

EUROPEAN CHITIN SOCIETY NEWSLETTER

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EDITORIAL

This issue is the first of the Newsletters for 2011, the recent Special Issue being officially the much delayed second one of 2010.

First I would like to extend my personal sympathy to all our Japanese colleagues for the natural disaster that occurred there recently and which continues to cause disruption to Japan and its inhabitants. I hope that the country is now firmly on the road to recovery, although understanding that this will be a matter of years and not of weeks or months.

This year is the bicentenary of the publication of Henri Braconnot's paper "Sur la nature des champignons" in which he described the first isolation of chitin, so it is fitting that the European Chitin Society is holding one of its biennial conferences, EUCHIS '11, the 10th is the series which began in 1995 in France. This year the conference will be held on May 20-24th in St Petersburg under the auspices of the Russian Chitin Society and full details are available from the ECS website www.euchis.org for any "late birds" that need them.

There is another major international chitin conference later on this year, the 9th Asia-Pacific Chitin & Chitosan Symposium, which is to be held in Nha Trang, Vietnam on 6-9th August, and some details, including the symposium website address where full details can be found, are given in the Newsletter. There is also an invitation from the President of the Polish Chitin Society, Dr Malgorzata Jaworska, to attend their annual seminar and workshop which this year will be held in Warsaw on 21st-23rd September.

The third 'regional' grouping, the Iberoamerican Chitin Society (SIAQ - Sociedad Iberoamericana de Quitina) held their 5th annual conference in Santiago do Chile in June last year, having been postponed from February and moved from Concepcion because of the earthquake that devastated Chile earlier that year. It speaks volumes about the resilience of the organising committee that they were able to re-organise the meeting so rapidly. A report on the meeting by our former President, Professor Martin Peter, is included in this issue. There is also a report on the chitin/chitosan conference held at Qianjiang in China last November

Finally, in accordance with the ECS's regulations the theses abstracts of the candidates for the Braconnot Prize are published in this issue and members are recommended to read these.

George Roberts
Honorary Secretary



Dear members of EUCHIS family,

This is the first issue of 2011. I wish to start conveying all our prays for the safety and good health of our Japanese colleagues after the devastating earthquake and tsunami which hit their country recently. The world has learned from Japan many lessons in this disaster:

THE CALM
THE DIGNITY
THE ABILITY
THE GRACE
THE ORDER
THE SACRIFICE
THE TENDERNESS
THE TRAINING
THE MEDIA
THE CONSCIENCE

We look forward for successful and happy events both in general and in Chitin world! This year the first meeting will be the EUCHIS'11 which will be held very soon in St. Petersburg.

As you will find in this issue, there will be more meetings coming up to share our recent results with each other.

With my best wishes to you all in good health and peace,

Prof. Dr. Sevda Şenel

5th Symposium of the Sociedad Iberoamericana de Quitina (SIAQ)

The 5th Symposium of the Sociedad Iberoamericana de Quitina (SIAQ) took place in Santiago do Chile, June 06 – 09, 2010. It was organized under the SIAQ presidency of Telma Franco, with Gustavo Cabrera (Santiago do Chile) as chairman, and Galo Cardenas (Concepcion), Paola Anaya (Los Angeles), and Edelio Taboada (Temuco) as members of the local organization committee. The recently founded private university "Aldofo Ibanez", located in beautifully designed buildings in the foothills of the Andes, not only offered splendid views over the city and the nearby snow-capped mountains, but also excellent auditoriums and technology available for the oral presentations. One could hardly believe that the country had been hit badly by the devastating earthquake on February 27, just 450 km away, destroying also the institute of chemistry of the University of Concepcion. Public life had fully recovered, metro and buses were on their usual high-frequency schedules, walking in the city was safe, and a Sunday-lunch with degustation of the unique Chilean seafood in the Mercado Central was as exciting as ever before.

About 90 delegates attended the conference, with an impressive number of 29 students, nine of them receiving support with partial compensation of travel costs by SIAQ. Besides Spanish and Portuguese Iberian members, a few participants came from other European countries and also from Asia.

The scientific programme included six plenary lectures, 23 oral presentations and 111 posters, documenting the lively scientific activity of SIAQ. The topics were divided into classical thematic areas, i.e. production, enzymes, applications in the various areas, covering also nanotechnology and biomaterials. Plenary talks were given by D. Laurent (Lyon) on hydrogels, biomaterials, and tissue engineering, R.H Chen (Taipei) on kinetic reaction parameters and physicochemical properties of chitosan prepared with different regimes, C. Peniche (La Habana) on nanomaterials and applications in medicine, A. Heras (presented by B. Miralles, Madrid) on protein-chitosan composite materials, A. Gandini (Aveiro) on chitosan-cellulose composites, and S. Campana (Sao Carlos) on ultrasound deacetylation of chitin. Oral presentations and posters gave a comprehensive overview on production of chitin/chitosan from organisms of South and Central America, on fungal enzymes, preparation of various materials and applications in technology, food, medicine, and agriculture.

Two Chilean Companies presented chitosan based agrochemicals. Last not least, a round table on regulatory matters was organized, highlighting the situation for nutraceuticals in Brazil and for agrochemicals in Chile. Also, SIAQ will take an initiative in the question concerning standardization of chitosan.

In summary, it was a great, rewarding meeting. A CD containing the abstracts was provided in the conference packages, 40 groups submitted extended abstracts which will be published as *Advances in Chitin Science*, Vol. XII, on an indexed CD, and authors of 20 of the extended abstracts are invited to submit a full paper for publication in a special issue of *Polymer International*.

During the members assembly of SIAQ, a new board was elected for the years 2010 – 2013, consisting of S. Campana (Sao Carlos, Brazil, President), G. Cabreara (Santiago, Chile, Vice-President), P. Anaya (Los Angeles, Chile, Secretary), C. Yoshida (Campinas, Brazil, Treasurer), and J. Lizardi (Hermosillo, Mexico, Speaker). With congratulations and all the best wishes for the new Board, we are looking forward to forthcoming activities of SIAQ and the 12th ICCC, organized and hosted in Fortaleza, Brazil, 2012, in conjunction with the next Iberoamerican conference SIAQ VI.

Campinas, S.P., Brazil, June 19, 2010

Martin G. Peter

Chinese Chitin Conference

The 2nd International and Cross-Strait Chitin and Chitosan Symposium/7th National Academic Conference on Chitin and Chitosan was held on the 5-9th November 2010 in Qianjiang, China. It was organised by Wuhan University, the Qianjiang Regional Government and the Qianjiang Huashan Aquatic Food Company. The Scientific Committee was chaired by Professor Yumin Du, Director of the Chitin Specialised Committee of the Chinese Chemical Society.

The conference was held in a very modern hotel on the outskirts of Qianjiang City; indeed everything was so fresh and new looking that it was possible to imagine that the conference was their opening event, but apparently there had been one or two other groups staying prior to the conference. There were approximately 300 delegates, consisting of some 240 from mainland China, 25 from Hong Kong and Taiwan, and 32 from other countries around the world, including Japan, Korea, Thailand, India, Europe and North and South America. Some 170 oral presentations were delivered, together with 20 posters, spread over four main topic areas:

- Chitin modification and application;
- Chitosan oligosaccharides, enzymes and biological activity;
- Biomedical materials and functions;
- Applications in food, agriculture and environmental fields.

The standard of the presentations was high and for most of the time the speakers kept to the timetable so that it was relatively easy to move between parallel sessions.

The Qianjiang region is the centre of the Chinese crayfish farming industry, resulting in an abundance of shellfish waste and so the region is determined to become “the chitosan capital of the world”; hence there was considerable interest in the conference, including newspaper interviews with several of the foreign scientists attending. In view of the resources that are being put into chitin/chitosan research and development it seems very likely that the region will achieve its aim to become the world leader in chitosan production and utilisation.

After a very interesting and stimulating conference the overseas delegates were treated to a two-day trip, first to the cities of Jingzhou and Qianjiang, and then to the spectacular Three Gorges dam and hydroelectric scheme. This must be one of the “modern wonders of the world” and will remain for a very long time in the minds of the delegates fortunate enough to see it. A memorable finish to a memorable conference.

George Roberts

9th Asia-Pacific Chitin and Chitosan Symposium



Welcome

The organizers are pleased to announce the 9th Asia-Pacific Chitin and Chitosan Symposium (9th APCCS) that will be held in 2011, 3 to 6 August in Nha Trang (Vietnam) at the Yasaka Saigon Nhatrang Hotel. The coastal city Nha Trang is located in central Vietnam about 450 km north of Ho Chi Minh City, and is easily accessed by plane or train from Hanoi or Ho Chi Minh City. The conference site is located right on the beachside of the beautiful Nha Trang Bay.

The Symposium will last for 3 days and will include sessions on Resources, Chemical structure, Enzymology, Functional properties, and Applications in technology, food, medicine & biotechnology. In addition to meeting colleagues and listen to their most recent results in the field of chitin and chitosan, a visit to Vietnam will allow you to enjoy excellent seafood and to see its long coastline (3260 km) which makes the country suitable for e.g. shrimp aquaculture.

We kindly invite you to participate to the 9th APCCS to enjoy a stimulating Symposium and a warm hospitality.

Considering the situation of strong earthquake in Japan and its profound impacts on the Asia – Pacific region and the global economy, the Organizing Committee of the 9th Asia-Pacific Chitin and Chitosan Symposium would like to inform you that the early bird for APCCS 2011 registration has been extended to **May 30, 2011**.

Speakers

Plenary speakers

Prof. Tamo Fukamizo, Department of Advanced Bioscience, Kinki University, Japan

“Plant Chitinases: New Insights from Crystallography, Substrate Binding, and Engineering Studies”

Prof. Kjell Morten Vårum, NOBIPOL, Department of Biotechnology, Norwegian University of Science and Technology, Norway

"Structure-Function relationship in Chitosans"

Prof. George A.F. Roberts, The University of Nottingham, United Kingdom (UK)

“Sources and extraction of chitin and chitosan”

Keynote speakers

Prof. Kurt I. Draget, NOBIPOL, Department of Biotechnology, Norwegian University of Science and Technology, Norway

"Chitosan gels"

Prof. Ro-Dong Park, Department of Biological Chemistry, Chonnam National University, Korea

The title will be given later

Prof. Se-Kwon Kim, Department of Chemistry, Pukyong National University, Korea

"Biological activities of COS and their derivatives"

Prof. Tamikazu Kume, Centre for Applications of Nuclear Technique in Industry (CANTI - VAEC), Vietnam

"Radiation Processing of Chitin/Chitosan"

Prof. Trung Si Trang, Nha Trang University, Vietnam

"Shrimp by-product and chitin production in Vietnam"

Prof. Dzung Anh Nguyen, Tay Nguyen University, Vietnam

"Agriculture application of chitosans"

Prof. Rangasamy Jayakumar, Amrita Center for Nanosciences and Molecular Medicine, Amrita Institute of Medical Sciences and Research Centre, India.

"Nanostructured Chitin Materials and Their Applications"

Full details of registration, submission deadlines etc. can be found on the conference website:

www.biotech.ntnu.no/APCCS2011/index.php

Polish Chitin Society Annual Seminar & Workshop

Dear Colleagues,

In the name of Polish Chitin Society, I have both the pleasure and the honor to invite you to participate in the XVII Seminar and Workshop on “New Aspects of the Chemistry and Application of Chitin and its Derivatives” that will be held in Warsaw (Poland) on 21st -23rd September 2011.

Polish Chitin Society was founded in June 1993 and since that time it organizes annual meetings in different interesting places of Poland. The aim of the conference is to join scientists working in different fields of chitin and chitosan. We specially encourage young scientists (students, PhD students) to attend this conference as it helps to get some new information and to get connections with other young scientists not only from Poland but also from Russia, Germany or Brazil. Because of these international participants, the language of the conference is English.

Except the scientific discussion we always organize a side seeing of some interesting places connected with a seminar dinner where in more unformal conditions we can exchange our knowledge.

Polish Chitin Society annually issues a journal “Progress on Chemistry and Application of Chitin and its Derivatives” containing the newest scientific attainments in chitin and chitosan. All papers are in English and are available for free at the website of the society <http://www.ptchit.lodz.pl/en> . All authors who would like to publish their papers in our journal will find there the instruction for manuscript preparation (http://www.ptchit.lodz.pl/en21,information_for_authors.html) .

The cost of the conference is 650 PLN (approx. 170 euro) which covers all meals, including the conference dinner, conference Proceedings, but NOT includes the cost of hotel accommodation (single room approx. 50 euro/ day) and travel expenses.

We will deeply appreciate receiving notice of your interest in attending the Seminar by e-mail (jaworska@ichip.pw.edu.pl) no later than 31st May

Best regards

Malgorzata M. Jaworska

President of Polish Chitin Society

THESES ABSTRACTS

Thesis Title:

“Chitosan as BMP-2 Carrier: Material Development, Characterization and applicability in bone tissue engineering”.

Author: Ander Abarrategi

Advisor: Dr. Jose Luis Lopez-Lacomba **Co- Advisor:** Dr. Viviana Ramos
Instituto de Estudios Biofuncionales. Universidad Complutense Madrid, Spain.

Abstract:

Tissue engineering (TE) is an emerging and multidisciplinary science, basically focused on the recovery of tissue functions via new functional tissue generation. In this sense, TE needs: biomaterials which provide an appropriate environment; cells that will form the new tissue and; growth factors that will induce this tissue formation. In this context, the aim of this work is to provide osteoinductive properties to clinically available implantable materials using chitosan films, rhBMP-2 and stem cells.

rhBMP-2 is one of the best known Bone Morphogenetic Factors. This rhBMP-2 was synthesized and its activity was exhaustively evaluated *in vitro* on cultured cells. The performed DNA microarray assays show the transcriptional changes induced by the rhBMP-2 and its osteoinductive effect on cultured cells.

On the other hand, chitosan films were evaluated as biocompatible material. For this purpose, C2C12 and mesenchymal Stem Cells were seeded onto these films and they adhere, grow and proliferate properly. The performed transcriptional studies show that cells slightly recognize this growing surface as a foreign chemical structure.

Chitosan films were also evaluated as rhBMP-2 carrier material. *In vitro* assays were performed in order to simulate the *in vivo* rhBMP-2 delivery: by partial film dissolution in the initial wound healing process; by low diffusion from the film and; by film enzymatic biodegradation. Performed assays show that rhBMP-2 is active on the film and also after release, both *in vitro* and *in vivo*.

Finally, chitosan/rhBMP-2 film was studied as coating of titanium implants and porous β -TCP ceramics. The performed *in vivo* assays show that the coating induces the bone formation around the implants and improved the properties of the porous β -TCP scaffolds.

All these results show both *in vitro* and *in vivo* that chitosan/rhBMP-2 films are a biocompatible and osteoinductive material applicable as coating for titanium implants and porous β -TCP ceramics.

Title of the Thesis: “Chitosan, a biopolymer with applications in drug delivery”

Author: Dr. Ruth Expósito Harris

Abstract

Over the last few decades, the interest on controlled release systems has grown in the pharmaceutical field. The sustained release of drugs has various advantages such as the reduction in the frequency of administration, improving patient compliance, the decrease of adverse effects and a more uniform therapeutic effect.

Controlled release systems are formed by natural or synthetic polymers, which should be biodegradable and non toxic. Chitosan, used in this study, is a natural polymer that is obtained by partial deacetylation of chitin, which is present in crustaceans, insects, fungi and molluscs. This polymer, as well as being biodegradable and non toxic, has other interesting properties that promote its application in controlled drug delivery systems, such as its bioadhesion properties and its ability to enhance drug absorption through epithelia. These characteristics have risen the interest on chitosan in this field.

The main objective of this Thesis has been, on the one hand to obtain chitosan microspheres, films and nanoparticles for the encapsulation of drugs and, on the other hand, to study the cytotoxicity of chitosan and its absorption enhancement properties on Calu-3 monolayers.

The results show that the chitosan based systems obtained controlled the release of the drugs and prove that chitosan nanoparticles and solutions, in a certain concentrations, promote the opening of tight junctions in Calu-3 cell monolayers and the permeability of macromolecules.

The original idea of this Thesis came up due to the interest of the pharmaceutical industry on the development of new drug delivery systems. Therefore, the results that were obtained show the potential application of chitosan based systems. Interesting results and contributions to this field have been achieved.

Novel chitin and chitosan based affinity sorbents for recombinant protein purification with the use of chitin-binding affinity tag

Author: Dr DV Kurek

Abstract

Chitin and chitosan have found a widespread application as a sorbents for heavy metal ions and dyes removal. But also for past decade several studies were made where chitin/chitosan based sorbents were used for chitinase purification. In presented nominee's work chitin and chitosan were used for synthesis of affinity sorbents, which were used for recombinant protein purification. This research work was carried out because nowadays protein structure fundamental studies, medicine and biotechnology require large amounts and a wide range of recombinant proteins and also purification degree was highly increased. Affinity chromatography traditionally was used for recombinant protein purification and application of affinity tags technique have made possible to purify different recombinant proteins with the use of same affinity sorbents. Now there is a big number of commercially available purification systems but still each of them has its own disadvantages. Concerning chitin/chitosan affinity sorbents there is only one expensive commercial affinity chromatography system by New England Biolabs (USA) which applies chitin based sorbents and bacterial chitin-binding domain as an affinity tag. Main goal of this research work was to obtain new chitin/chitosan based affinity sorbents with the use of different synthesis strategies and to try to find molecular mechanisms of chitin-binding domain interaction with solid substrate through variation of sorbent structure and point mutations in domain structure.

Five types of new affinity sorbents were obtained and three of them showed sufficient selectivity for chitin-binding affinity tag. Chemical cross-linking through epichlorohydrin was used to increase mechanical properties of obtained sorbents and degree of cross-linking which doesn't affect sorbents selectivity was determined. During this research work was suggested to use natural chitin structures as an affinity sorbents. In 2007 a group of scientists showed that chitin could be found in some marine sponge skeletons. Chitin there plays crucial role as a basis for biomineralization during sponge skeleton formation. Important fact is that chitin in marine sponge skeletons forms three-dimensional highly organized on micro- and nanolevels structure. Was suggested that such chitinous matrices could be used as a natural affinity sorbents for recombinant proteins purification. During 6 month internship in Institute of bioanalytical chemistry of Dresden Technical University screening of marine sponge species was carried out in order to find suitable of application as affinity sorbents chitinous structures. During this work obtained structures were characterized with different physico-chemical methods (solid state NMR, FTIR, Raman spectroscopy, SEM, TEM, fluorescent microscopy) and chitinous matrices from marine sponge *Aplysina cauliformis* were selected to be used as affinity sorbents for recombinant proteins purification. After first chromatography experiments was determined that such matrices have high degree of crystallinity and the next step is to decrease it in order to make chitin in this structures more accessible for chitin-binding domains which are used as an affinity tags.

It is important to mention that during work with marine sponges in some species chitin was not found but collagen, which is used as a template for biomineralization instead of chitin, has a structure different from human and animal collagen. This discovery is not related directly with chitin or chitosan but is worth mentioning that obtained information about this collagen structure due to its significance was published in a Nature Chemistry journal article.

Utilization of various chitinous wastes for production of industrial important mycolytic enzymes by *Pantoea dispersa* and its potential in controlling the *Fusarium* wilt disease in pigeonpea crop

Author: Dr Vipul Gohel

Abstract:

The aim was to find an answer to how to manage seafood industries crustacean chitin waste and control of *Fusarium* wilt in pigeonpea crop by using single process. The waste material in crustacean meal industries represents high percentage of the landing. The global catch of fish and invertebrates is about 107 tons annually, of which 70-85% is composed of processing discards releases ammonia and nitrate that seeps through soil in concentrations large enough to pollute ground water. To solve this problem initially he has focused on processing of chitin from this industrial waste and used as a raw material for chitinase production by microorganisms. Later, this process chitin was deacetylated for chitosan production, which was tested for antibacterial and antifungal activity against various pathogenic bacteria and plant pathogenic fungi such as *Fusarium udum* and *M. phasiolina*. He tried his level best to introduce novel ideas and concepts, and explore new approaches that can push the state-of-art and stimulate further research. Conventionally the disposal costs of more than 5000INR per tonne, which is not economically viable for many businesses. His innovative and cost effective research makes the waste materials to million dollar industry and earns about 400INR crores annually as a source of income by converting of 1 lakh tonnes of crustacea waste and ensures safe and clean environment. Further which gives livelihood and job opportunities to the fisherman and coastal dwellers.

His research work describes eco friendly waste management system and gives value addition to the waste materials. Conventionally the disposal costs of more than 5000 INR per tonne, which is not economically viable for many businesses (Michaela and David, 2008). His innovative and cost effective research makes the waste materials to million dollar industry and earns about 400 INR crores annually as a source of income by converting of 1 lakh tonne of crustacea waste and ensures safe and clean environment . Further which gives livelihood and job opportunities to the fisherman and coastal dwellers (Mangala, 2008).

Chitin is an abundant renewable natural source obtained from marine invertebrates, insects, fungi and algae. Shrimps, crabs, squids, oysters, shellfish and cuttlefish are rich in chitin. Every year about 100 billion tons of discarded crustacean shells and shellfish sink through the world's oceans. In India, enormous amount approximately 1 lakh tones per year of chitinous wastes from shrimp or crab shell is generated by food processing industries. This waste management has become increasingly difficult and expensive. This has significantly affected the shellfish and crustacean processing sector, particularly the crustacea sector as there is a lack of cost-effective outlets for their waste. There is a big challenge to solve the disposal of this waste and reduce environmental problems. His research work describes eco friendly waste management system and value addition to the waste materials conventionally the disposal costs of more than 5000 INR per tonne are common, which is not economically viable for many businesses (Michaela and David, 2008). Moreover, this disposable process includes either burning or land filling, both of which are harmful to the environment since burning releases carbon dioxide and carbon monoxide into the environment, and thus adds to global warming, while land filling is harmful as the waste degrades very slowly and one of the degradation products, i.e.,

ammonia, seeps through the soil, polluting the ground water. Presently, these wastes chemically convert into chitin and chitosan. Both these products have high export value due to their wide applications in medicine and pharmaceuticals. It is estimated that about 400 INR crores can be raised annually as a source of income by using entire 1 lakh tonnes of crustacea waste (Mangala, 2008). This chemical process includes demineralization and deproteinization mediated by a strong acid or base. This process also creates waste disposal problems, because neutralization and detoxification of the discharged waste water are necessary. Furthermore, the value of the deproteinized liquid is diminished because of the presence of sodium hydroxide. Moreover, demineralization process includes the use of strong acid (commonly HCl) that harms the physiochemical properties of chitin, results in a harmful effluent wastewater and increases the cost of chitin purification process.

To establish whether it is possible for India processors to generate an income or reduce the costs of crustacea waste disposal, we initiated a project to look at the range of options available for crustacea waste management and identify which have potential for the India and Gujarat processing sector. The project looked at all the crustacea species processed in the India and their wastes used for raw material for utilization as a nutrient for production of mycolytic enzymes potential in controlling *Fusarium* wilting diseases in various crops which is also a one of major challenge in agricultural sector Gujarat, India and worldwide also.

Agricultural pests so far identified include 10000 species of insects and 8000 fungi. Pigeonpea is one of the important legumes grown predominantly in the semi arid tropics of Indian subcontinent. In India, pigeonpea is grown in 3816 ha, contributes 2876 thousand tonnes of grain annually. *Fusarium* wilt caused by *Fusarium udum* is a major disease of pigeon pea throughout the world. Annual loss due to wilt in India is around 71 million US dollars. In spite of the use of wilt-resistant varieties of pigeonpea, such as GT 100 and BDN 2, high incidences of wilt (up to 30%) occur in Gujarat state (India) (Vaidya et al., 2004). At present fungicides such as thiram, bavistin and benomyl are generally used for controlling *Fusarium* wilt. Due to pesticide related hazards, the need for biological control methods is required. He has isolated number of mycolytic enzyme producing bacteria, which are able to control these fungal infections. More work is required in this area especially number of field trials are to be made to control fungal infection. Apart from pigeon pea, number of other plants also will be studied to control them from fungal infections.

Food security is one of the essential existential needs which can never be ignored by any society. The world population is expected to rise to around 10 billion mark by 2025. More people mean more food. To supplement the nutritional need agriculture must become intensive and sustainable i.e. to maintain and enhance, without destroying the very environment on which it depends. The development of such a global system for sustainable food production is one of the greatest challenges faced by the human species.

The quantum of fertile soil is limited. Secondly the expansion of urban settlements, industrialization and provision for ever growing civic needs are exerting severe pressure on lands reserved for cropping. Most of the population explosion is witnessed in developing and under developed countries. It is speculated that global demand for cereals increase from recent 1 billion ton to 2.7 billion tones and considering the losses in storage and processing, the real need may be about 3.4 billion tones. Most of this additional demand need to be met either by improving the crop yield or by preventing the post-

harvest losses till the produce reach the consumers. Increase in the crop yield is severely compromised by pests and diseases.

Attempts were being made to find eco-friendly and an economical method to resolve these two problems in a single-step process that should be more economical and eco-friendly method to manage these wastes to produce useful mycolytic enzymes (chitinases, proteases and glucanase). This single-step process includes use of the waste as a carbon source in fermentation processes for the production of useful agricultural products, such as mycolytic enzymes, by microorganisms.

He has developed the method which functioning fermentative production of not only chitinase but also agriculturally important other mycolytic enzymes such as proteases and glucanase using these chitinous waste materials. This process will be used for making formulations of biocontrol agents to control fungal plant pathogens which have a great potential in Agricultural industries.

His system provides less expensive and efficient method to obtain high-level of mycolytic enzymes by *Pantoea dispersa*. Moreover, it is an important in the utilization of chitinous wastes that not only solves an environmental problem but also decreases the cost of production of mycolytic enzymes. These products can be further used for formulations, which can then be used in the fields to protect crops against fungal diseases.