ENVIRONEWS

INTERNATIONAL SOCIETY OF ENVIRONMENTAL BOTANISTS

Newsletter

LUCKNOW (INDIA) VOL 19 No 3 July, 2013

IN THIS ISSUE

ISEB-ENVIRONEWS – 75 Not Out

The International Society of Environmental Botanists (ISEB) has been founded on CSIR-NBRI, Lucknow campus on December 3rd,1994 with the aim to highlight the role of plants in indicating/monitoring and remediating environmental pollution and also to address the health related problems caused by rapidly declining air quality resulting in global climate change and loss to biodiversity.

Starting with 28 members, ISEB now has a membership of over 400 spreaded over India, UK, USA, Canada, Spain, Lithuania, Bangladesh, Sri Lanka *etc.* Its quarterly newsletter, *Environews* was launched on 1st January 1995 with the objective to appraise with the latest complex scientific findings and researches on environment and plant sciences to the non-specialists as well. The current issue is the 75th issue of *Environews*, which has now the global reach.

ISEB with a view to promote its objectives had from the very beginning targeted its activities towards all sections of the society, which includes less literate to illiterate masses, common men in rural and urban areas, students in educational institutions from primary to university level and scientists and researchers in academic institutions and national laboratories.

In past eighteen years, ISEB has organized wide spectrum of activities, viz., environmental awareness, educational & training programmes, lecture series, demonstrations, slide & film shows, art & poster competitions, debates at rural community centres, panchayats, schools, colleges, government offices *etc.* Scientific talks by eminent scientists and experts in various disciplines were also organized at regular periodicity. ISEB maintains a highly informative and educative website which has become popular all over the world. During the past three years it has been visited by over 40,000 individuals of more than 130 countries across the globe.

Four International Conferences on 'Plants and Environmental Pollution' (ICPEP) were organized by ISEB jointly with CSIR-National Botanical Research Institute, in years 1996, 2002, 2005 and 2010 in Lucknow, India. Delegates from 45 countries attended these conferences. The Society is already in the process of organizing the Fifth International Conference of the series (3-6 December 2014). The announcement of pre-registration of the conference has been made in April and by now over 330 pre-registrations has already been received from 47 countries.

A new Executive Council has been elected with Dr. C.S. Nautiyal, Director CSIR-NBRI as its President. In coming months some major activities are being planned. A biannual scientific journal *"International Journal of Environmental Botany"* will be released in December 2013. A scheme to award ISEB fellowships to distinguished scientists every year is also being implemented.

Pre-registration announcement: (There is no pre-registration fee)

Fifth International Conference on Plants & Environmental Pollution (ICPEP- 5)

3-6 December 2014; Lucknow, India

Organizers: International Society of Environmental Botanists and CSIR-National Botanical Research Institute, Lucknow, India

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Note: Only Pre-registrations are presently invited. Announcement for Registration & submission of abstracts will be made later, after the completion of pre-registration process. For Online Pre-registration please visit ISEB website

LETTERS

Thank you for the newsletter. The total volume has come with very innovative ideas and ample information in areas of environment and botany. Thank you for highlighting about my publication of textbook on "Sustainable solid waste management". I have seen in the newsletter about the Award of ISEB Fellowship for the year 2013. I would like to know the eligibility and other details to apply for this fellowship. I request the committee to select the life members based on their contribution and excellence in their work. Sir, I am sending my revised biodata with other contribution to my work for your consideration.

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WELCOME NEW LIFE MEMBERS OF ISEB

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LITERATURE RECEIVED IN EXCHANGE/ON GRATIS BY ISEB

Acid News: No. 1, March 2013 (Published by Air Pollution & Climate Secretariat, Gotenborg, Sweden), Editor: Christer Agren.
(http://www.airclim.org/acidnews/index.php).

Association Meetings International (AMI): November 2012 and February 2013 (West Sussex, UK), Managing Editor: Martin Lewis.
(http://www.meetpie.com)

Notulae Botanicae Horti Agrobotanici Volume 40, Issue 2, 2012 (Cluj-Napoca Romania), General Editor: Prof. Dr. Radu Sestras.
(http://notulaebotanicae.ro)

Headquarters Asia Pacific: Volume 12, December 2012 (Headquarters Magazines meetings), Industry Publishers, Singapore.
(www.macautourism.gov.mo)

Impact: News letter of IAAPC (Indian Association of Air Pollution Control), Vol. 6, No. 1, 2 June 2013

Contact address: Prof. Arun Arya, IAAPC, C/o. Dept. of Botany, The M.S. University of Baroda, Vadodara, India.

NEWS FLASH

Diamond Jubilee Lectures at CSIR-NBRI

CSIR-NBRI is currently celebrating its Diamond Jubilee. To commemorate this event, the Institute has drawn up an elaborate year-long programme to organize a series of lectures by eminent scientists from India and abroad. Under this ongoing programme following distinguished scientists have delivered highly informative and thought provoking lectures on important topics: Dr. A.K. Mattoo (Maryland, USA), Prof. S.K. Sopory (Vice-Chancellor, JNU, New Delhi), Dr. C.R. Bhatia (former Secretary, DBT, Govt. of India), Prof. S. Rajan (ISRO, Bengaluru), Prof. Asis Datta (NIPGR, New

Delhi), Dr. K.C. Gupta (Director CSIR-IITR, Lucknow).

Many more lectures by scientists under this series will be organized in the coming months.

Dr Muhammad Iqbal, Professor of Botany at Jamia Hamdard, New Delhi and Vice President of ISEB, delivered a talk on "Active ingredients of medicinal plants in changing environment" at the Institute of Botany in Baku, Azerbaijan. He was invited by the Azerbaijan National Academy of Sciences to deliver a lead lecture and chair a technical session in a Workshop on 'Environmental Changes and Conservation of Plant Diversity' held during April 20-24, 2013. His visit was sponsored by the Science Development Foundation under the President of the Azerbaijan Republic.

Dr. Kamla Kulshreshtha, Principal Scientist, CSIR-NBRI and Member of ISEB Executive Committee was nominated by Director NBRI to participate in a Training Programme "Science and Technology for the Rural Societies" at the Centre for the Disaster Management, Lal Bahadur Shastri National Academy of Administration, Mussoorie, during May 20-31, 2013.

The programme was sponsored by the Department of Science & Technology (DST) Govt. of India, under the plan scheme entitled "National Programme for Training of the Scientists and Technologists" working in the Government Sector.

Besides extensively touring remote and interior hilly areas of village Jardhar at Chamba district Dr. Kulshreshtha interacted and shared her scientific experience with the womenfolk. She also made a formal presentation on "Dry Flower Technology and Floral Crafts". She also took part in panel discussions and submitted her detailed technical report.

Dr. S.C. Sharma, Vice-President ISEB coordinated 'Tree Plantation Programme' in the Botanic Garden of The University of Lucknow on June 5th the World Environment Day. Dr. Sharma also delivered a talk in the seminar organized on this occasion in the Botany Department of the University. In his talk, he explained the salient features of Arboriculture, and Science of Tree Culture. He emphasized in his talk on the proper selection of the plant species, which is suited to subtropical climate and edaphic conditions of Lucknow, and 'after care' of the planted saplings. Prof. Dinesh Sharma, Mayor, Lucknow Corporation; Prof. A.K. Sen Gupta, Acting Vice-Chancellor, Lucknow University; Prof. Yogesh K. Sharma, Head, Botany Department, Faculty members and students participated in the seminar on "Go Green" and planted tree saplings on the University campus.

Distinguished visitor

Prof. Arun Arya, Head, Department of Botany, Faculty of Science, The M.S. University of Baroda, Vadodara (17.06.2013)

Application of Essential oils: an alternative method for controlling post-harvest losses

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Problem and need

Food security, in a populous country like India is the most pressing national issue. There never has been enough food for the health of all the people and so, the food production must be greatly increased. Besides enhancement of yield, the post-harvest losses need to be controlled. The redemption of such losses is the most feasible option for meeting the ever increasing demand for food in the future.

Fresh produce can become infected before or after harvest by pathogens widespread in the air, soil and water. It has been estimated that out of 100,000 species of fungi, less than 10% are plant pathogens and more than 100 species of fungi are responsible for the majority of post-harvest diseases. The agricultural produce before it is transported from fields and reaches the consumers, it undergoes various processing procedures, which improve their storability. The techniques and procedures followed to reduce loses after the crop harvest are referred to as post harvest technology.

Fungicides are chosen as most easily available and simply applicable option by the farmers. Synthetic fungicides such as Imazalil, thiabendazole, pyrimethanil prochloraz and guazatine are generally used on packlines as the first line of defense against post harvest pathogens. In recent past many problems have popped up relating to indiscriminate use of fungicides as post-harvest chemicals. The severity of damage caused by direct application of fungicides to agro-products is much higher than those associated by their use as foliar sprays or soil mixes.

The chemical pesticides have been tested for their ill effects such as reproductive toxicity and carcinogenesis in mammals. High doses of these agents have been proved to be fatal to animals and fruits. The direct exposures of humans to the fungicides have caused grave health concern due to residual toxicity and long degradation periods and other side-effects on humans. In recent years public perspective towards the use of chemicals as pesticides has shown drastic shift due to hazards such as pest resurgence, environmental as well as soil pollution. Ultimately, biomagnification of pesticides in the food chain may occur through accumulation of these xenobiotic substances in organisms Dip solutions such as Imazalil, prepared in large tanks of at least 1500 l volume, are maintained for several days before the residue is disposed. Toxic waste disposal is a costly exercise and hazardous waste poses serious environmental problems.

Resistance in populations of post-harvest pathogen to commonly used fungicides has posed a serious problem. For example; many synthetic fungicides are currently used to control blue mould rot of citrus fruit. However, the reported acquired resistance by *Penicillium sp.* to fungicides used on citrus has become a matter of grave concern in recent years. In view of serous side-effects of synthetic fungicides, alternative strategies need to be developed for reducing losses due to post harvest decay. These strategies include natural, non chemical and organic amendments that are perceived as safe by the public, and pose negligible risk to human health and environment.

Present study

At present biocontrol by the application of microbial antagonists (fungi, bacteria, and yeasts), natural plant-based antimicrobial substances (volatile aromatic compounds, acetic acid, jasmonates, glucosinolates, essential oils, plant extracts and propolis), antimicrobial substances from soil (fusapyron and deoxyfusapyrone) and natural animal-based antimicrobial substances like chitosan have emerged as the latest non-conventional technologies and as a new hope in the present scenario.

Over the past 20 years the use of antagonistic microorganisms has emerged as an effective non-conventional bio-control strategy to combat major post harvest decay of perishables. Bio-control offers a viable option, however, they are inconsistent, show great variability in their efficacy and confer only a protective effect that diminishes with time. The limitations are inherent in most biological control agents and their successful application will depend on integration with low toxicity compounds or chemicals generally recognized as safe.

The use of non-selective fungicides (sodium carbonate, sodium bicarbonate, active chlorine and sorbic acid) and physical treatments such as heat therapy, low temperature storage, hot water treatments and radiation can significantly lower the disease pressure on harvested commodities. Harvesting and handling techniques that minimize injury to the commodity, along with storage conditions that are optimum for maintaining host resistance will also aid in suppressing disease development after harvest. However, none of these treatments are consequently effective, and many of these cause damage to the commodities.

The alternative methods are also not completely reliable; the drawbacks as well as the risk associated with these strategies bring to focus, other control methods, particularly those which are eco-friendly.

Eco-friendly and biodegradable approaches

Various plants have an important historical tradition in healing or are particularly valued for their medicinal, savory and aromatic quality. They are considered as medicinal plants if they are collected only for their medicinal or aromatic properties Essential oils are aromatic, volatile extracts from components of such plants (leaves, flowers, fruits, bark, roots, rhizomes, and wood) that are usually obtained by technologically simple processes of maceration and water solution, steam or hydro-distillation. The extracts are used as flovours, fragnaces and for medicinal purposes or health care purposes. Nevertheless, the term volatile is preferred because it refers to the most component of the oils, which are stored in extracellular space in the epidermis or mesophyll, have low boiling points and can be recovered from the plant tissues by steam or hydro-distillation.

Production of essential oils by plants is believed to be predominently a defense mechanism against pathogens and pests and indeed, essential oils have been shown to possess antimicrobial and antifungicidal properties Essential oils and their components are gaining increasing attention because of their relatively safe status, their wide acceptance by consumers, and their exploitation for potential multi-purpose functional use. Essential oils are made up of many different volatile compounds and the chemical composition of the oil quite often varies between species. It is difficult to correlate the fungitoxic activity to single compounds or classes of compounds. It seems that the antifungal and antimicrobial effects are the result of many compounds acting synergistically. Thus, there would be negligible chance of development of resistant races of fungi after application of essential oils to fruit and vegetables. So essential oils are among the most promising groups of natural compounds that are used to develop safer antifungal agents.

Chemical composition of essential oils

Modern research has shown that medicinal plants act through a relatively small number of constituents called active principles. In a number of cases, tannins have a more extensive action than the isolated active principles. Essential oils are volatile, natural, complex compounds characterized by a strong odour and are synthesized by aromatic plants as secondary metabolites. They are liquid, volatile, limpid and rarely coloured, lipid soluble and soluble in organic solvents with a generally lower density than that of water. They can be synthesized by all plant organs, i.e. buds, flowers, leaves, stems, twigs, seeds, fruits, roots, wood or bark, and are stored in secretory cells, cavities, canals, epidermic cells or glandular trichomes.

The general categories of plant products are as follows:

1) The lipids including the simple and functionalized hydrocarbons, as

well as terpenes;

2) Aromatic compounds, including phenols:
3) Carbohydrates;
4) Amines, amino acids and proteins;
5) Alkaloids;
6) Nucleosides, nucleotides and nucleic acids

There is no reason to doubt that the antifungal and antimicrobial activity of some volatile oils components in vitro exhibits the same antibiotic activity in nature. The extent of recent interest in antimicrobial activity is shown by the wide range of organisms which have been tested against volatile oils, including filamentous fungi, yeasts and plant viruses The major constituents of many of these oils are phenolic compounds (terpenoids and phenylpropanoids) like thymol, carvacrol or eugenol, of which antimicrobial and antioxidant activities are well documented

Essential oils are very complex natural mixtures which can contain about 20–60 components at quite different concentrations. They are characterized by two or three major components at fairly high concentrations (20–70%) compared to other components present in trace amounts. For example, carvacrol (30%) and thymol (27%) are the major components of the *Origanum compactum* essential oil, linalol (68%) of the *Coriandrum sativum* essential oil, a- and b-thuyone (57%) and camphor (24%) of the *Artemisia* herba-alba essential oil, 1,8-cineole (50%) of the *Cinnamomum camphora* essential oil, a-phellandrene (36%) and limonene (31%) of leaf and carvone (58%) and limonene (37%) of seed *Anethum graveolens* essential oil, menthol (59%) and menthone (19%) of *Mentha piperita* essential oil. Generally, these major components determine the biological properties of the essential oils. The components include two groups of distinct biosynthetical origin. The main group is composed of terpenes and terpenoids and the other is composed of aromatic and aliphatic constituents, all characterized by low molecular weight.

Extraction of Essential Oils

Essential oils are extracted from various aromatic plants generally localized in temperate to warm countries like Mediterranean and tropical countries where they represent an important part of the traditional pharmacopoeia.

They are usually obtained by steam or hydro-distillation first developed in the middle Ages by Arabs. There are several methods for extracting essential oils. These may include use of liquid carbon dioxide or microwaves, and mainly low or high pressure distillation employing boiling water or hot steam.

Role in post-harvest

Essential oils possess a wide spectrum of different impressive qualities including antiphlogistic, spasmolytic, antinociceptive and antioxidant activity. Moreover, they exert immunomodulant, psychotropic, acaricide and expectorant effects. Due to their multifunctionality, EOs find a huge application area in medicine and aromatherapy.

The general antifungal activity of essential oils is well documented and there have been some studies on the effects of essential oils on post-harvest pathogens. These essential oils are thought to play a role in plant defense mechanisms against phytopathogenic micro-organisms. Most of the essential oils have been reported to inhibit post-harvest fungi in *in vitro* conditions and the reported effect of eighteen essential oils against post harvest fruit pathogens. Thyme oil proved to be the best inhibitor against all of the pathogens tested, like *Lasodiplodia theobromae; Colletotrichum gloeosporioides; Alternaria citrii; Penicillium digitatum; B. cinerea*. The biological activity attributed to the action of oils in *in vitro* conditions could be the cytotoxicity of the oil components, completely squashed and severely collapsed hyphae are recorded in case of *Alternaria alternata*, the conidiation was deeply hampered and ultimately at higher concentration no conidia were formed.

In vitro efficacy of citrus oil against *A. niger* was tested by a few researchers. *Citrus sinensis* essential oil caused complete growth inhibition of *A. niger* on agar plates. Higher concentration of oil was found to be lethal. The oil showed fungistatic activity at low concentration. The essential oil significantly reduced the growth of *A. niger* in a dosage -response manner. *Citrus sinensis* is a result of attack of oil on the cell wall and retraction of cytoplasm in the hyphae and ultimately death of the mycelium. Essential oil is found to be inhibitory for *A. flavus* as well as *A. parasiticus*, the two aflatoxin producing fungi, the activity of oil is reported to be affecting aflatoxin production.

The small amount of oil applied to the pathogens gave a promising result to use them in vivo to manage the storage fungi. The incorporation of essential oils into fruit coatings, primarily applied to retain moisture, has gained popularity. The advantage of using coatings amended with essential oils, rather than vapour, is that there is a closer contact between the essential oils and fruit surfaces, allowing exposure of each fruit to similar concentrations of inhibitor over a longer period. Amiri *et al*. (2008) applied different formulations amended with eugenol oil (*Eugenia caryophylata*) to two apple cultivars and successfully reduced the disease incidence after cold storage. Trans (isomerized) jojoba oil was applied by Ahmed et al. as a coating for 'Valencia' oranges. They effectively maintained fruit quality for up to 60 days using concentrations of 20–30% of (trans)-jojoba oil

Regnier *et al.,* (2008) successfully achieved pathogen control, without any observed physiological breakdown, by applying commercial coatings amended with *L. scaberrima* essential oil to mango fruit. Further, general observation was that the mango fruits with amended coatings exhibited no shriveling or browning even after ten days of storage. Other alternatives such as the inclusion of sachets impregnated with essential oils such as thymol oil during 35 days packaging reduced the development of moulds of table grapes.

E. Bosquez-Molina *et al.,* (2010) reported for the first time the use of essential oils of thyme and Mexican lime in reducing *C. gloeosporioides* and *R. stolonifer* infection of papaya fruit. In addition, another positive effect of thyme and Mexican lime is that they do not have the strong flavor that characterizes other essential oils. Coating application extends the storage life of horticultural commodities since they cover the fresh produce by providing physical barriers to reduce loss of water vapor and aroma volatiles and delay the side effects of respiration. Some studies have concluded that whole essential oils have greater antimicrobial activity than the major components mixed, which suggests that the minor components are critical to the activity and may have a synergistic effect or potentiating influence.

In future

Although the antimicrobial activity of essential oils is documented, the normal amounts added to foods for flavor is not sufficient to completely inhibit microbial growth. The antimicrobial activity varies widely, depending on the type of essential oils, test medium, and microorganism. For these reasons, essential oils should not be considered as a primary preservative method. However, the addition of essential oils can be expected to aid in preserving foods stored at refrigeration temperatures, at which the multiplication of microorganisms is slow.

A partial listing of the summary of the antimicrobial effectiveness of essential oils is as follows.

1. Microorganisms differ in their resistance to a given essential oil.
2. A given microorganism differs in its resistance to various essential oils.
3. Bacteria are more resistant than fungi.
4. The effect on spores may be different than that on vegetative cells.
5. Gram-negative bacteria are more resistant than gram-positive bacteria.
6. The effect of essential oils may be inhibitory or germicidal.
7. Essential oils harbor microbial contaminants.
8. Essential oils may serve as substrates for microbial growth and toxin production.
9. Amounts of essential oils added to foods are generally too low to prevent spoilage by microorganisms.
10. Active components of essential oils at low concentrations may interact synergistically with other factors (NaCl, acids and preservatives) to increase preservative effect.
11. Nutrients present in essential oils may stimulate growth and/or biochemical activities of microorganisms.

Application of essential oil is a very attractive method for controlling post harvest diseases. Thus, food product safety and shelf life depend, in some measure, on the type, quantity, and character of essential oils added to the products.

Algae: The Source of Hydrogen Energy

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Introduction

With the industrial revolution in the 20th century the use of fossil fuel increased markedly and with the passage of time this requirement kept on increasing. We now consume about 13 terrawatts (1 TW = 10^{12} W = 3.2 EJ/year) of energy worldwide, and approximately 80% of that comes from burning fossil fuels (Johansson, 2004). Although major part of energy demand comes from the fossil fuel, which lay the foundation for the industrial society, but the use of fossil fuels are increasing day-by-day causing threat to environment and disappearing at an alarming rate. Combustion of fossil fuels is adding about 6 gigatonnes (Gt $=10^9$ tons) of carbon per year to the atmosphere (IPCC, 2007). The average facade temperature of the globe has increased more than 1^0 F since 1900 and the speed of warming has been almost three folds since 1970. This increase in earth's average temperature is called global warming. Various viral diseases such as ebola, hanta and machupo were appeared due to warmer climates. The marine life is also facing serious problems due to the increase in temperatures. Based on the study on past climate shifts, notes of current situations and computer simulations, many climate researchers assume that because of greenhouse gas discharges, the 21st century might experience temperature rise of about 3 to 8^0 C, climate pattern shift, melting of ice sheets and rise in sea levels.

It is because of these environmental issues one should consider more environmental friendly solutions to satisfy the current energy consumption. Biomass which has been used for centuries is one of the most attractive alternatives for fossil fuels. Presently various types of biofuels (biodiesel, biogas, bioalcohols etc.) derived from biomass·are being used in the energy sector. Currently, biomass contributes about 12% of today's world energy supply, while in many developing countries it contributes 40-50% energy supply (Demirbas, 2001). Though the burning of these fuels also emits green house gases but in comparison to fossil fuels their emissions are negligible. We need biofuels as a temporary solution until something better is available. Such a temporary solution must last for many years.

The rate at which the solar energy is trapped and converted into various useful energy derived products by the plants cannot be achieved by any other artificial means. Photosynthesis is the key process involved in the plants that synthesises various end products in the form of biomolecules, which can be further converted into the biofuels. Not only the end product but during the whole process there are few side products also which are being used as potential energy sources. The major part of the biofuel production takes place from variety of natural crop products like rapeseed, soybean, mustard, flax, sunflower, canola, palm oil, corn oil, hemp, jatropha and waste vegetable oils etc. But there are some other sources too including animal waste which can be used for biofuel generation. For example, Mekong Delta people are using 'tra' and 'basa' fishes to produce the non-toxic, clean biofuel. Another amazing source of biofuel (Hydrogen) is the bacteria that live inside the guts of termites which helps to digest wood and other plant products and produces hydrogen.

In spite of having variety of available options stated above, researchers are continuously exploring cost effective sources of biofuel, which can fulfill the future energy demands. As it is well known that in the future there will be huge shortage of land as well as fresh water. Under these circumstances algae seems to be the most promising candidates for biofuel production, unlike other oil producing crops it do not require land and fresh water to grow, rather it can be grown in the waste water like industrial effluent, sewage and salt water. Most importantly algae are able to grow year round with very less multiplication time (2-3 weeks) while other oil producing crops are generally annual and can be harvested once a year for oil production. Apart from synthesizing good amount of lipids, algae are the only known eukaryotes except blue-green algae (prokaryotes) with both oxygenic photosynthesis and a hydrogen metabolism.

Biological hydrogen production has several advantages over hydrogen production by any other mean. Hydrogen gas from algae due to its high energy content on a mass basis, easy availability and renewable nature is thought to be the ideal future fuel. Hydrogen gas synthesized form algae can be used to generate electricity which can be further utilized in transportation and domestic sectors. Green algae synthesizes hydrogen aerobically as well as anaerobically, during light periods however, the production of hydrogen gas is less in comparison to the dark periods. The reason behind this is the sensitivity of hydrogenase enzyme towards the photosynthetic oxygen. Blue-green algae (cyanobacteria) also synthesizes hydrogen gas in association with nitrogen fixation which occurs in a special structure called heterocyst. There are two major types of hydrogenases enzymes present in the algae: Fe-hydrogenases which is commonly present in the green algae and Ni-Fe-hydrogenases which is present in cyanobacteria.

What are biofuels?

Biofuel is solid, liquid or gaseous fuel derived from any biological carbon source including treated municipal and industrial wastes (Yuan *et al.*, 2008). Also known as agrofuel can be produced directly or indirectly from biomass (organic material) including plant materials and animal waste. Whereas biomass is defined as the renewable energy resource derived from the carbonaceous waste of various human and natural activities including the by-products from the timber industry, agricultural crops, raw material from the forest, major parts of household waste and wood. Biofuels derived from biomass do not release net carbon dioxide (CO_2) to the atmosphere; rather they recycle the CO_2. The advantages of biomass energy as an alternative energy source is its renewable nature, free from net CO_2 emissions and its abundant availability in the form of agricultural residue, city garbage, cattle dung and firewood. Biofuels are divided into three main categories: First-generation biofuels are made largely from edible sugars and starches, second-generation biofuels are made from non-edible plant materials and third-generation biofuels are made from algae and microbes.

Worldwide bioethanol is the most commonly used biofuel. It is an alcohol made by fermenting the sugar components of biomass. Today, it is made mostly from sugar and starch crops. Cellulosic biomass, like trees and grasses, are also used as feedstocks for ethanol production. Ethanol can be used as a fuel for cars in its pure form, but it is usually used as a gasoline additive to increase octane and improve vehicle emissions.

Biodiesel is a mixture of fatty acid alkyl esters made from vegetable oils, animal fats or recycled greases. It can be used as a fuel for vehicles in its pure form, but it is usually used as a petroleum diesel additive to reduce levels of particulate matter, carbon monoxide, hydrocarbons and air toxics from diesel-powered vehicles. In the United States, most biodiesel is made from soybean oil or recycled cooking oils. Animal fats, other vegetable oils, and other recycled oils can also be used to produce biodiesel, depending on their costs and availability. In the future, blends of all kinds of fats and oils may be used to produce biodiesel.

Biogas is produced by the process of anaerobic digestion of organic material by anaerobes. It can be produced either from biodegradable waste materials or by the use of energy crops fed into anaerobic digesters to supplement gas yields. Biological H_2 production, known as "green technology", has received considerable attention in recent years. Biohydrogen can be produced by a various methods, which includes water electrolysis, thermo catalytic reformation of hydrogen-rich organic compounds, and biological processes. H_2 gas, which is derived from algal biomass, is expected to become one of the key energy resources for global sustainable development.

Biofuels from algae

Algae are referred to as eukaryotic as well as prokaryotic, chlorophyll containing plant-like organisms that are usually aquatic, photosynthetic and ranges from unicellular to multicellular forms (marine algae). They do not exhibit true roots, stems, leaves, vascular tissue and have simple reproductive structures. Due to their wide availability they are ubiquitous in nature that grow in almost every drop of sunlit water and every gram of fertile soil, on the barks of trees, surfaces of animal shells, rocks and as symbionts in plants. Algae are found in the fossil record dating back to approximately 3 billion years in the Precambrian period and at present microscopic algae are found in almost all water bodies, covering over 75% of the earth surface.

Microalgae mass cultures have been considered for almost fifty years as potential biofuel sources, with the first conceptual engineering analysis presented in the late 1950's. Relative to terrestrial plants, microalgae are more efficient at converting sunlight into chemical energy, and require a smaller footprint and less water for cultivation (Dismukes *et al.*, 2008). Microalgae contain lipids and fatty acids as membrane components, storage products, metabolites and sources of energy. Algal oils posses characteristics similar to those of fish and vegetable oils, and can thus be considered as potential substitutes for the products of fossil oil. Direct lipid extraction from microalgae appears to be more convenient and cost effective than fermenting algae to produce either methane or ethanol.

More recently, emphasis has been on higher value fuels, particularly H_2 gas, preferably coupled to utilization of CO_2 from power plants. H_2 gas produced by the algae during the photosynthetic process is considered as the most potent future energy carrier because it is renewable and does not produces green house gas (CO_2) during combustion, it also liberated large amount of energy per unit weight and can be easily converted into electricity by the fuel cell. Biological H_2 production has several advantages over hydrogen production by photoelectrochemical or thermochemical processes. H_2 production by the photosynthetic microorganisms like algae is very cost effective in nature which only requires a transparent closed box with very low energy requirement in comparison to hydrogen production by solar battery-based water splitting. Till now lot of research has been done in the field of hydrogen production from algae.

Chlamydomonas reinhardtii, a type of green algae is considered to be the most potential species for hydrogen production. Apart form this various cyanobacterial species have also been reported for their high hydrogen production. Researchers are continuously exploring the new culture techniques by which they can fulfil the future energy demand.

Biological Hydrogen Production: Photosynthesis

Hydrogen production occurs during the process of photosynthesis. The process of photosynthesis occurs in the chloroplasts of plant cells. Chloroplast contains the reaction centres, which are generally known as the photosystems. There are two types of photosystems; photosystem-I (PS-I) and photosystem-II (PS-II). During the process of photosynthesis both the photosystems works simultaneously and absorbs light photons to create electron reducing potential. Upon light absorption the PS-II splits water molecule into oxygen gas and the electron released cascades through a series of reactions. The cascade of reactions creates a proton gradient across the thylakoid membrane which houses these reaction centres. The proton gradient drives the ATP synthase protein to generate adenosine triphosphate (ATP), an energy medium used in living organisms. At the same time photon absorbed by PS-I excites electron which is used by the ferredoxin (Fd), a water soluble protein, to reduce NAP^+ to NADPH. ATP and NADPH synthesized during the photosynthetic process are then used to reduce the CO_2 to built hexoses and other organic material. Plants lack the hydrogenase enzyme, present in green algae and cyanobacteria, which can catalyze the reduction of protons to H_2 under specific conditions (Benemann, 1997).

Hydrogen production in green algae

Hydrogen production in green algae is catalyzed by the Fe-hydrogenase enzyme which mediates the donation of high potential-energy electrons to protons. The hydrogenases containing no other metal than Fe are called Fe hydrogenases, also known as "Fe-only" hydrogenases. Two families of Fe-Hydrogenases are recognized: **first is** cytoplasmic, soluble, monomeric Fe-Hydrogenases, found in strict anaerobes such as *Clostridium pasteurianum* and *Megasphaera elsdenii*. They are extremely sensitive to inactivation by O_2 and catalyse both H_2 evolution and uptake; the **second is** periplasmic, heterodimeric Fe- Hydrogenases from *Desulfovibrio* spp., which can be purified aerobically and catalyse mainly H_2 oxidation. Cytochrome *C3* and cytochrome *C6* act as physiological electron donors or acceptors for Fe-Hydrogenases.

Photo-chemical H_2 production

H_2 production in green algae occurs within the chloroplast and it is light dependent process. The process of photosynthetic electron transport in green algae can operate with a photon conversion efficiency of 85-90% (Ley & Mauzerall., 1982; Greenbaum, 1988). The process of H_2 production starts with the absorption of photons (in PS-II) that result in the photo-splitting of water molecules, as a result proton, electron and a molecule of O_2 is produced. The electrons which are produced by the H_2O oxidation by PS-II are carried by number of electron carriers (plastoquinone, cytochrome b_6f complex and plastocyanine) to PS-I. As a result PS-I transfer the electron to ferredoxin, the reduced ferredoxin servs as the physiological electron donor to the Fe-hydrogenases. Finally Fe-hydrogenases accept the electron from ferredoxin and, using available protons, synthesise molecular hydrogen.

Nonphotochemical H_2 production

During photochemical process light energy is used for the photolysis of H_2O followed by electron generation which are then used by Fe-hydrogenases to produce H_2. In non photochemical H_2 production the electrons for the generation of H_2 comes from the oxidation of cellular endogenous substrate which is explained by the breakdown of starch under anaerobic conditions. The process of glycolysis converts starch into pyruvate, during this process NAD^+ oxidises to NADH + H^+ followed by the transfer of electron to plastoquinone pool (PQ) mediated by NAD(P)H plastoquinone reductase complex, latte on via PS-I electron transfers to ferredoxin and finally with the transfer of electron to Fe-hydrogenases complex H_2 is produced. In an another pathway, during anaerobic conditions pyruvate oxidises to acetyl-CoA by pyruvate-ferredoxin oxidoreductase complex, this complex also converts oxidised form of ferredoxin to its reduced form which then be used to reduce Fe-hydorgenases complex for the generation of H_2 (Posewitz *et al.*, 2009).

H_2 production via sulphur deprivation

Melis and co-workers in the year 2000 reported that by depriving sulphur in the culture medium of *Chlamydomonas reinhardtii,* H_2 production can be enhanced several folds. The chemistry behind this process lies in the modification of electron transport process in the chloroplast as a result of the partial inactivation of PS-II. Sulphur deprivation plays an entirely different effect on both oxygenic and mitochondrial respiration. On giving sulphur deprivation, after 100 h the photosynthetic activity of *C. reinhardtii* significantly decreases from ~44 (mmol O_2) (mol chlorophyll)$^{-}$1s^{-}1 to ~2 (mmol O_2) (mol chlorophyll)$^{-}$1s^{-}1. The reason behind the significant decrease in the level of photosynthesis is the decrease in the amount of sulphur containing amino acids; cysteine and methionine, which are needed in the biosynthesis of the proteins that are frequently required for the replacement of D1 kDa reaction centre protein in H_2O oxidising PS-II complex, present in the chloroplast. The photosynthetic rate of *C. reinhardtii* decreases as compared to the rate of mitochondrial respiration during sulphur deprivation. After some time the closed culture of *C. reinhardtii* become anaerobic as all the oxygen present in the culture is exhausted (Ghirardi *et al.*, 2000).

During partial inactivation of PS-II the electron produced during photolysis of H_2O cannot be consumed for the production of molecular oxygen, rather they are accepted by the proton available in the cell and with the help of Fe-hydrogenases enzyme, converted into H_2. Though sulphur deprivation produces good amount of H_2 gas, but it is necessary to add sulphur to the growth medium, because sulphur is the key ingredient of amino acids (cysteine and methionine) that polymerise to form certain proteins which are useful for the sustainability of the cell. So after some saturation limits of H_2 production the cell must be replenished with sulphur which do not let the cell die and again enable the cell to produce molecular hydrogen (Melis *et al.*, 2000).

Hydrogen production in blue-green algae (Cyanobacteria)

Cyanobacteria often referred to as "blue-green algae." While most algae is eukaryotic (multi-celled), cyanobacteria is the only exception. They are primitive in occurrence with some fossils dating back almost 4 billion years (Precambrian era), making them among the oldest organisms in the fossil record. Cyanobacteria may be single-celled or colonial. Depending upon the species and environmental conditions, colonies, sheets or even hollow balls may form from filaments. Some filamentous colonies show the ability to differentiate into three different cell types. Vegetative cells are the normal, photosynthetic cells formed under favourable growing conditions. Climate-resistant spores may form when environmental conditions become harsh. A third type of cell, a thick-walled heterocyst, contains the enzyme nitrogenase, vital for nitrogen fixation. Photosynthesis in cyanobacteria uses water as an electron donor and produces oxygen as a by-product. The photosynthesis occurs in membranes called thylakoids, with chlorophyll being employed to absorb the sun's rays.

Hydrogen production occurs in 14 different genera of cyanobacteria under wide range of culture conditions (Lopes Pinto *et al.*, 2002). The process of hydrogen production in cyanobacteria occurs in the special structure called heterocysts. The chief enzymes involved in the formation of hydrogen are hydrogenase and nitrogenase. In comparison to hydrogenases the enzyme nitrogenase is less sensitive to oxygen which is produced during photosynthesis process by the photolysis of H_2O. Cyanobacteria has develop a special mechanism to protect nitrogenase form oxygen i.e. the localization of nitrogenase inside the heterocysts where the concentration of oxygen is very low or completely absent that makes the process of H_2 production very efficient. H_2 gas is produced in the reaction when nitrogenases reduce atmospheric nitrogen into ammonia.

For production of hydrogen there are three enzymes present in the Cyanobacteria: 1) a nitrogenase, evolving H_2 during N_2 fixation; 2) an uptake hydrogenase, reutilizing this H_2; and 3) a bidirectional (reversible) hydrogenase (Hansel & Lindblad, 1998; smith, 1990; Rao & Hall, 1996; Schulz, 1996; Benemann, 1996). The nitrogenase enzyme is made up of two sub units: one is dinitrogenase which is heterotetramer ($\alpha_2\beta_2$), its main role is to break the atom of nitrogen. The second one is dinitrogenase reductase, it is a homodimer and its main role is to mediate the transfer of electron from the external source (ferredoxin of flavodoxin) to the dinitrogenase unit of nitrogenase (Flores & Herrero, 1994; Masepohl *et al.*, 1997; Orme-Johnson, 1992; Dutta *et al.*, 2005).

The second main enzyme present in the Cyanobacteria is hydrogenases. In different cyanobacterial species this enzyme is present in two different forms: uptake hydrogenases and bidirectional (reversible) hydrogenases respectively. Every hydrogenase found in cyanobacteria bind one iron and one nickel atom at its active site. These Ni-Fe-hydrogenases are classified into multiple groups out of which only NAD(P)H-dependent bidirectional hydrogenases can evolve hydrogen using electron from either NADPH or NADH (Vignais *et al.*, 2001; Carrieri *et al.*, 2008). The enzyme uptake hydrogenases catalyse the oxidation of H_2. This enzyme is found in the thylakoid membrane of the heterocysts and transfers the electron from H_2 to oxygen through the respiratory chain and the reaction is known as oxyhydrogenation. The enzyme uptake hydrogenase is made up of two sub-units, the larger subunit is responsible for the uptaking of H_2 and the smaller subunit is responsible for the reduction of oxygen. The cyanobacterial strains which contain uptake hydrogenases cannot synthesise net H_2 because the H_2 formed is again re oxidized by this enzyme (Dutta *et al.*, 2005). The enzyme bidirectional (reversible) hydrogenase is associated with the cytoplasmic membrane. It is believed to be a common cyanobacterial enzyme, and its presence is not linked to nitrogenase. The enzyme synthesises the H_2 via the reaction $2H^+ + 2e^- \leftrightarrow H_2$ (g). As discussed earlier the sources of the electrons are NADPH and NADH (Tamagnini *et al.*, 2002).

Improvement of algal strains for H_2 production

Among the hydrogenases present in all the hydrogen producing algal (blue-green & green algae) strains Fe-hydrogenase is the most sensitive to the oxygen gas, this sensitivity is due to the binding of oxygen molecule at the unoccupied coordination site located at the active centre of the enzyme (Hall *et al.*, 1995). Sustained hydrogen production can only be achieved when H_2ase enzyme will remain active in all adverse conditions. Various approaches by which hydrogen sensitivity can be achieved include genetic engineering and physiological separation of oxygen and hydrogen production. Through site directed mutagenesis or point mutation at *hyd*A gene which encodes Fe-hydrogenases, oxygen sensitivity may be achieved. This can be done by identifying that particular gene in the DNA sequence which encodes those amino acids where the oxygen irreversibly binds. Substitution of these regions with the help of genetic engineering may result in the oxygen tolerant algal strain (Das *et al.*, 2006). Uptake hydrogenase present in the cyanobacteria is responsible for the oxidation of H_2 where as the reversible hydrogenase synthesises good amount of H_2. By various genetic engineering techniques the activity of uptake hydrogenase can be down regulated or can be completely eliminated and with the increased activity of reversible hydrogenase the H_2 production rate of the cyanobacterial can be enhanced. For example in a mutant strain of *Anabaena* (AMC 414), the large sub unit of the uptake hydrogenase (*hup*L) was inactivated which result in the H_2 production at the rate which is twice the rate of the parent strain (Zhang *et al.*, 1983). The synthesis of uptake hydrogenase can also be blocked by giving such culture conditions which are deficient in Ni, as Ni is required for the assembly of the holo enzyme and for the catalytic activity of the enzyme (Hall *et al.*, 1995). With advanced molecular techniques now it is possible to over express Fe-hydrogenase encoding *hyd*A gene under strong promoters for enhanced hydrogen production. Genetic manipulation at transcriptional regulatory site results in the constitutive expression of *hyd*A gene which was found to be active under repressed conditions only (Mishra *et al.*, 2004).

NEWS & VIEWS

The threat of Ocean acidification

Oceans make up 71% of the planet, providing a habitat for 50% of all species, providing large volumes of oxygen and being the conveyor belt for climate. It was the production of oxygen in the oceans in prehistoric Earth that created the atmosphere and enabled diverse life.

The ocean is integral to life on earth, sustaining the atmosphere with moisture, keeping the planet cool enough, acting as a carbon sequester, ensuring the hydrologic/water cycle is constant and providing an invaluable protein supply to humans. It has taken humans just two hundred years to destroy the natural equilibrium that nature has established to keep the cycles going, the crisis disequilibrium we are facing is that of climate change, the human-induced radical changes to our climate system globally. Pollution emitted from a land-locked site, kilometres from the oceans will inevitably reach the oceans through the various interdependent cycles from the atmospheric cycle to the hydrologic cycle to biochemical cycle. Pollution released in one medium e.g. air emissions moves to other mediums such as soil and water and spreads across the globe.

Over the past 200 years the oceans have taken up 500 $GtCO_2$ from the atmosphere out of 1300 $GtCO_2$ total anthropogenic emissions. The *p*H of water in the ocean has been altered by a decrease of 0.1. Scientists during the early days of climate change impacts, recognized the invaluable role of the oceans as sinks for CO_2 but over time studies revealed how the oceanic environment is suffering due to this overload of CO_2, altering the biochemistry and ecosystem functioning of the oceans. It is estimated that the oceans absorb about a quarter of CO_2 emissions.

Atmospheric CO_2 reaches the ocean through precipitation, fallout, wind-blown particulate matter, in the ocean. CO_2 forms a chemical reaction with salt water, forming bicarbonate ions and carbonic acid. This creates irreparable damage to the ocean's *p*H balance, making it more acidic and thereby having a direct impact on *p*H dependent processes such as calcification. Calcium carbonate minerals, necessary for the formation of shells and skeletal structures of marine organisms are depleted, thus decimating species and having consequences for the entire marine food chain. This food chain extends to the terrestrial and ocean-land interface food chains where humans and bird life depend on the oceans as a direct food source.

Increased acidity in the ocean changes the ability of species to build the necessary physiological material needed to survive, shellfish need shells and marine animals require their skeletons as do we land animals. Can we imagine having your skeleton eroded with acid? Well that's exactly the painful reality been forced upon by humans on existing marine life-forms, let alone the reproductive and birth defects being suffered by new offspring due to the hindered calcification process arising from high content acid in the oceans. Coral reefs are a haven habitat for biodiversity, we have already destroyed them with marine development and ocean acidification will corrode and erode the reefs.

As with human-induced climate change impacts, increased oceanic CO_2 levels and acidification, are happening at such a rapid pace that unlike prehistoric changes over million-year timelines whereby nature can evolve and adapt, human destruction is happening in the blink of evolutionary time.

According to the US National Oceanographic and Atmospheric Administration (2011), estimates of future carbon dioxide levels, based on business as usual emission scenarios indicate that by the end of this century the surface waters of the ocean could be nearly 150 percent more acidic, resulting in a pH that the oceans haven't experienced for more than 20 million years.

Source: http://www.earthtimes.org

Coal pollution causes premature deaths

Air pollution from Europe's 300 largest coal power stations causes 22,300 premature deaths a year according to research report prepared by Stuttgart University's. The study, which was commissioned by Greenpeace International states that it costs billions of pounds for the treatment of people and in loss of working days. Air pollution from coal plants is now linked to more deaths than road traffic accidents in countries like Poland, Romania, Bulgaria and Czech Republic. Polish coal power plants have the worst health impact in the European Union and the irony is that Polish government is planning to build a dozen new power plants.

Acid, gas, soot and dust emissions from coal burning are, along with diesel engines, the biggest contributors to microscopic particulate pollution that penetrates deep into the lungs and the blood stream. Tens of thousands of kilogrammes of toxic metals such as mercury, lead, arsenic and cadmium are spewed out of the stacks, contributing to cancer risk and heart ailments.

Source: guardian.co.uk

Carbon dioxide emissions from Internet

Internet and other components of information, communication and technology (ICT) industry annually produces more than 830 million tonnes of carbon dioxide (CO_2), the main greenhouse gas, and is expected to double by 2020, according to researches carried out by the Centre for Energy-Efficient Telecommunication and Bell Labs. The report says that ICT industry which delivers Internet, video, voice and other cloud services, produces about 2 per cent of global CO_2 emissions -- the same proportion as the aviation industry produces. The same projection suggests that ICT sector's share in greenhouse gas emission is expected to double by 2020.

Source: The Economic Times

Air pollution killing 620,000 Indians, every year

According to the Global Burden of Disease (GBD) Study 2010, air pollution is now the fifth largest killer in India after high blood pressure, indoor air pollution, tobacco smoking and poor nutrition. Air pollution is killing 620,000 Indians, according to the report. Close to half of the total urban population breathes air which exceeds the permissible limits of PM10. According to the WHO guideline annual mean PM10 value should be below 20 micrograms per cubic metre and 50 micrograms per 24 hour. Finding released by the scientist showed that annual premature deaths caused by particulate air pollution have increased six-fold since 2000, with India seeing the greatest impact of outdoor air pollution making up for one fifth of global deaths related to air pollution.

The Global Burden of Disease (GBD) report is a world-wide initiative involving the World Health Organization which tracks deaths and illnesses from all causes across the world every 10 years.

Source: www.firstpost.com

Air Pollution causes Low Birth Weight Babies

According to a recent study by an international group of researchers that pregnant women exposed to black soot from urban vehicles and coal-fired power plants are more likely to have low birth-weight babies. The study was conducted and data analyzed on three million births collected at 14 sites in nine countries.

The massive survey found that at all these sites; pregnant women who breathed the most polluted air - as measured by carbon soot concentrations - were significantly more likely to have babies with low birth weights - below 2,500 grams or 5.5 pounds. At that size, a baby - if he or she survives infancy - is at risk of chronic health problems and learning disabilities later in life.

Particulate air pollution is determined by a combination of soot particle's concentration in a cubic meter of air, and their size, measured in microns.

According to a professor of obstetrics and gynecology at the University of California San Francisco, the impact varies with concentration and size of the particulate matter.

Source: VOA

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Email: casanz2013@arinex.com.au
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