Herbal technology – Concepts and scope*

Herbal technology circumscribes all the advancing technical frontiers (except genes) meant to tap myriads of modes of manipulating plants around us. A large number of technologies have been developed to harvest the bountiful products that the plants manufacture, including natural dyes, biofertilizers, biopesticides and biofuel. The National Seminar on Herbal Technology was the first step in codifying principles and defining scientific methods of this new concept of profitably managing the plants around us. The seminar was followed by an exhibition, which was open to public. A total of sixty-two papers and three plenary lectures were presented in the seminar. Among these, thirty-three papers were on herbal medicines, eleven on natural dyes, nine on biopesticides, five on biofertilizers and four on biofuel. A total of 140 participants attended the seminar.

The technical sessions of the seminar started with a lead lecture by M. Daniel (M. S. University, Vadodara) on concepts and scope of herbal technology. This was followed by a session on herbal medicines. Emphasis was on new medicinal plants (from ethnobotanical surveys), new uses of known medicinal plants, active components and biomarkers, viable substitutes and methods of cultivation, storage, extraction, formulations, efficacy and quality control. The new medicinal uses of plants like *Achyranthes* (hypoglycaemic and estrogenic), *Aegle* (hypoglycaemic), *Phyllanthus* (contraceptive) and *Sida* (antiplaque activities) and new active components of *Sida*, *Aloe*, *Boerhavia, Eclipta* and *Phyllanthus* were taken as models and the role of minor components like phenolics was emphasized. Remya Ramachandran (Vivekananda College, Salem) dealt with the efficacy of aqueous extracts of *Cassia alata* Linn. leaves in increasing the hexokinase activity in diabetic rats, which leads to increasing utilization of glucose and thus decreased blood glucose levels. The levels of glucose-6-phosphatase and fructose-1, 6-bisphosphatase activity were found reduced after administration of this extract. According to S. Kedia (J.N.V. University, Jodhpur), the soil mixture ratio of 1 : 1 : 1 sand, clay and farmyard manure was found better for growing *Eclipta* and *Asparagus*, while *Peganum* and *Withania* faired well with the mixture in 1 : 2 : 1 ratio. Reports of excessive doses of lead and mercury in some Indian ayurvedic medicinal preparations and the usage of ayurvedic drugs along with allopathic drugs leading to changed pharmacodynamics were the main topics discussed by Y. Gautam (Ayurvedic Health Centre, Naina Tikker, Solan, HP). He appealed for strict quality control standards in ayurvedic medicines. Biomarkers for quality control studies on powders, extracts and formulations of many medicinal plants have not been identified and this hampers the growth of the herbal industry. Biomarkers such as unicellular conical trichomes, spherical glandular hairs, intraxylary phloem and flavonols such as quercetin and 3′-OMe quercetin were identified for *Woodfordia floribunda*, while for *Lagerstroemia flos-reginae*, 2-layered palisade and sphaeraphides along veins and flavonols were found by M. D. Elizabeth (M.S. University). P. Richa (M.S. University) presented the identifying features of barks of *Ficus benghalensis* and *F. religiosa* as microsclerieds and quinones in the former and rectangular calcium oxalate crystals and flavonoids in the latter plant. Silica bodies in leaves of *Cymbopogon, Cynodon* and wheat grass and laticifers, and four types of trichomes in *Euphorbia thymifolia* were highlighted by N. Priya and T. Sallykutty (M.S. University) respectively. The possibility of using seeds of all the seven species of *Cassia*, available in Baroda, as sources of gum was emphasized by S. Jayana (M.S. University).

In the session on natural dyes, the application of dye extracted from banana peel on mordant cotton and silk was described by R. Inderpal (JNV, University), while V. Luniya, also from the same university, dealt with application of dye extracted from flowers of *Prosopis juliflora* on cotton, silk and wool. D. Rathi (Nirmala Niketan, Mumbai) discussed encapsulation of fragrances, essential oils and flavours in microcapsules and their application on cotton and polyester. Such microcapsules are found to preserve the substance in a finely divided state and release the substance as required, an interesting application of this being the encapsulation of vitamins, nutritional extracts, antibacterial agents and even mosquito repellents. A. Bansal and S. Shama (CSKHPKV, Palampur) described how the yellow coloured flowers of *Grevillea robusta* and *Bidens pilosa* were used for dyeing silk.

Biopesticides, being plant extracts, contain minerals, co-factors, etc. besides pesticidal compounds and therefore, on being absorbed through the cuticle, also impart several benefits to the plants. N. K. Dubey (BHU, Varanasi) spoke of *Ageratum conyzoides* as a biopesticide. This plant contains precocenes which act as antijuvenile hormones to a number of insects. The volatile oils which are abundant in members of Rutaceae, Apiaceae, Lauraceae, Myrtaceae and Lamiaceae being lipidic, resist the microbes and due to the dryness they impart on the taste buds as well as the odour, they act as feeding deterrents or repellents. M. Bhavisha (Saurashtra Univ., Rajkot) mentioned that the essential oils of *Mentha piperita*, *Litsea cubeba* and *Anethum graveolens* are antibacterial to both Gram-positive and Gram-negative organisms.

In the section on biofertilizers, since they also provide vitamins, growth factors and other growth requirements besides minerals to the plants, Neelam Periera (NIO, Goa) mentioned that the presence of cytokinin, IAA and colloidal gels in *Ascophyllum nodosum* (seaweed) were advantageous in using seaweeds as biofertilizers. The yield potential of blue-green algae biofertilizers for paddy crop and efficacy of AM fungi were evaluated by S. K. Nandan (Science College, Dhule) and Tanushree Chatterjee (M.S. University). In the section on biofuels, Divya Nair (M.S. University) mentioned that seeds of *Jatropha gossypifolia*, *Cordia sebastena*, *Balanites roxburghii, Anisomeles ovata* and lemon, which contained 25–35% oil, were viable alternatives of *Jatropha curcas* as biofuel.

The exhibition on Herbal Technology conducted on 30 January 2005 attracted more than 500 visitors, among which nearly half were farmers who were interested in biofertilizers and biopesticides. Data on microbial fertilizers (both literature and cultures/samples of nitrogen fixing-symbiotic and non-symbiotic algae, blue-green algae and *Azolla*) were exhibited and were highly appreciated. More than 60

*A report on the National Seminar on Herbal Technology conducted at the Department of Botany, M.S. University of Baroda, Vadodara during 28–29 February 2005.

plants used as biopesticides, data on microbial biopesticides (bacteria, fungi, virus and protozoa) and predatory insects, sources of liquid resins (*Copaifera longdorfii*, *Hardwickia pinnata* and *Dipterocarpus turbinatus*) which can be used as biodiesel, petrocrops, sources of ethanol and a large number of plants yielding non-edible oils as well as production of biodiesel by methylating the oils, were exhibited. Sources of natural dyes (40) and more than 150 medicinal plants also were presented.

M. Daniel, Department of Botany, The Maharaja Sayajirao University of Baroda, Vadodara 390 002, India.
e-mail: mdanieluni@yahoo.co.in

RESEARCH NEWS

Microbial diversity: No limits?

Yogesh S. Shouche and Milind S. Patole*

Though invisible to unaided human eye, prokaryotes are omnipresent and outnumber eukaryotic cells on the earth by several orders of magnitude. They catalyse unique and indispensable transformations in the biogeochemical cycles in the biosphere, produce important components of the earth's atmosphere, and represent a large portion of life's genetic diversity. However, till recently, a vast majority of them escaped the scrutiny of scientists' probing eyes due to the inherent limitations of the methods used to study them. Developments in molecular biology have enabled us to get a glimpse into the lives of microbes recalcitrant to growth in the laboratory. The estimated number of prokaryotic species on earth is thought to be more than 10^5 and their total number 4–6×10^{30}. These estimates include sites like marine and aquatic waters, soils, etc. Some recent publications expand the range of known habitats where microbial life thrives.

The first paper deals with marine subsurface communities. Marine sediments overlay two-thirds of the earth's surface and harbour diverse and abundant fauna. It was estimated earlier that of the 3.8×10^{30} prokaryotes calculated to be in the unconsolidated subsurface sediments, 97% or 3.7×10^{30} occur at depths shallower than 600 m. The estimated number of prokaryotes for deeper sediments is only 0.13×10^{30} cells. This value was uncertain because it was based on extrapolation, but it still represents considerable microbial biomass[1]. One would then wonder about their function, metabolism and biogeochemical role at these depths. In other words, what do they eat, how do they respire and what roles do they play? The study by D'Hondt *et al.*[2] provides some clues to these questions. They collected deep-sea sediment cores from equatorial Pacific Ocean off the coast of Peru and measured the number of microbes, potential electron acceptors like sulphates and nitrates, and microbial metabolic products like carbon dioxide, methane, manganese and iron.

In a standard scenario, photosynthesis captures light energy and fixes atmospheric carbon dioxide. This organic carbon is oxidized in the aerobic zone by respiration. As one goes down towards the upper sediments, oxygen is depleted and alternative electron acceptors like nitrate and sulphate that diffuse downward from water column are utilized. This produces a typical profile that is governed basically by the free energy yielded by the oxidants; those yielding greatest free energy are utilized first. The profiles obtained by D'Hondt *et al.*[2] deviated from the expected pattern and gave a strong indication that oxidants which normally diffuse downward from overlaying sea water, have in fact entered the sediments from sub-seafloor sources. There was compelling evidence that sulphates have originated from the brines below the sediment base, and nitrate and oxygen have entered from deep basaltic aquifers beneath the sediment column. This 'upside down' redox profile enables microbes to respire anaerobically and might drive the cycling of iron and manganese.

In another publication, Schippers *et al.*[3] have provided direct quantification of live cells in these sediments. They use an approach that is based on targetting ribosomal RNA as an indicator for living cells, because only live and metabolically active cells will have functional ribosomes. Dormant or dead cells may maintain intact cell wall and DNA, but RNA would be degraded in inactive cells. They used a highly sensitive molecular technique targetting specifically rRNA as an indicator of living cells, called 'Catalysed reporter deposition–fluorescence *in situ* hybridization' (CARD-FISH), coupled with 'Quantitative real-time polymerase chain reaction' (Q-PCR). Their results confirm the presence of large number ($>10^5$) of active live prokaryotes in these sediments. Bacteria were found to dominate over Archaea. Although D'Hondt *et al.*[2] were able to recover some microbes and characterize them, their role in this metabolism remained questionable, because many of them (*Bacillus*, *Rhizobium*, *Vibrio*, *Paenibacillus*) were close relatives of surface bacteria and thus unlikely to represent authentic deep-sea-surface communities. Further analysis using direct amplification of 16S rRNA genes may provide some information. Some indications already exist that there would be some novel lineages, because one isolate differs from its closest known relative by 14% at the level of 16S rRNA gene sequence. There are also reports of deeply rooted but previously unknown archaeal 16S rRNA sequences.

Another paper deals with deep hypersaline anoxic basins found in Eastern Mediterranean Sea[4]. These have probably resulted from dissolution of subterranean Miocene salt deposits that became exposed to sea water after tectonic activity. Brines in these basins are characterized by an-