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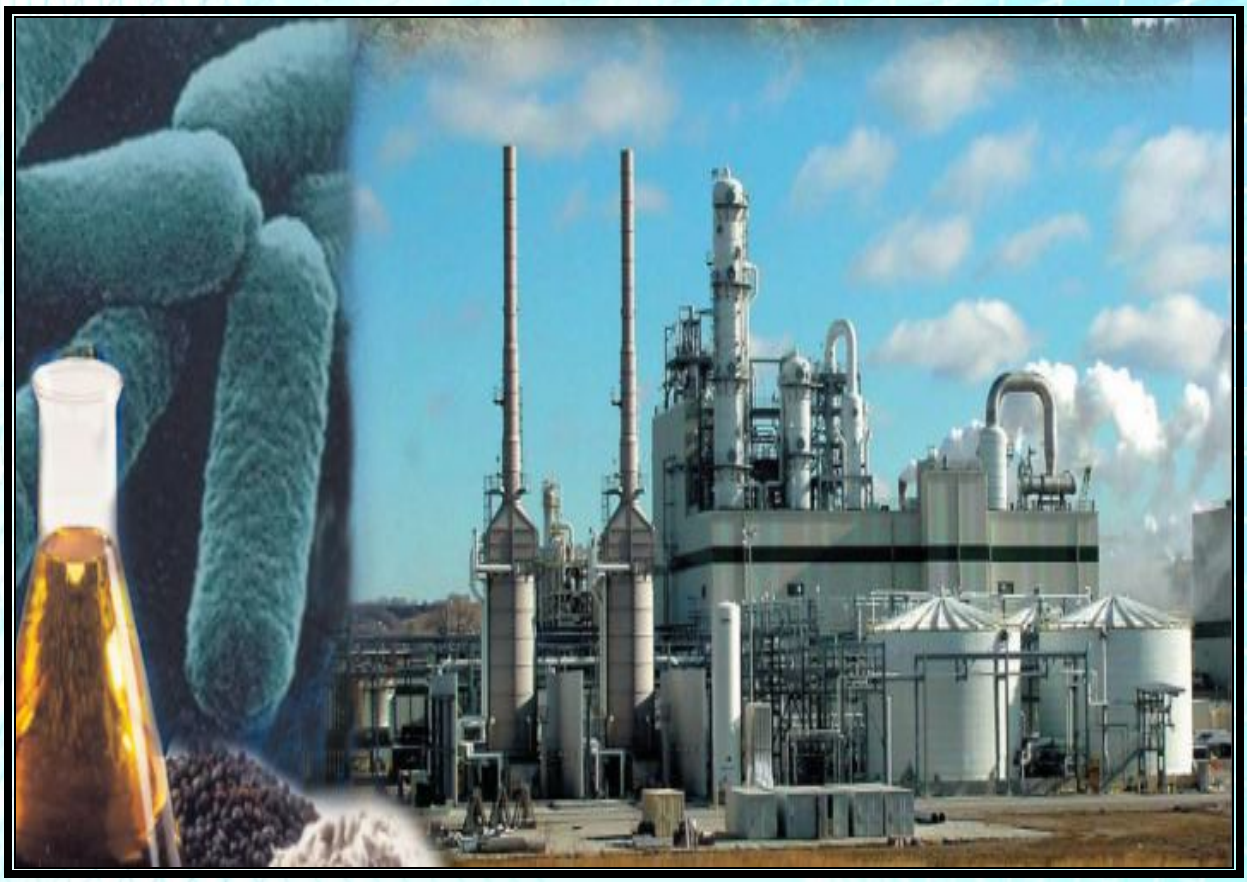
INDUSTRIAL APPLICATION OF BIOTECHNOLOGY

NEWS LETTER



DEPARTMENT OF ENVIRONMENTAL SCIENCE, UNIVERSITY OF KALYANI, NADIA, WEST BENGAL
Email: scsantra@yahoo.com, desku@envis.nic.in, Phone: +91-33-25828750, Ext :372
Telefax :+91-33-2580 8749,Website:http://www.deskuenvis.nic.in

EDITOR

PROF. S. C. SANTRA
(ENVIS Coordinator)

ENVIS STAFFS

DR. (MRS) ANUSAYA MALLICK
(Programme officer)

MR SOURAV BANERJEE
(Data entry operator cum web assistant)

INSTRUCTIONS TO CONTRIBUTORS

ENVIS Newsletter on Environmental Biotechnology is a half-yearly publication publishes articles related to the thematic area of the ENVIS Centre. Popular or easily intelligible expositions of new or recent developments are welcome

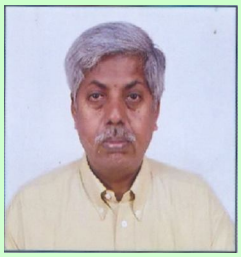
Manuscripts should be typewritten (font should be Times New Roman and font size ought to be 12) on one side of the paper in double spacing with maximum of 6-8 typed pages

Figures and typed table should be in separate pages and provided with title and serial numbers. The exact position for the placement of the figures and tables should be marked in the manuscript.

Articles should be sent to

The Coordinator
ENVIS Centre
Department of Environmental Science
University of Kalyani, Kalyani-741235
Nadia, West Bengal
Email:**scsantra@yahoo.com**
desku@envis.nic.in

EDITORIAL



A Third Wave of Biotechnology or Industrial Biotechnology – is strongly developing. This industrial biotechnology also referred to as White Biotechnology. This creating a new and more sustainable Industrial Revolution. It holds immense promise for transforming a wide variety of industrial processes by preventing pollution, reducing costs, conserving natural resources, and delivering innovative products to improve our quality of life. It applies the techniques of modern molecular biology to improve the efficiency and reduce the environmental impacts of industrial processes like textile, paper and pulp, and chemical manufacturing. It is in the interest of both business and government to foster the diffusion of these innovative applications into many sectors of the manufacturing economy. It is expected that industrial biotechnology will be increasingly adopted by chemical, pharmaceutical, food, and agricultural industries.

In this newsletter (Vol. no. 24). We have attempted to discuss the **Industrial application of Biotechnology** related issues and case studies.

(S. C. Santra)

IN THIS ISSUE:

INDUSTRIAL APPLICATION OF BIOTECHNOLOGY

FORTHCOMING EVENTS

QUERY FORM

Industrial Biotechnology

Industrial biotechnology is a set of practices that use living cells (such as bacteria, yeast, algae) or component cells like enzymes, to generate industrial products and processes (Fig.1). Products include biomass-based materials such as fuels and chemicals. Other processes include the treatment of waste water and energy efficiency measures. Industrial biotechnology use of genetically enhanced bacteria, yeasts, fungi and results in;

- ➲ lower production costs, more profit
- ➲ reduces or prevents pollution
- ➲ enhances resource conservation

Industrial biotechnology is known as white biotechnology because it have got positive environmental aspects like:

- ➢ Reduce waste generation.
- ➢ Reduce energy consumption
- ➢ Remove use of solvents
- ➢ Elimination of dangerous intermediate products

Industrial biotechnology can be used to:

- ➲Create new products, such as plant-based biodegradable plastics;
- ➲Replace petroleum based feed stocks by processing biomass using biorefineries to generate electricity, transport fuels or chemicals;
- ➲Modify and develop new industrial processes, such as by using enzymes to reduce the amount of harsh chemicals used in textiles and the pulp and paper industry;
- ➲Reduce the environmental impact of manufacturing; for example by treating industrial wastewater onsite using biological mediums such as microbes;
- ➲Provide energy savings by adding enzymes in detergents, allowing clothes to be washed in lower temperatures; and
- ➲Provide water savings through more efficient processes such as using enzymes to break down chemicals and reduce subsequent washing steps in the textile industry.

The application of biotechnology in Indian industry is still at a nascent stage. There are some success stories but still a lot needs to be done to make the industry to innovative research-oriented. India has a strong presence in generic drugs market and this has helped many Indian companies to enter the market products. Biotech industry ideally is not a homogenous sector like pharma or agro-industry. It has medical, agricultural and industrial biotechnology.

Fig: 1 Various facts of Industrial Biotechnology

Applications of Industrial Biotechnology

• Industrial toxic waste treatment

Biotechnology in industrial waste treatment and Bioremediation addresses the increasingly important topic of waste treatment. Biotechnology in industrial waste treatment and bioremediation examines the primary waste streams, including air, water, soils, sediments and explores specific treatment methodologies for industrial and environmental contaminants. The observations and successful field applications compiled in biotechnology in industrial waste treatment and bioremediation make it an excellent reference for understanding, evaluating, developing, and operating efficient and cost-effective treatment systems.

➢ Oilzapper: eliminate crude oil spills, manage oily sludge

Tata Energy Research Institute (TERI), New Delhi, developed an indigenous bacterial consortium, named **Oilzapper** by assembling four different bacterial species, isolated from various oil contaminated sites of India, which could degrade different fractions of Total Petroleum Hydrocarbon (TPH) of the oily waste (Fig. 2). The end product of bioremediation is CO_2, water and dead biomass which is environment friendly. Oilzapper technology has been applied by TERI for bioremediation of different types of oily wastes at different climatic conditions in India and abroad. TERI has bioremediated >1, 50,000 tonnes of different types of oily waste globally and presently >60,000 tonnes of oily waste is under treatment. In >100 field case studies of different batch size on *in situ* and *ex situ* bioremediation process by TERI. The initial TPH content varying from 5% to 52% has been biodegraded to <1% in major cases in 2–6 months. The bioremediated soil was non-toxic and natural vegetation was grown on the same. Successful fish culturing was done in one oil contaminated lake after bioremediation. Bioremediation technology has helped various oil industries for the management of their hazardous oily wastes in environment friendly manner. Bioremediation by Oilzapper technology is an ongoing investigation whose results are highly encouraging.

The end-users of Oilzapper are

1. Indian Oil Corporation Ltd., India
2. Bharat Petroleum Corporation Ltd, India
3. Hindustan Petroleum Corporation Ltd.
4. Oil and Natural Gas Corporation Ltd., India
5. Oil India Ltd., India
6. Indian Petrochemicals Corporation Ltd.
7. Reliance Industries Ltd., India
8. Abu Dhabi National Oil Company, Abu Dhabi
9. Kuwait Oil Company, Kuwait

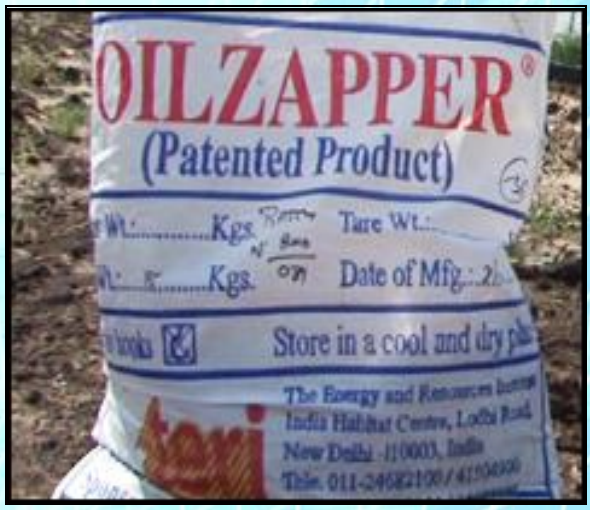


Fig: 2 Oilzapper product developed by TERI

Source:http://www.teriin.org/

➢ Biomethanation of organic solid wastes

The team (TERI Enhanced Acidification and Methanation) process offers a clean and hassle free solution to the problem of solid waste management (Fig.3). It produces good quality biogas with methane content 70-75% and rich organic manure from organic solid waste. The manure is richer in all the three major nutrients, namely nitrogen, phosphorus and potassium in comparison to other forms of manures like compost, green manure, farm yard manure and cattle dung manure. The whole process takes much lesser time than the conventional anaerobic or aerobic composting processes.

Source:http://www.teriin.org

Fig: 3 Biomethination of organic waste

➢ Biomining of industrial waste

Biomining is the recovery of metals from metal sulfide minerals or low grade ores in the mining industry, based on the ability of microorganisms to oxidize reduced iron and sulfur compounds. The disposal of vast quantities of hazardous industrial waste also results in contamination of both land and ground water, and causes serious environmental damage. Stringent environmental regulations require that these wastes be treated to mitigate its environmental impact. At the same time, these solid wastes (such as spent catalyst, electronic scrap material and incineration fly ash) with high metal values, may be viewed as secondary ores for metal recovery and recycling. Bio urban mining of these "ores" would also effectively reduce the need for primary mineral resources

Indeed, bio urban mining represents a green technology with low cost and low energy requirements (compared to conventional pyrometallurgical and hydrometallurgical leaching which requires the use of high temperature and pressure and strong acidic conditions). The use of microorganisms as biocatalysts in bio urban mining would solve the problem of detoxification of hazardous wastes, as well as allow resource recovery through the reclamation of metal values (Brandl et al,. 2001).

✓ 'Bio mining' garbage for compost

The Bruhat Bangalore Mahanagara Palike (BBMP) is exploring bio-mining in Bangalore's garbage. Bio-mining is clearing landfills by converting waste into compost, methane gas, bio-diesel and power.

Fig : 4 Garbage to bio-compost through Biomining
http://www.hindu.com/

Autonagar, Hyderabad: An enterprising entrepreneur's firm has been incessantly dredging into portions of estimated 45 lakh tonnes garbage dumped over a period of two decades to convert it into bio-compost. Bhavani Bio-Organics Pvt. Ltd. has been making the compost for use in agriculture enriching the soil with vital nutrients in a first of its kind exercise anywhere. "Bio-mining" happens when compacted garbage is injected with air through perforated pipes and microbes with constant tossing and turning for a few days to convert it into the mineral rich compost. (Fig.4)

➢ Nashik Compost Project: Municipality Solid Waste (MSW) to compost

Nashik is the only city in Maharashtra which has taken lead towards scientific management of MSW. The Nashik Municipal Corporation is collecting 300-350 Tons MSW per day. A compost factory has been established by the corporation for converting garbage into valuable compost /manure. Nashik Municipal Corporation has established a compost plant at the cost of Rs.4.61 crores from its own funds for the processing of waste. The plant is fully owned by the municipal corporation the waste collected is transported to the compost plant where it is mechanically segregated and processed to produce fine quality compost. The non-biodegradable material, which cannot be converted into compost is transported to the sanitary landfill site developed near the compost plant. Most of the organic waste is converted in compost and sold to farmers (Fig. 5).

Fig: 5 Compost packising at Nasik's facility

➢ Jordan: Aman Landfill Gas Project

Collaboration between the Greater Amman Municipality (GAM) and the World Bank in municipal solid waste disposal constitutes an important step towards a greener society, through the implementation of the first commercial-scale project converting landfill gas to energy at the Ghabawi Sanitary Landfill site. This is an innovative solid waste management project that will contribute not only to the improvement of solid waste management in greater Amman, but also offers Amman the opportunity to mobilize additional and unconventional revenues and to mitigate negative environmental effects at both the local and global level. One of the main component objectives of this project is to avoid methane (a greenhouse gas) emissions from the Ghabawi Sanitary Landfill by installing landfill gas collection and electricity generation plant. This will introduce environmentally friendly technology, and generating electricity from LFG. (Fig. 6)

Source:http://www.worldbank.org

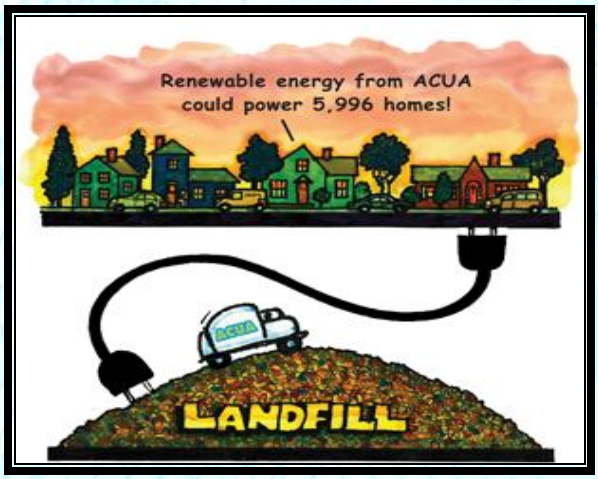


Fig: 6 Landfill gas to energy

➢ Integrated Microbial and Algal Effluent Treatment (IMAET) Biotechnology For Biomanagement of liquid effluent

Integrated Microbial and Algal Effluent Treatment (IMAET) biotechnology developed by Biotechnology Resource Centre (BRC), Mumbai, India. It has been successfully implemented for the bio-management of primary and secondary biodegradable liquid effluents produced by diverse industries such as gelatin, food processing, soybean oil extraction plants, paper mills, textile units etc. in India. The liquid effluents under study yielded substantial BOD and COD loads, low pH, high TSS and TDS contents. The liquid effluents were subjected to treatment by specific enzymes and microbial consortia. Later, this pretreated effluent (50%) in combination with BRC-Spiru^{TM} medium was utilized for cultivation of commercially important micro-algae such as Spirulina, Chlorella etc. Within 15-16 days the final treated water exhibited a significant decrease in COD by 90.08 ± 0.176%, and BOD by 89.24 ± 0.544%. The final treated discharge was applied for secondary usages. Bio-safety of the harvested biomass was tested on fish and mice (Ghatnekar et. al, 2010). (Fig. 7&8)

Fig: 7 Effluent treatment for BRC's IMAET biotechnology treatment

Fig: 8 Spirulina cultured in BRC, Control and gelatine wastewater (50%) treated in BRC-Spiru^{TM} medium

• Waste water treatment

➢ Wastewater use in aquaculture

The East Calcutta sewage fed fishery are the largest single wastewater use system in aquaculture in the world. The wetland ecosystem of Kolkata supports 100,000 direct stakeholders and 5,100ha of cultivation. Annually, it provides direct employment for about 70,000 people, produces 128,000 quintals of paddy, 69,000 quintals of fish and 7.3 quintals of vegetables (Fig.9)

Fig: 9 Swage fed fishery in Calcutta

➢ Waste water use in Agri-horticulture

Vegetables: In New Delhi, about 12,000 farmers use treated wastewater in areas around Keshopur STP and Okhla STP to irrigate 1,700 ha of land to grow vegetables. In Hyderabad, about 13 different kinds of vegetables are grown with wastewater all year round. (Fig. 10)

Fig: 10 Agriproducts grown in waste water

Flowers: Farmers in Kanpur grow roses and marigold with wastewater. In Hyderabad, the farmers cultivating Jasmine through wastewater generates a lot of employment. The jasmine plantation produces flowers for 8-9 months per year and a 118 farmers can earn approximately Rs. 15,000 to Rs. 20,000 per ha for an 8-9 month flowering season.

Plantation of Avenue trees and parks: In Hyderabad, secondary treated wastewater is used to irrigate public parks and avenue trees.

Fodder crops: In Hyderabad, along the Musi River about 10,000 ha of land is irrigated with wastewater to cultivate para grass, a kind of fodder grass.

Agroforestry: In the villages near Hubli-Dharwad in Karnataka, the main wastewater-irrigated agroforestry land uses are orchards and agrosilviculture which consists of spatially mixed tree-crop combinations.

• Waste to wealth

Waste to Wealth is about creating economic benefits out of what was traditionally regarded as waste. Generation of wastes is inevitable in all industrial processes. Each industry is unique in its waste generation spectrum. In the background of rising energy costs, scarcity of resources, and deterioration of ecological systems, innovative mechanisms to shape waste into useful ingredients (energy and/or other useful by-products) represents an appealing solution to several pressing problems.

➢ Waste to Wealth' programme by KCI

The Waste to Wealth programme is based on unified technology used at Kanoria Chemicals & Industries Limited (KCI). KCI's Ankleshwar Chemical Works for gainful utilisation of waste generated from manufacturing processes. The programme has three components, namely,

- ➲ Waste to Water,
- ➲ Waste to Energy and
- ➲ Waste to Soil Nutrients.

• Waste to Water

The technology is used for recovery of recyclable water from effluent, KCI identified Reverse Osmosis (RO) technology as a possible route for achieving of maximum recycle and minimum possible disposal.

• Waste to Power

The bio-gas produced during treatment of distillery effluent is gainfully used for power generation after removing its H_2S content with the help of 'Thiopaq' scrubber technology supplied by Paques Bio-system of the Netherlands. This has reduced Sulphur emission into the atmosphere from 900 kg to 9 kg per day.

• Waste to Soil Nutrients

The bio-compost plant not only helped in increasing the production level, but has also made it possible to put up a demonstration farm growing various types of crops such as sugarcane and banana to showcase the effectiveness of bio-compost as good manure. The use of distillery waste in bio-compost results in recycling of nutrients available in the molasses back to the soil, and at the same time reduces the dependence on chemical fertilizers.

➢ Bharatiya Agro-Industries Foundation

Bharatiya Agro-industries Foundation (BAIF) mission is to create opportunities for gainful self-employment for the rural families, especially disadvantaged sectors, ensuring sustainable livelihood, enriched environment, improved quality of life, and good human values (Fig. 11)

BAIF provides complete livelihood support through the Livelihood Support Programme to the farmer, and his entire family. It provides first inputs like neem cake, bone meal; then bio-fertilizers and then mixed fertilizers. Bio-fertilisers are thus a part of a package of inputs provided to the farmers. The focus is on the creation of self-sustaining units, where production of inputs, utilization of family labour, and generation of income takes place. The farmer, thus, gets income from various sources like forestry, horticulture, grasslands, vermi-compost, and so on.

Fig: 11 Agro industrial activities

➢ Vermi Composting from Solid Waste

This case study is about round the year production of vermi compost by reuse & recycling of cattle dung and cow dung slurry from Gaushla and Biogas plants and its successful management through a low cost technology at village Bhounti; promoted by Kanpur Gaushala Society (KGS), Kanpur, Uttar Pradesh and is a good example of income generation from solid waste management by using a very low cost technology (Fig. 12).

Fig: 12Vermi Composting from Solid Waste

➢ Kumar Krishi Mitra Bio-Products

Kumar Krishi Mitra (KKM) bio-products Pvt. Ltd. is a biotechnology company, which focuses on the use of beneficial microbes for environment friendly agriculture. The main aim is enhanced profitability through increased sale of bio-fertilizers. It provides safe inputs to farmers, to increase soil productivity and yield. It focuses on research, discovering, cultivating, and marketing safe and environmentally friendly microbial inputs for agriculture for domestic and foreign markets.

KKM manufactures a range of liquid bio-fertilizers and bio-pesticides. Bioplin is a liquid bio-fertilizer for Nitrogen supplementation and contains nitrogen-fixing strains of *Azotobacter*. Phosfert is a liquid bio-fertilizer for Phosphorus supplementation and contains phosphate solubilising strains of *Azotobacter* and *Bacillus polymyxa*. Vitormone is a liquid bio-fertilizer used for foliar application

➢ Wood Substitute from Industrial waste

Industrial wastes such as redmud, flyash, jarosite, marble slurry dust, copper tailings, and natural fibres like sisal and jute have been used as fillers for developing a variety of polymer composites. The materials have been subjected to a characterization such as resistance to weathering and fire, mechanical, chemical, wear etc. A comparison of features shows higher strength, greater resistance to corrosion and weathering for the developed materials than that of the conventional ones (wood). They are also insensitive to attack by termite, rodent, rot etc unlike wood. Display of their self extinguishing nature helps to reduce the severity of damage to the residents and buildings in the event of fire hazards. Also, their less maintenance and basic costs than wood make them further attractive. Products like door shutters, roofing sheets, panels etc. for building applications, as well as furniture. etc. (Fig. 13)

Fig: 13 Manufacture of structural materials from waste

➢ Production of single cell protein (SCP) from pineapple waste using yeast.

Single-Cell Protein (SCP) represents microbial cells (primary) grown in mass culture and harvested for use as protein sources in foods or animal feeds. Pineapple waste was used as sole carbon source in five concentrations for preparation of fermentation media on which two strains of yeasts, *Saccharomyces cerevisiae and Candida tropicalis* were grown. The increased concentration of pineapple hydrolysate enhanced the biomass yield and the protein formation within the yeast cells. Lower carbon utilization by the two yeast strains occurred in the waste containing media. It helps in the SCP production from cheap enexpensive agro materials. (Fig. 14).

- (Dhanasekeran, et al., 2011).

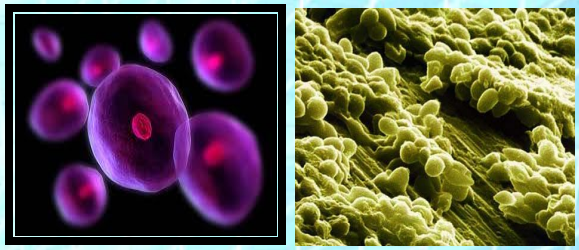


Fig: 14 Single-Cell Protein

➢ Utilization of fruit wastes for production of single cell Protein

The bioconversion of fruit wastes into single cell protein production has the potential to solve the worldwide food protein deficiency by obtaining an economical product for food and feed. Using food processing leftovers in the production of single cell protein as substrate would alleviate pollution. The cucumber and orange peels were evaluated for the production of single cell protein using *Saccharomyces cerevisiae* by submerged fermentation. Results showed that tested fruit wastes were highly susceptible to hydrolysis. A comparative study of fruit wastes revealed that cucumber peel generates higher amount of protein followed by that of orange with 53.4% and 30.5% crude protein respectively per 100 gm of substrate used. Percentage of protein in single cell protein was much lower (17.47%) when *Saccharomyces cerevisiae* was grown on supplemented fruit hydrolysate medium that contained inorganic nitrogen sources but devoid of glucose. (Mondal, et al,. 2012)

➢ Ethanol production from the organic fraction obtained after thermal pretreatment of municipal solid waste (MSW).

The use of organic fraction from municipal solid waste (MSW) as substrate for ethanol production based on enzymatic hydrolysis was evaluated. MSW was subjected to a thermal pretreatment (active hygienization) at 160ºC from 5 to 50 min. The organic fiber

obtained after 30 min was used as substrate in a simultaneous saccharification and fermentation (SSF) and fed-batch SSF process using cellulases and amylases. In a fed-batch mode with 25% (w/w) substrate loading, final ethanol concentration of 30 g/L was achieved (60% of theoretical). In these conditions, more than 160 L of ethanol per ton of dry matter could be produced from the organic fraction of MSW. (Fig.15)

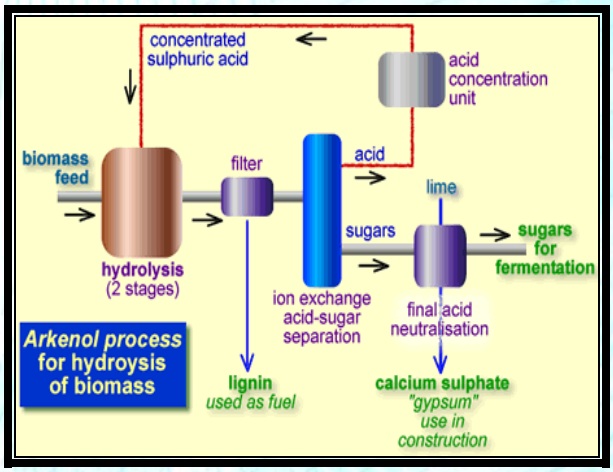


Fig: 15 Ethanol production from waste

Waste handling companies

✓ Eco-wise

Headquartered at Noida, India. Ecowise waste management provides comprehensive waste management services to a variety of establishments including residential, commercial and industrial entities. They ensure that, the waste collected by them are treated and disposed in accordance with MSW Rules 2000. Ecowise is an ISO 9001, 14001 and 18001 Certifications. It is currently collecting waste from Center Stage Mall,Noida, Haldiram, ATS.,etc.

✓ Vermigold

Vermigold is an on-site organic waste recycling Systems Company which combines advanced vermiculture biotechnology with cutting edge engineering to enable end users to Recycle organic waste in a trouble free and eco friendly manner. Vermigold ecotech has won the 2013 Energy Globe award from India. It is India's first and only Internationally certified waste management system that certifies their system as best in class and kindest to the environment.

✓ Synergy Waste Management (P) Ltd.

It is one of the leading service providers for Bio-Medical waste management in India. Promoters are the Rawalwasia Group. They are generally operators of Common Bio-medical waste treatment facilities, part of urban infrastructure in India. Areas of operations are New Delhi, Meerut, Lucknow, Hisar, Bhagalpur and Gaya. It is ISO 9001: 2008 and ISO 14001: 2004 certifications. Also, it is the largest Indian home grown operator of CBWTFs.

✓ Timarpur-Okhla Waste Management Pvt Ltd.

Timarpur-Okhla Municipal Solid waste management project is the first commercial waste-to-energy facility in India that aims to convert one-third of the Delhi garbage into the much needed electricity, enough to serving 6 lakh homes. The project is CDM is registered with United Nations Framework Convention on Climate Change for earning Carbon Credits.

✓ Attero, Electronics Asset Management Company

Attero is India's largest integrated end-to-end electronics asset management company. Attero aims to increase value for all electronic inventories, right from end of life electronics to surplus and seconds electronics, while ensuring a safer and more secure future for the planet. It is mainly concerned with E-waste mining.

✓ Antony Waste Handling Cell Pvt. Ltd.

Antony waste handling cell, an offshoot of Antony group of companies, Mumbai is one of the leading players in the field of Solid waste management services in the country, since the past 8 years. It has features as Engineered Sanitary land filling., Refuse Transfer stations, etc.

✓ UPL Environmental Engineers Ltd.

UPL has always made conscious efforts in maintaining and improving standards of environmental care. This group roofed the experts in environmental care. The name includes, Bharuch Enviro Infrastructure Pvt.

Ltd., Enviro Technology Ltd., Gharpure Engineering and Construction Pvt. Ltd.

✓ **Shivalik Solid Waste Management Ltd.**

Shivalik Solid waste management Limited as offshoot of UPL group of companies, Mumbai. Areas under which Shivalik Solid waste management Ltd. Is providing services are Treatment, Storage and Disposal facilities, Multiple effect evaporator, Empty used drums, Environmental monitoring and laboratory analytical services, Waste oil/used oil, Paint Sludge, e-waste and CFL, Used lead acid batteries, EIA, Environmental consultancy, Environment statement, Energy audit, Waste water management consultancy.

✓ **Greenobin**

It is a Gurgaon based startup that is focussed on collecting paper waste and market the same to paper recycling plants for further use. Its services include, Office Recycling, Security Shredding, Recycling bins. The start initially focuses on Corporate offices, followed by school/colleges and households as primary customers.

✓ **Green Power Systems**

Green Power Systems (GPS Renewables Pvt. Ltd.) is a waste management technology firm. GPS custom builds units for an unsegregated waste ecosystem. The inaugural products, BioOrja and Biowaste Shredder, are arguably the first waste-to-energy solution for urban India. GPS intends to enable any urban establishment to have an economically viable waste - to - energy solutions.

✓ **Let's Recycle**

It is an initiative of NEPRA Resource management Pvt. Ltd., a social enterprise that operates in segment of dry waste management and recycling, where it collects dry waste from waste generators and segregates the recyclables and sends to authorized recyclers. It currently provides employment to 302 employees, comprising of 76 women. It has ragpickers of 1076. It provides environmental benefit- diverted over 3000+ MT towards recycling.

Source: http://thetechpanda.com/

• Waste to energy

The most significant waste-to-energy technologies are based on biological or thermal methods. Biological method involves bio-methanation producing methane enriched bio-gas, which can be used as fuel whereas thermal method (incineration) involves combustion of organic wastes as fuel with the evolution of heat energy for recovery (Fig. 16).

Advanced thermal conversion involves destructive heating of organic materials with a limited supply of oxygen (gasification) or without any oxygen (pyrolysis) to produce a combustible gaseous product consisting of simple hydrocarbons and hydrogen.

Fig: 16 Energy generation from waste

➢ **Waste to electricity plant**

The Municipal Corporation of Delhi (MCD) embarked on a project to reduce the amount of MSW (7,000 MT of MSW daily, which is expected to increase to 18,000 MT by 2021) being disposed in the landfill sites and utilizing the waste for productive purposes such as generation of power from waste. MCD has identified two locations, namely Timarpur and Okhla, for implementing this project. 16 MW power generation from 450 Tons/ day RDF from Okhla Plant + 225 Tons/day RDF from Timarpur Plant + Biogas from Bio-methanation Plant (100 Tons/day) at Okhla using segregated green waste. Since January 2012, 190 million units of electricity have been generated and 158 million units supplied to the National grid.

The following facilities are to be developed as a part of the integrated municipal waste handling project:

- Plants for converting MSW to Refuse Derived Fuel (RDF), capable of processing 1300 TPD at Okhla and 650 TPD at Timarpur.
- A bio-methanation plant capable of handling of 100 TPD of green waste at Okhla.
- A water recovery plant capable of handling up to 6 MLD of treated sewage at the Okhla site for recycling into process water and cooling water.
- A Power plant with a generation capacity of 16 MW at Okhla.
- Transportation of RDF from Timarpur to Okhla for combustion in the boiler of the power plant mentioned above.

Jindal ITF, part of Jindal SAW, has sourced German technology to efficiently get rid of as much of the city's solids waste as possible and in the bargain generate energy (Fig. 17).

Fig: 17 Timarpur-Okhla Waste Management

➢ Earth Stove

Nishant Bioenergy develops and sells cooking stoves fuelled by biomass residues. It is designed for use throughout the day, and sized to provide full meals for up to 650 people. At one end of the stove the briquettes are fed by hand into the combustion chamber, at a rate of about 15 kg per hour: this can easily be varied to suit cooking needs. The hotplates, which hold two large (250 litre) cooking pots, can also be used for making chapattis, which are familiar home food and very popular in boarding schools. The exhaust gases flow out of a chimney through the roof of the kitchen. A 400 litre water tank around the chimney absorbs heat from the exhaust gases, and provides water at up to 90^{o} C for cooking and making tea (Fig. 18).

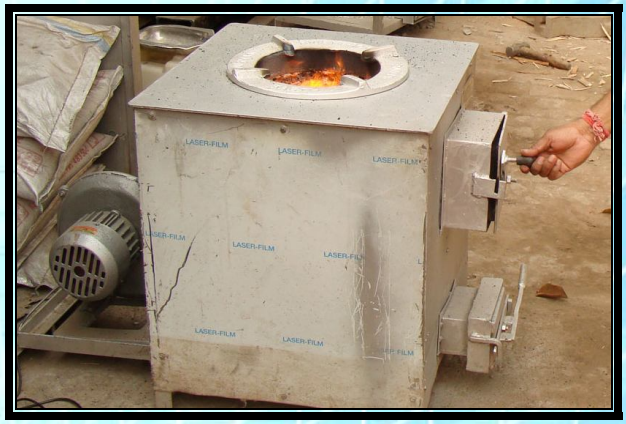


Fig: 18 Fuel efficient Earth Stove

Source:http://www.nishantbioenergy.com/

➢ MSW to Electricity Generation Project

Hyderabad (A.P) is generating 3500MT garbage everyday. GHMC has adopted new technology of energy recovery from MSW management. Electricity from 400MT garbage (MSW) daily. The technology involves two steps; separation of combustible & non-combustible from MSW; conversion technology from MSW to Eco-friendly RDF fuel. Plant receives 117,250 tons of unprocessed MSW on annual basis. Approximately 50% of combustible material can be recovered from 350 tons of unprocessed waste. RDF, which is derived from organic material, includes paper, textile, kitchen waste & wood. Power plant uses 75% of MSW organic waste (combustible material) with 25% of rice husk procured from the neighboring rice producers. The generated electricity is supplied to the grid through a grid substation located at a distance of 3.5 KM from the power plant (Fig. 19)

Fig: 19 Municipal Solid Waste Power Plant

Table1: Successful Waste-to-Energy Plants in India based on Anaerobic Digestion

Location	Capacity	Feed type	Type of reactor used	Biogas utilization
Leather & Abattoir Industry Waste				
Rudraram, Andhra Pradesh	60 tpd	Abattoir waste	BIMA	Boiler fuel
Melvisharam, Tamil Nadu	5 tpd	Fleshing & primary sludge	CSTR	Aerator operation
Melvisharam, Tamil Nadu	2 tpd	Tannery fleshing &sludge	UASB	Boiler fuel
Dewas, Madhya Pradesh	1.2 - 1.5 tpd	Chromed leather dust	UASB	UASB
Vegetable Market Yard Waste				
Vijayawda, Andhra Pradesh	20 tpd	Vegetable market and slaughterhouse waste	UASB	Power generation
Koyambedu, Tamil Nadu	30 tpd	Vegetable waste	BIMA	Power generation
Municipal Wastewater/ Sewage				
Bhubaneshwar, Orissa	400 m3/d	Domestic Sewage	Fixed film	Heating and illumination
Surat, Gujarat	0.5 MWe	Domestic Sewage	Anaerobic sludge	Power generation
Animal Agro Residue				
Karur, Tamil Nadu	12000 m3/d	Bagasse wash water	UASB	Lime kiln
Ludhiana, Punjab	235 tpd	Cattle manure	BIMA	Power generation
Fruit and Food Processing Waste				
Dharmapuri, Tamil Nadu	12000 tpd	Tapioca waste water	HUSMAR	Power generation

http://www.altenergymag.com/emagazine.php

Waste to energy profile companies

1. Kanoria Chemicals

Use of anaerobic digesters for bio methanation of effluent producing biogas to be utilized for generating electricity.

Outcome: At an initial outlay of under Rs. 9 crores, a 2 MW plant has been put up producing a little over 1 million units of electricity each month and generating a saving of Rs 40 lakhs /month.

2. Agarwal Duplex Ltd.

Replacement of the existing boiler with a new fluidised bed boiler. The new boiler used bagasse as a fuel in place of coal under high pressure. The steam from this boiler was used to power extraction cum condensing turbine to produce electricity.

Outcome: At an initial outlay of $2 million, the project resulted in annual savings of $1.5 million for the company. Reduction in GHG emissions by 37.4 tons per year.

3. M/s Alkabeer Exports Ltd.

Biogas plants were installed for treating both solid and liquid wastes generated from slaughterhouse. The sludge from the anaerobic digester is dried and is being marketed as a nutrient rich soil conditioner

Outcome: The biogas plants have resulted in a total saving of Rs 6.00 lakh per month; Adoption of biomethanation technology has resulted in saving of furnace oil as well as chemicals used for treatment of wastewater.

4. Vasundhara Dairy

Upflow Anaerobic Sludge Bed (UASB) technology used for converting Waste to Energy with Biogas; Produced biogas is flared into the atmosphere.

Outcome: 40 cubic meter of Biogas produced; Plant investment - Rs 45 Lakhs

5. Varalakshmi Company

UASB technology used for conversion of Waste to Energy project using DFG engine

Outcome: Power generation plant of 0.2 MW - run using a 40 TPD sago effluent plant; Capital Investment of Rs 3.6 crores leading to production of almost 1.2 lakhs of electricity units (in KWh) per month.

6. **Universal Starch**

UASB technology used for conversion of Waste to Energy project; Produced biogas is fed to the boiler to save boiler fuel consumption.

Outcome: Project cost of Rs 2 crores - 10,000 cubic metres of biogas produced each day

7. **Vensa Biotek**

UASB technology for biomethanation of effluent producing biogas to be utilized as fuel in the boiler. Produced biogas is used directly as fuel for generating steam in the boiler.

Outcome: Project cost of Rs. 1.8 crores for 8,000 cubic meter per day biogas production; Payback period of 4 years

- **Industrial pollution abatement**

1. Odour Control in Domestic Solid Waste Treatment Plant, Chennai

A decentralized integrated bio-mechanization plant has been implemented near Koyambedu Market in Chennai to utilize vegetable, fruit, flower wastes. The plant generates about 2000 m^3 of biogas and 4 tons of bio-fertilizer from 30 tons of degradable wastes. The biogas is being converted into electricity using biogas engine and connected to Tamil Nadu Electricity Board power grid. For the first time odour control system with bio-filter is implemented with contributions by Ministry of Non-Convention Energy Sources, Govt. of India and Chennai Metropolitan Development Authority. The main sources of odour are from waste storage yard, collection sump, sorting area and minceration unit. The air from these areas is collected through presuction pipes and connected to a blower. The inlet of the pipe is covered with anticorrosion mesh to avoid flies and solid particle entry into the pipe leading to bio filter. A bio filter is developed using wooden chips as media. Water is sprinkled occasionally to keep the media under wet condition.

2. Anoxic Bioremediation

i. In Hauz Khaz Lake, New Delhi

The lake receives treated sewage from near by Vasant Kunj Sewage Treatment Plant with a daily flow of 3MLD. The treated wastewater from the STP into the lake becomes a problem when sometimes untreated sewage of STP finds its way into the lake along with the treated one. This situation led to deterioration of lake and strong odour was emanated causing nuisance in the neigbourhood. In order to solve this problem by natural in-situ treatment, Anoxic Bioremediation Technology (ABR) was implemented using selected anaerobic and facultative microbes Persnickety® 713 (FIg. 20)

Fig: 20 Hauz Khaz Lake, New Delhi

ii. In Kushak Drain, New Delhi

Bioremediation on Kushak Drain has been carried out on 2.8 km stretch from S.P. Marg to Satya Sadan. New Delhi. The project was contracted to JM Enviro Technologies Pvt. Ltd. Company with an objective to treat the wastewater biologically by using the bacterial product Persnickety@713 in order to achieve CPCB standards for ground water recharge; to provide odourless atmosphere to the inhabitants surrounding the drains and to remove all the floating materials in the drain (Fig. 21).

Fig: 21 Kushak Drain, New Delhi, New Delhi

Export of Biotech products in India

The performance of the industry is gauged at economy level - contribution to GDP, Export, quantum of sales etc. It could also at the technology level – capability to innovate, nurture innovation and compete locally and globally through introduction of products (Fig. 22 & Fig. 23)

Source:http://www.nistads.res.in/

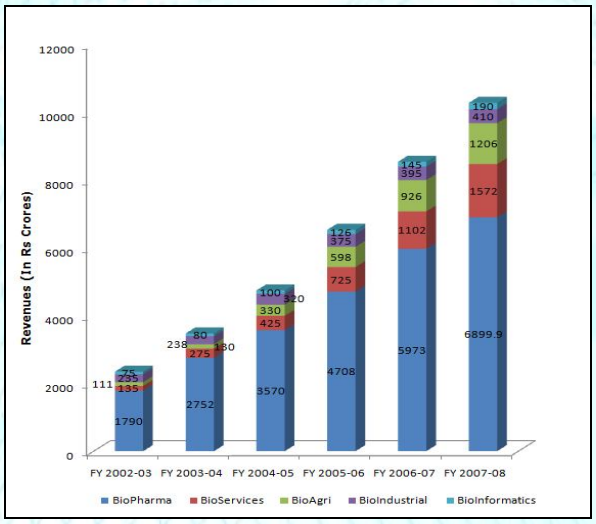


Fig: 22 Growth of revenue for Indian Biotech industry 2002-2007

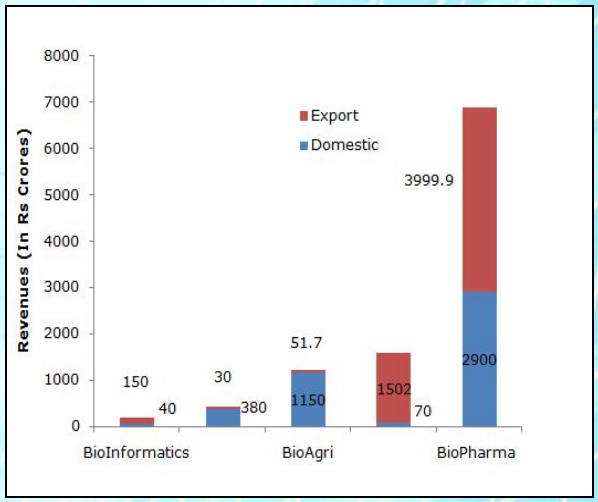


Fig: 23 Biotech Industrial products (Domestic Vs Export)

Table 2: Biotech Industry Exports of different sectors during FY 2009-11

Segment	2009-10		2010-11	
	Exports Rs Crore (US$ Million)	Share (%)	Exports Rs Crore (US$ Million)	Share (%)
BioPharma	4767.7 (1081.7)	54	5535.4 (1255.6)	52
BioServices	2507 (569)	95	2986.3 (677.4)	92
BioAgri	58.1 (13.2)	3	74.4 (16.9)	3
BioIndustrial	124.1 (28.2)	22	150.2 (34.1)	24
Bioinformatics	73.9 (16.8)	32	106.02 (24)	42
Total	170.9 (38.8)	53	8852.3 (2008)	51.3

Source: Association of Biotechnology led Enterprises

FORTHCOMING EVENTS		
Events	**Date**	**Place & Correspondence**
16th European Congress on Biotechnology, Edinburgh	July 13 - 16 2014	London,UK https://www.eiseverywhere.com
International Conference on Nanotechnology:Fundamentals and Applications. (ICNFA's 14)	August 11-13, 2014	Prague, Czech Republic http://icnfa.com/
9th Conference on Sustainable Development of Energy, Water and Environment System	September 20 – 27, 2014	Venice-Istanbul http://www.mediterranean2014.sdewes.org/
Biosensors: Application in Industrial Biotechnology	October 21 2014	London, UK https://www.soci.org/
3rd Global Sustainable Biotech Congress (GSBC) - 2014 (GSBC-2014)	Dec 01-05, 2014	Maharashtra, India http://www.nmu.ac.in/gsbc/en-us/home.aspx

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