are perishable as they contain greater than 90% moisture[1]. If cold storage is not available, they need to be processed at the most in a couple of days to improve their shelf-life.

Decentralized dehydration and food processing will help farmers increase their income. For this, an economically viable, simple, non-polluting, heat-producing device that can run on a large variety of biomass residues is required.

The Nimbkar Agricultural Research Institute has developed a low-cost, multi-fuel biomass furnace of about 170–670 kW (thermal) capacity to produce syrup from sweet sorghum juice[2]. Such small furnaces are not available in India, so its development will fill the need gap.

In addition to concentrating sweet sorghum or sugarcane juice, clarified juice or pulp of various fruits and vegetables, such as banana, melon, guava, mango, papaya, tomato, etc. can be concentrated using this furnace. The reduction in water content of the raw material can increase its shelf-life and facilitate its handling, transportation and off-season supply[3].

Though this furnace was developed and successfully used for producing syrup from sweet sorghum juice, we feel it can also be used to evaporate water from juices and pulps of different fruits and vegetables.

The design was done by considering the following: (i) the furnace should run on the residues of the material being processed, i.e. it should be self-sufficient in terms of fuel; (ii) it should also run on loose biomass residues commonly available and be flexible regarding their density and moisture content (<30%); (iii) the heating rate of the furnace should be controlled for various applications; (iv) the combustion should be excellent, thus producing a minimum of smoke and particulates and (v) the furnace should be low-cost, simple in design and mostly use locally available materials for construction.

Table 1 shows the furnace characteristics and Figures 1 and 2 show the schematics of the sweet sorghum syrup plant and the furnace section respectively.

Airflow inside the furnace occurred from the primary and secondary air inlet rings (Figure 3). It was controlled to minimize the back pressure and optimize the fuel combustion so that the burn was as clean and complete as possible.

Visual inspection of flue gases determined the air/fuel ratio control so that colourless smoke resulted. The present jaggery-making furnaces have a poor air/fuel ratio and hence, they emit very dark smoke and particulates[4]. With trial and error, the air/fuel ratio was optimized for most types of biomass fuel used in the furnace. This resulted in low particulates emission of 20–25 mg/kg of residues burnt[2].

Various biomass-based fuels ranging in density from 30 to 500 kg/m^3 were successfully used in the furnace (Table 2).

The furnace was primarily used to prepare sweet sorghum syrup and sugarcane jaggery. For sweet sorghum syrup, about 200 kg of air-dried bagasse + leaves were adequate for a 50–70 kg syrup batch[2]. The total biomass produced by crushing sweet sorghum stems was 260 kg. This was 1.3 times more than needed for combustion, thereby making the furnace fuel self-sufficient. Fuel self-sufficiency also resulted in making fuel costs negligible.

The air-dried sweet sorghum leaves and bagasse having moisture content between 7% and 33%, were shredded in a specially designed biomass shredder cum feeder (Figure 4). It was designed to cut up the larger pieces of biomass and feed them to the furnace[2]. Another chute fed the loose biomass residue with small pieces (such as that left after threshing) to the furnace. This shredder cum feeder allowed easy feeding of biomass, and only one person was required to do so.

The efficient burning of biomass residues in the furnace can reduce the large quantities of gaseous pollutants and aerosol particles from the atmosphere generated when these residues are burned in the open field. For example, particulate emissions from open field residues burning are 5–10 g/kg of biomass burnt[5]. Whereas our furnace had emissions of only 20–25 mg/kg of residues combusted – two orders of magnitude less than open burning. Burning residues in the field causes large scale pollution, especially in Northern India, where jaggery manufacturing is a major rural industry[6].

A clean, multi-fuel-fired furnace was developed as a part of the project 'Development of a fully mechanized plant to produce syrup from sweet sorghum'. It has a thermal capacity of 170–670 kW and burns the biomass fuel cleanly with very little smoke.

In addition to the experiments conducted to check for fuel self-sufficiency, experiments were also conducted to determine optimum design for chimney, fuel feeding port location, air inlet sizing, fuel feeding rate and strategy for batchwise or continuous syrup making[2].

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Table 1. Furnace characteristics

Characteristics	Specifications
Biomass shredder cum feeder to carry out continuous feeding of the fuel (power of shredder; 3.725 kW)	45–180 kg/h fuel feed rate depending upon the size of the biomass particles. For sweet sorghum bagasse/leaves combination; 45 kg/h was found to be an optimum fuel feed rate.
Furnace size	Inner diameter: 1.32 m Volume: 1.37 m^3 Height: 1.0 m Wall thickness: 0.23 m (made of fire bricks) Chimney height: 4.35 m (made of regular bricks)
Capacity of furnace	170–670 kW (thermal)
Cost of furnace	Approx. Rs 50,000
Efficiency of furnace	20–25%
Material of furnace	Fire bricks with high temperature cement
Smoke production	Was reduced substantially by regulating the air/fuel mixture. The air flow was controlled by a valve attached to a 1 kW blower.

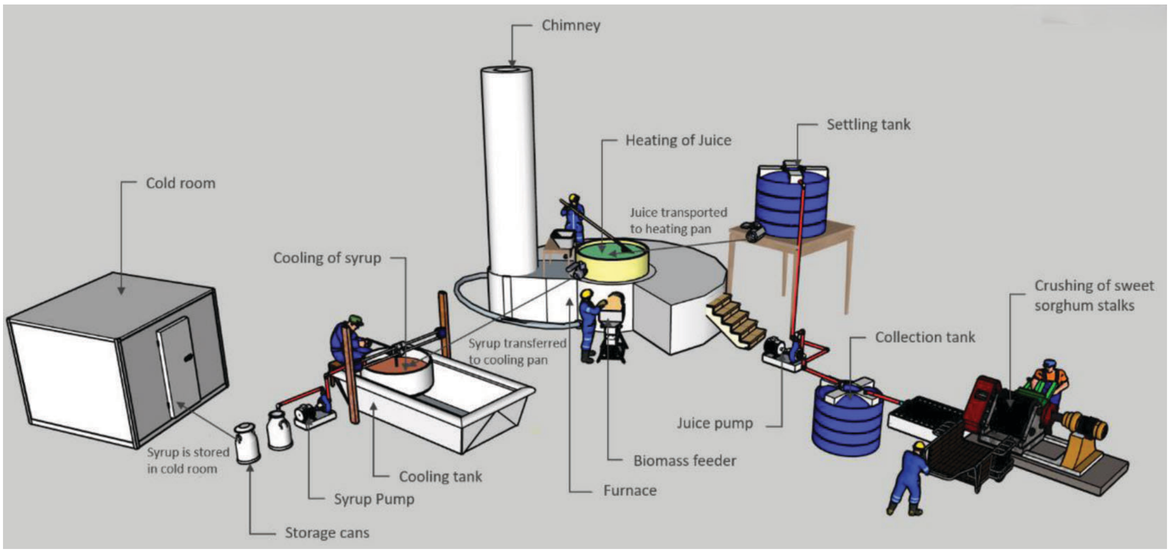

Figure 1. Sweet sorghum syrup production plant[2].

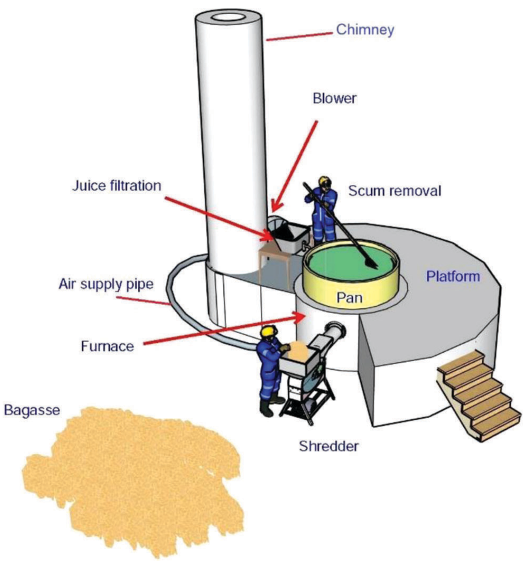

Figure 2. Schematic of furnace section[2].

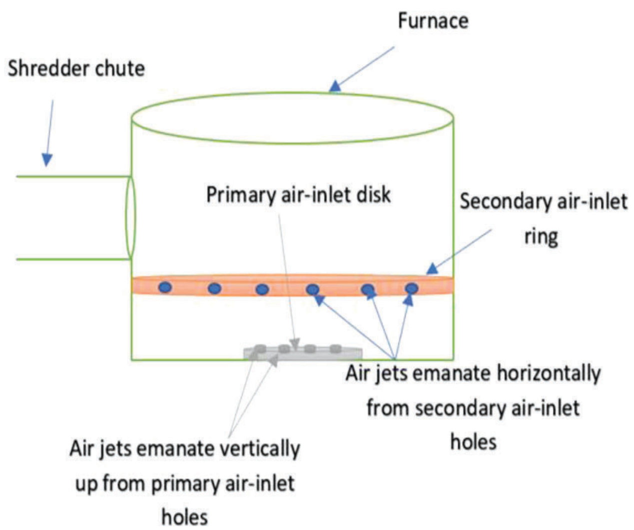

Figure 3. A sketch depicting air jets emanating from primary and secondary air inlets[2].

Table 2. Different biomass fuels tested in the furnace

Fuel	Average density (kg/m^3)
Sweet sorghum leaves	33
Pearl millet residue left after threshing	42
Sweet sorghum bagasse	80 (ref. 2)
Sugarcane bagasse	100 (ref. 2)
Shredded leaves and bagasse of sweet sorghum	68
Sorghum and safflower residues after threshing	102
Wood logs and branches	500

Most of the data is from ref. 7, unless otherwise noted.

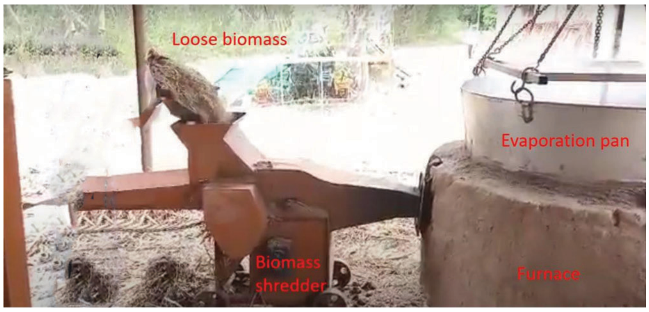

Figure 4. Fuel feeding into the furnace.

Future work: It will be very useful to design the unit such that the furnace can be mounted on a truck which can be taken to the farm site. This will make it more convenient to process the raw material and save the cost of carting it to the processing site.

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A study on the role of epidermal tissues in limb regeneration in a ladybird beetle, *Cheilomenes sexmaculata* (Coccinellidae)

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Larval systems are de-differentiated and reorganized in insects undergoing complete metamorphosis, and body plan of adults are established during pupal stage. In ladybirds, limbs amputated in larval stages are regenerated during pupation. Given that changes in pupa are akin to embryogenesis, does the lost limbs are redeveloped as a part of metamorphosis or has some pre-patterning initiated prior pupation? To test this, we exposed third larval instars of *Cheilomenes sexmaculata* to amputation and scraped off the epidermal tissues from the amputation site every 24 h post amputation. We observed that the limb regeneration did not occur in the treatment where scrapping was done. Thus, the present study highlights the critical role of epidermal tissues at the wound site in limb regeneration, emphasizing that these tissues probably contain essential pre-regenerating cues.

Keywords: Amputation, holometabolous, leg development, metamorphosis, pupa.

MORE than 80% of insects undergo complete metamorphosis or holometaboly with an intercalated pupal stage between larva and adult[1]. The pupal stage, which is largely immobile, involves extensive remodelling of organs and tissues, resulting in rebuilding of entire body plan[2]. Many metabolic and developmental genes have been reported to revert to embryonic-like state during metamorphosis, viz. wingless, decapentaplegic, distal-less, dacshund[3]. Ozerova and Gelfand[4] proposed a recapitulation of the embryonic expression program during metamorphosis. Through extensive meta-analyses of datasets from various holometabolous insects, they demonstrated an increased similarity between the pupal stage and the embryonic stage. This perspective adds weight to the notion that the larval phase in holometabolous insects could be viewed as a prolonged extension of embryonic development, with metamorphosis representing a progression from embryogenesis[3].

Ladybird beetles are holometabolous insects that undergo limb regeneration[5–7]. An amputated limb is regenerated when larva metamorphosizes into adult. The capacity of limb regeneration has been reported to be broadly conserved in coccinellids with 15 out of 16 species of ladybird beetles exhibiting limb regeneration with delayed pupal duration. Regeneration neither occurred from one molt to

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