

Biotechnology for Processing Natural Resources Employing Microbial-Catalysts and Fermentation Systems

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This work is dedicated to

My Parents

My Ma Roopa Nigam
{an extraordinary person}

&

In loving memory of my father,
Mahesh Chandra Nigam {who left us too early}

I. Abstract

Research presented in this thesis has revealed exciting possibilities in the subject of Microbial technology. The work completed in several funded projects was aimed and focussed on the selection and modification of microorganisms as biocatalysts, and their application in the processes of interest. Therefore, the title of thesis reflects the work incorporated in, as “Biotechnology for processing natural resources employing microbial-catalysts and fermentation systems”

The research work submitted in this thesis has been conducted and published after the award of my PhD degree in 1985, and includes some of my postdoctoral work 1986-1989 in **Germany**, but mostly the research work completed during my full-time employment as a research-active academic member of staff at Ulster University since Jan 1990-present in **UK**.

The contribution of my research and published work, in public domain, has been to advance the study of subject, in the area of applied Microbial-Biotechnology; on aspects of Fermentation-technology using cultivation of microorganisms in submerged and solid-state/substrate systems; Microbial processes for Bioremediation; Bioconversion of renewable bioresources, industrial residues and by-products from food and drink industries; Biotreatment & Biodegradation of agricultural wastes and residues for their reuse as added-value products etc. The work published has been presented in six separate sections, and full copy of some publications have been attached.

The whole journey of this research work has produced several doctoral and postdoctoral researchers, who are taking this advancement of science further in their jobs-responsibilities as researcher/supervisor/examiner in several countries.

The main exciting possibility as an outcome of work in this thesis for new researchers is –

“The microorganisms, as powerful biocatalysts, can be purposely modified for their economical and practical exploitation to perform a range of bioprocesses. The systems can be optimised and scaled for their application in several industries, such as food, biofuel, pharmaceutical and for environment sustainability”.

II. Acknowledgements

I would like to thank my all PhD, Postdoctoral, visiting researchers together with my various collaborators at Ulster University and in several countries, for their input directly or indirectly, into the research presented in this thesis. Without their association, critical-suggestions and contribution, none of the work presented in this thesis would have been possible.

Special thanks go to my mentor and colleagues, Professors Roger Marchant and Ibrahim M. Banat for their continued support, throughout my research career since January 1990 at Ulster University in Northern Ireland.

I wish to acknowledge and express heartfelt thanks to my both sons Dhruv and Divakar for their love and understanding of my overtime working, either in the lab or on laptop.

My sincere thanks to my all Relatives and Friends for their encouragement and moral support throughout my long academic and research-journey in India and Northern Ireland, UK.

Poonam Nigam

February 2020

III. Statement of extent to which research was carried out by candidate

(with personal involvement in work and involvement of others)

Research in the outputs selected for this submission was conducted in the field of Microbial-process technology and presented under the title “**Biotechnology for processing natural resources employing microbial-catalysts and fermentation systems**” by me after the award of my doctoral degree in 1985.

I have been working in several research projects funded by different funding bodies and companies. The publications included in this submission represent some of the work performed by me as Senior Research officer in Biotechnology at Ulster University, UK for six years, and later by doctoral, postdoctoral researchers working under my supervision, and in collaboration with some members of research-active academic staff. A number of these researchers have gone to secure academic and research posts in several countries.

Irrespective of position in the list of authors, I have no hesitation in stating that I made a substantial contribution to each paper, as and when it became necessary in the successful completion of each research project. My involvement included in the conception of ideas, the design of experiments, interpretation of results, writing manuscripts, editing drafts and submission to journals, and timely responses/corrections in manuscripts to editors/referees of scientific journals.

A full list of Doctoral, Postdoctoral and visiting researchers supervised by me at Ulster together with their research project-titles is presented in **Appendix 1.1**.

Scanned copies of statements given by some of my co-authors, for my contribution to research are included in **Appendix 5**. The declarations given by my co-authors fully support the comments above.

Poonam Nigam

February 2020

IV. Statement regarding submission of presented work in this thesis for any other degree

I hereby give this statement that I have not submitted this work previously for the award of any academic degree. The research publications/outputs included in this submission are after the award of my doctoral degree PhD in 1985 in India. I have been FT employed as a Research-active academic at Ulster University, UK since January 1990 (30 years), therefore, I qualify to submit my thesis for the award of DSc degree at Ulster University.

Research selected for this submission was undertaken in the field of **Bioprocesses employing microbial-catalysts and fermentation technology for industrial applications.**

I wish to inform that I have previously submitted my Research-Profiles and detailed Portfolios based on my research publications, scientific outputs & contribution of my work with several global collaborators, for the evaluation by several international scientific/academic societies, I was awarded following affiliations and recognition:

2020	Hind-Rattan (Jewel of India), one of Government of India's top civilian awards	Non-Resident Indian Welfare Society, Government of India
2019	British Indian Award in Science & Technology (Finalist)	UK & Ireland's Ethnic Awards Company
2018	Fellow -Academy of Microbiological Sciences (FAMSc)	Association of Microbiological Society AMI (AMI)
2016	Fellow - Royal Society of Biology (FBRS)	Royal Society of Biology, UK
2014	Senior Fellow (SFHEA)	Higher Education Academy, UK
2014	Fellow Centre for Higher Education Research & Practice, UK (FCHERP)	Ulster University, UK
2014	Fellow , Life membership (FIFIBiop)	International Forum on Industrial Bioprocesses
2013	Fellow , Life Membership (FBRSI)	Biotechnology Research Society India
2007	Fellow (FHEA), Life membership	Higher Education Academy, UK
1992	Chartered Biologist (C Biol)	Institute of Biology, UK (currently known as Royal Society of Biology)

Poonam Nigam

February 2020

V. Details of Published work & Outputs to be considered

As evidenced by the Short Curriculum Vitae and Full Publication List (Appendices 3 & 4), I have substantial experience in the field of Microbial Biotechnology research since 1981. I have published 3 biotechnology books (co-edited & co-authored), 181 peer-reviewed full scientific research papers, 42 book chapters, 24 review articles in scientific journals, 90 conference abstracts and 1 European patent.

For this evaluation, I have selected following publications for consideration in the general area of Microbial Biotechnology. More specifically, I have worked in the study and optimisation of two types of **BIOPROCESSES using microorganisms** and their derivatives as biocatalysts for a wide range of applications in different industries. These bioprocesses were designed for two growth conditions or states of cultivation of selected microorganisms, depending on the type of substrates used in the process:

1. Solid-state or Solid-Substrate Fermentation (SSF) Bioprocess,
2. Liquid-state or Submerged Fermentation (SmF) Bioprocess.

The published work and outputs are grouped according to specific subject area as indicated below:

Section 1: Bioprocesses - Food Biotechnology [1-15]

Section 2: Biosynthesis - Microbial Enzymes [1-19 of 33]

Section 3: Bioconversion & Biotreatment - Industrial residues & by-products (1-16 of 43)

Section 4: Bioproduction - Ethanol (biocatalysts & Fermentation-systems) (1-17 of 30)

Section 5: Bioremediation -Textile & Distillery effluents (1-20 of 30)

Section 6: Bioactivity - Antibacterial, Antioxidant in natural resources [1-19 of total 33]

Details of publications presented in sections 1-6 as below-

Author- Poonam Singh Nigam shortened as Nigam P

Section 1: BIOPROCESSES - Food Biotechnology [1-15 publications]

Project 1 –Fermented food (cheese, yogurt, milk.....)

Project 2 – Sourdough bread making

Project 3 –Food additives

1. Fermented food (cheese, yogurt, milk.....)

1. Vasiliki S, Terpou A, Bosnea L, Kanellaki M & Nigam P, (2018) [Entrapment of *Lactobacillus casei* ATCC393 in the viscus matrix of *Pistacia terebinthus* resin for functional Myzithra cheese manufacture](#), LWT – Food Science and Technology, 89, 441-448

2. Kourkoutas Y, Kandylis P, Panas P, Dooley J, Nigam P, Koutinas AA (2006) [Evaluation of freeze-dried kefir coculture as starter in feta-type cheese production.](#) Applied & Environmental Microbiology, 72 (9), 6124-6135.
3. Terpou A, Nigam P, Bosnea L & Kanellaki M (2018) [Evaluation of Chios mastic gum as antimicrobial agent and matrix forming material targeting probiotic cell encapsulation for functional fermented milk production.](#) LWT – Food Science and Technology 97, 109-116
4. Terpou A, Bekatorou A, Kanellaki M, Koutinas AA, Nigam P (2017) [Enhanced probiotic viability and aromatic profile of yogurts produced using wheat bran \(*Triticum aestivum*\) as cell immobilization carrier.](#) Process Biochemistry 55, 1-10.
5. Angelika-Ioanna G, Argyro B, Kanellaki M, Nigam P, Koutinas AA (2015) [Apple juice preservation through microbial adsorption by nano/micro-tubular cellulose.](#) Innovative Food Science and Emerging Technologies, INNFOO 33, 416-421.
6. Bosnea L, Moschakis T, Nigam P, Biliaderis CG (2017) [Growth adaptation of probiotics in biopolymer-based coacervate structures to enhance cell viability.](#) LWT - Food Science and Technology 77, 282-289.
7. Koutinas AA, Sypas V, Kandylis P, Michelis A, Nigam P et al (2012) [Nano-Tubular Cellulose for Bioprocess Technology Development.](#) PLoS ONE, 7 (4) e34350, 1-10

2. Sourdough bread making

8. Plessas S, Bekatorou A, Gallanagh J, Nigam P et al. (2008) [Evolution of aroma volatiles during storage of sourdough breads made by mixed cultures of *Kluyveromyces marxianus* and *Lactobacillus delbrueckii ssp bulgaricus* or *Lactobacillus helveticus*.](#) Food Chemistry, 107 (2), 883-889.
9. Plessas S, Fisher A, Koureta K, Psarianos C, Nigam P, Koutinas AA (2008) [Application of *Kluyveromyces marxianus*, *Lactobacillus delbrueckii ssp bulgaricus* and *L. helveticus* for sourdough bread making.](#) Food Chemistry, 106 (3), 985-990.
10. Plessas S, Trantallidi M, Bekatorou A, Kanellaki M, Nigam P, Koutinas AA (2007) [Immobilization of kefir and *Lactobacillus casei* on brewery spent grains for use in sourdough wheat bread making.](#) Food Chemistry, 105 (1), 187-194.
11. Plessas S, Pherson L, Bekatorou A, Nigam P, Koutinas AA (2005) [Bread making using kefir grains as baker's yeast.](#) Food Chemistry, 93 (4), 585-589.
12. Harta O, Iconomopoulou M, Bekatorou A, Nigam P et al (2004) [Effect of various carbohydrate substrates on the production of kefir grains for use as a novel baking starter.](#) Food Chemistry, 88 (2), 237-242.

3. Food additives

13. Nigam P, Luke JS (2016) [Food additives: Production of microbial pigments and their antioxidant properties.](#) Current Opinion in Food Science. A themed issue on Food Bioprocessing. 7, 93-100.
14. Elezi O, Kourkoutas Y, Koutinas AA, Kanellaki M, Bezirtzoglou E, Barnett YA, Nigam P (2003) [Food additive lactic acid production by immobilized cells of *Lactobacillus brevis* on](#)

[delignified cellulosic material](#). Journal of Agricultural & Food Chemistry, 51 (18), 5285-5289.

15. Nigam P & Singh D (1995) Processes For Fermentative Production of **Xylitol** - a Sugar Substitute. Process Biochemistry, 30 (2), 117-124.
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Section 2: BIOSYNTHESIS - Microbial Enzymes [1-19 of 33]

Project 1: Hydrolytic enzymes (pectinase, xylanase, cellulase, laccase....)

Project 2: Diagnostic enzymes (salicylate hydroxylase, di-hydro folate reductase)

Project 3: Biotransformation enzymes (Lipase, Esterase)

1: Hydrolytic enzymes (pectinase, xylanase, cellulase, laccase....)

1. Nigam P (2013) Microbial Enzymes with Special Characteristics for Biotechnological Applications. Biomolecules - Special Issue Enzymes, Their Biotechnological Applications, 3 (3), 597-611.
2. Sunnotel O, Nigam P (2002) Pectinolytic activity of bacteria isolated from soil, two fungal strains during submerged fermentation. World Journal of Microbiology & Biotechnology, 18 (9), 835-839.
3. Kohli U, Nigam P, Singh D, Chaudhary K (2001) Thermostable, alkalophilic, cellulase free xylanase production by *Thermoactinomyces thalophilus* subgroup C. Enzyme & Microbial Technology, 28 (7-8), 606-610.
4. Robinson, T, Chandran, B, Nigam P (2001) Studies on the production of enzymes by white-rot fungi for the decolourisation of textile dyes. Enzyme & Microbial Technology, 29 (8-9), 575-579.
5. Kumar R, Dahiya JS, Singh D, Nigam P (2000) Production of endo-1,4-beta-glucanase by a biocontrol fungus *Cladorrhinum foecundissimum*. Bioresource Technology, 75 (1), 95-97.
6. Dahiya JS, Singh D, Nigam P (1998) Characterisation of laccase produced by *Coniothyrium minitans*. Journal of Basic Microbiology, 38 (5-6), 349-359.
7. Pandey A, Nigam P, Soccol CR, Soccol VT, Singh D, Mohan R (2000) Advances in microbial amylases. Biotechnology, Applied Biochemistry, 31 (Part 2), 135-152.
8. Nigam P, Singh D (1996) Processing of agricultural wastes in solid-state fermentation for cellulolytic enzymes production. Journal of Scientific & Industrial Research, 55 (5-6), 457-463.

2. Diagnostic enzymes (salicylate hydroxylase, di-hydro folate reductase)

9. Zhou DM, Nigam P, Jones J, Marchant R (1995) Production of Salicylate Hydroxylase From *Pseudomonas putida* UUU-1, Its Application in The Construction of A Biosensor. Journal of Chemical Technology & Biotechnology, 64 (4), 331-338.
10. Banat IM, Marchant A, Nigam P, Gaston SJS, Kelly BA, Marchant R (1994) Production, Partial Characterization, Potential Diagnostic Use of Salicylate Hydroxylase from *Pseudomonas putida* UUC-1. Enzyme & Microbial Technology, 16 (8), 665-670.
11. Nigam P, Banat IM, Kelly BA, Marchant R (1993) Dihydrofolate-Reductase Synthesis In Continuous-Culture Using A Methotrexate-Resistant *Escherichia coli*. Enzyme & Microbial Technology, 15 (8), 652-656.

12. Nigam P, Marchant R (1993) Production of The Enzyme Dihydrofolate-Reductase By Methotrexate-Resistant Bacteria Isolated From Soil. *Journal of Chemical Technology & Biotechnology*, 56 (1), 35-40.
13. Banat IM, Nigam P, Marchant R (1992) the Isolation, Characterization of a Salicylate-Hydroxylase-Producing Strain of *Pseudomonas putida*. *Applied Microbiology & Biotechnology*, 37 (3), 378-381.

3. Biotransformation enzymes (Lipase, Esterase)

14. Muralidhar RV, Chirumamilla, RR, Ramachandran VN, Marchant R, Nigam P (2002) Resolution of (RS)-proglumide using lipase from *Candida cylindraceae*. *Bioorganic & Medicinal Chemistry*, 10 (5), 1471-1475.
15. Chirumamilla RR, Marchant R, Nigam P (2001) Captopril, its synthesis from chiral intermediates. *Journal of Chemical Technology & Biotechnology*, 76 (2), 123-127.
16. Muralidhar RV, Chirumamilla RR, Marchant R, Ramachandran VN, Ward OP, Nigam P (2002) Understanding lipase stereo-selectivity. *World Journal of Microbiology & Biotechnology*, 18 (2), 81-97.
17. Chirumamilla RR, Muralidhar R, Marchant R, Nigam P (2001) Improving the quality of industrially important enzymes by directed evolution. *Molecular, Cellular Biochemistry*, 224 (1-2), 159-168.
18. Muralidhar RV, Chirumamilla RR, Marchant R, Nigam P (2001) A response surface approach for the comparison of lipase production by *Candida cylindracea* using two different carbon sources. *Biochemical Engineering Journal*, 9 (1), 17-23.
19. Pandey A, Benjamin S, Soccol CR, Nigam P, et al. (1999) The realm of microbial lipases in biotechnology. *Biotechnology, Applied Biochemistry*, 29 (Part 2), 119-131.

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20. Thomas, S., Patil, A. B., Salgaonkar, P. N., Shrivastava, S. & Nigam, P., (2020) Screening of Bacterial Isolates from Seafood-Wastes for Chitin Degrading Enzyme Activity. *Chemical Engineering & Process Techniques*. 5 (1) p. 1-8 1059
21. Muralidhar R, Chirumamilla RR, Nigam P (2001) Racemic resolution of RS-Baclofen using lipase from *Candida cylindraceae*. *Proceedings of 15th Forum in Applied Biotechnology*, 66 (3a), 227-232.
22. Muralidhar RV, Marchant R, Nigam P (2001) Lipases in racemic resolutions. *Journal of Chemical Technology, Biotechnology*, 76 (1), 3-8.
23. Nigam P, Prabhu KA (1991) Effect of Cultural-Factors on Cellulase Biosynthesis in Submerged Bagasse Fermentation by Basidiomycetes Cultures. *Journal of Basic Microbiology*, 31 (4), 285-292.
24. Nigam P, Prabhu KA (1991) Influence of Sugars on the Activity of Cellulase System from 2 Basidiomycetes Cultures. *Journal of Basic Microbiology*, 31 (4), 279-283.
25. Nigam P, Prabhu KA (1991) Effect of cultural factors on lignin biodegradation by two *Polyporus* cultures in submerged bagasse fermentation. *Reeds of Research - Sharkara*, 30 (2) 6-8.
26. Nigam P, Prabhu KA (1988) Thermal-Activation and Stability of Cellulases Derived From 2 Basidiomycetes. *Biotechnology Letters*, 10 (12), 919-920.

27. Nigam P, Pandey A, Prabhu KA (1987) Cellulase, Ligninase Production by Basidiomycete Culture in Solid-State Fermentation. *Biological Wastes* 20 (1),1-9.
28. Nigam P, Pandey A, Prabhu KA (1987) Ligninolytic Activity of 2 Basidiomycetes Cultures in The Decomposition of Bagasse. *Biological Wastes*, 21 (1), 1-10.
29. Nigam P, Prabhu KA (1988) Isolation, recovery of cellulase, ligninase from crude enzymes produced by two Basidiomycetes cultures in submerged bagasse fermentation. *Reeds of Research - Sharkara*, 27 (14) 40 -46.
30. Nigam P, Prabhu KA (1986) The effects of some added carbohydrates on cellulases, ligninase and decomposition of whole bagasse. *Agricultural Wastes*, 17 (4), 293-299.
31. Nigam P, Prabhu KA (1985) Microbial-degradation of bagasse - isolation, cellulolytic properties of Basidiomycetes spp from biomanure from a biogas plant. *Agricultural Wastes*, 12 (4), 273-285.
32. Pandey A, Selvakumar P, Soccol CR, Nigam P (1999) Solid state fermentation for the production of industrial enzymes. *Current Science*, 77 (1), 149-162.
33. Banat IM, Nigam P, Kelly B Marchant R (1992) Salicylate hydroxylase synthesis in continuous culture using a strain of *Pseudomonas putida*. *Proceedings of First Egyptian-Italian Symposium on Biotechnology, ASSIUT*. 1,335-342.

Section 3: BIOCONVERSION & BIOTREATMENT - Industrial residues, by-products (1-15 of 42)

Project 1: Bio-refinery

Project 2: Utilisation of agri-residues

1. Bio-refinery

1. Aggelopoulos T, Bekatorou A, Plessas S, Koutinas A & Nigam P (2018) [Upgrading of Mixed Food Industry Side-Streams by Solid-State Fermentation with *P. ostreatus*](#). *Recycling*. 3 (2) 1-12
2. Medina J, David C, Adenise W, Nigam P et al (2016) [Steam Explosion Pretreatment of Oil Palm Empty Fruit Bunches \(EFB\) Using Autocatalytic Hydrolysis: A Biorefinery Approach](#). *Bioresource Technology*, 199, 173-180.
3. Elmekawy A, Sandipam S, Nigam P, et al (2015) [Food & Agricultural Wastes as Substrates For Bioelectrochemical System \(BES\): The Synchronized Recovery of Sustainable Energy & Waste Treatment](#). *Food Research International*, 73, 213-225.
4. Nigam P (2017) [Recycling of Solid Barley Waste Generated as a By-Product in Distillery & Brewery](#). *Waste Management*, 62, 255-261.
5. Singh A, Pant D, Olsen SI & Nigam P (2012) [Key Issues to Consider in Microalgae Based Biodiesel Production](#). *Energy Education Science & Technology Part A: Energy Science Research*, 29(1), 687-700.
6. Singh A, Olsen SI & Nigam P (2011) [A Viable Technology to Generate Third Generation Biofuel](#). *Journal of Chemical Technology & Biotechnology*, 86 (11), 1349-1353.
7. Nigam P, Singh A (2011) [Production of Liquid Biofuels from Renewable Resources](#). *Progress in Energy & Combustion Science*, 37, 52-68.

8. Singh A, Nigam P, Murphy JD (2011) [Renewable Fuels from Algae: An Answer to Debatable Land Based Fuels](#). *Bioresource Technology*, 102, 10-16.
9. Singh A, Nigam P (2011) [Mechanism & Challenges in Commercialisation of Algal Biofuels](#). *Bioresource Technology*, 102, 26-34.
10. Pandey A, Soccol CR, Nigam P, et al (2000) [Biotechnological Potential of Coffee Pulp & Coffee Husk For Bioprocesses](#). *Biochemical Engineering Journal*, 6 (2), 153-162.
11. Pandey A, Soccol CR, Nigam P et al (2000) [Biotechnological Potential of Agro-Industrial Residues. I: Sugarcane Bagasse](#). *Bioresource Technology*, 74 (1), 69-80.
12. Pandey A, Soccol CR, Nigam P, et al (2000) [Biotechnological Potential of Agro-Industrial Residues. II: Cassava Bagasse](#). *Bioresource Technology*, 74 (1), 81-87.

2. Utilisation of agricultural-residues

13. Sultana B, Naseer R & Nigam P (2015) [Utilization of Agro-Wastes to inhibit Aflatoxins Synthesis by *Aspergillus parasiticus*: A Biotreatment of Three Cereals For Safe Long-Term Storage](#). *Bioresource Technology*, 197, 443-450.
14. Naseer R, Sultana B, Khan M, Naseer D & Nigam P (2014) [Utilization of Waste Fruit-Peels to Inhibit Aflatoxins Synthesis by *Aspergillus flavus*: A Biotreatment of Rice for Safer Storage](#). *Bioresource Technology*, 173, 423-428.
15. Robinson T & Nigam P (2003) [Bioreactor Design for Protein Enrichment of Agricultural Residues by Solid State Fermentation](#). *Biochemical Engineering Journal*, 13 (2-3), 197-203.
-----15 of 43-----
16. Pant D, Singh A, Van Bogaert G, Olsen SI, Nigam P et al (2011) [Bio-electrochemical Systems \(BES\) For Sustainable Energy Production & Product Recovery from Organic Wastes & Industrial Wastewaters](#). *RSC (Royal Society of Chemistry) Advances*, 2(4), 1248-1263.
17. Kumar R, Dahiya JS, Singh, D & Nigam P (2001) [Biotransformation of Cholesterol Using *Lactobacillus bulgaricus* in a Glucose-Controlled Bioreactor](#). *Bioresource Technology*, 78 (2), 209-211.
18. Malik R, Singh D, Banat IM & Nigam P (1998) [Improved Biogas Production Using Cattle Waste & Distillery Effluent Mixed Slurry](#). *Renewable Energy*, 15-16, 1965-1968.
19. Nigam P & Singh D (1996) [Processing of Agricultural Wastes in Solid State Fermentation For Microbial Protein Production](#). *Journal of Scientific & Industrial Research*, 55 (5-6), 373-380.
20. Nigam P & Singh D (1995) [Utilization of Sugar Industry By-product Bagasse & Dairy-Effluent Whey in Solid State Fermentation \(SSF\) Process For Feed Production](#). *Proc 57th Convention of Sugar Technologists Association India*, 57, 625 -633.
21. Nigam P (1994) [Process Selection for Protein-Enrichment-Fermentation of The Sugar Industry By-products Molasses & Sugar-Beet Pulp](#). *Process Biochemistry*, 29 (5), 337-342.
22. Nigam P (1994) [Processing of Sugar-Beet Pulp in Simultaneous Saccharification & Fermentation for The Production of a Protein-Enriched Product](#). *Process Biochemistry*, 29 (5), 331-336.
23. Nigam P & Vogel M (1993) [Simultaneous & Two Stage Saccharification & Fermentation For Bioconversion of Sugar Beet Pulp: Effect of pH](#). *Proc 55th Convention of Sugar Technologists` Assoc. India*, 55, 31-40.

24. Nigam P & Vogel M (1992) [Study on Nutritional Supplements in One & Two Stage Bioconversion Process of Sugar Beet Pulp into Single Cell Protein \(SCP\) by Two *Candida* Yeasts](#). *Sharkara*, 31 (1), 7-11.
25. Nigam P & Vogel M (1991) [Bioconversion of Sugar Industry by-products – Molasses & Sugar-Beet Pulp for Single Cell Protein-Production by Yeasts](#). *Biomass & Bioenergy*, 1 (6), 339-345.
26. Nigam P & Vogel M (1991) [Fermentation of Enzymatically Saccharified Sugar Beet Pulp by *Candida tropicalis* in 10-Litre Fermenter](#). *Sharkara*, 30(1), 6-8.
27. Nigam P (1990) [Investigation of Some Factors Important for Solid-State Fermentation of Sugar-Cane Bagasse For Animal Feed Production](#). *Enzyme & Microbial Technology*, 12 (10), 808-811.
28. Nigam P (1990) [Mixed Culture Solid-State Fermentation of Sugarcane Bagasse for Feed Production](#). Proc 52nd Convention of The Sugar Technologists Association India 7-9
29. Nigam P & Prabhu KA (1990) [Some Factors Affecting Bioconversion of Whole Bagasse into Fungal Biomass](#). *Journal of Basic Microbiology*, 30 (10), 747-751.
30. Pandey A, Nigam P & Vogel M (1988) [Process Selection for Bioconversion of Sugar-Beet Pulp into Microbial Protein](#). *Biological Wastes*, 26 (1), 71-75.
31. Pandey A, Nigam P & Vogel M (1988) [Simultaneous Saccharification & Protein Enrichment Fermentation of Sugar-Beet Pulp](#). *Biotechnology Letters*, 10(1), 67-72.
32. Nigam P (1988) [Protein Enrichment of Bagasse by Solid State Fermentation for Animal Feed](#). Proc 5th Convention & Symposium Bioenergy Society of India, Baroda, 5, 1-5.
33. Nigam P, Nigam AK & Prabhu KA (1988) [Studies on Morphology & Growth Characteristics of Bacterial Cultures Utilising Agricultural Lignocellulosic Wastes](#). Proc 51st Convention Sugar Technologists` Assoc. of India, 51, 41 -49.
34. Nigam P, Pandey, A & Prabhu, KA (1988) [Fermentation of Bagasse by Submerged Fungal Cultures – Effect of Nitrogen-Sources](#). *Biological Wastes*, 23 (4), 313-317.
35. Nigam P & Vogel M (1988) [Selection of Preculture Conditions For Solid-State Fermentation of Sugar-Beet Pulp](#). *Biotechnology Letters*, 10 (10), 755-758.
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Section 4: BIOPRODUCTION - Ethanol (biocatalysts & Fermentation-systems) (1-17 of 30)

Project 1: Industrial production

Project 2: Immobilised yeasts

Project 3: Starch conversion

Project 4: Sugarcane Molasses fermentation

1. Industrial production of ethanol

1. Abdel-Fattah WR, Fadil M, Nigam P & Banat IM (2000) [Isolation of Thermotolerant Ethanogenic Yeasts & Use of Selected Strains In Industrial Scale Fermentation in An Egyptian Distillery](#). Biotechnology & Bioengineering, 68 (5), 531-535.
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3. Singh D, Banat IM, Nigam P & Marchant R (1998) [Industrial Scale Ethanol Production Using Thermotolerant Yeast *Kluyveromyces marxianus* IMB3 in an Indian Distillery](#). Biotechnology Letters, 20 (8), 753-755.

2. Immobilised yeasts for ethanol fermentation

4. Ganatsios V, Koutinas AA, Bekatorou A, Kanellaki M, Nigam P (2014) Promotion of Maltose Fermentation at Extremely Low Temperatures Using A Cryotolerant *Saccharomyces cerevisiae* Strain Immobilised on Porous Cellulosic Material. Enzyme & Microbial Technology 66, 56-59.
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9. Nigam P, Banat IM, Singh D, McHale AP & Marchant, R (1997) [Continuous Ethanol Production By Thermotolerant *Kluyveromyces marxianus* IMB3 Immobilized on](#)

[Mineral Kissiris At 45 °C](#). World Journal of Microbiology & Biotechnology, 13 (3),283-288.

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11. Yadav BS, Rani U, Dhamija S, Nigam P & Singh D (1996) [Process Optimization For Continuous Ethanol Fermentation by Alginate-Immobilized Cells of *Saccharomyces cerevisiae* HAU-1](#). Journal of Basic Microbiology, 36 (3), 205-210.

3. Starch conversion to ethanol

12. Aggarwal NK, Nigam P, Singh D, Yadav BS (2001) [Process Optimization For The Production of Sugar For The Bioethanol Industry From Tapioca, a Non-Conventional Source of Starch](#). World Journal of Microbiology & Biotechnology, 17 (8), 783-787.
13. Aggarwal NK, Nigam P, Singh D, Yadav BS (2001) [Process Optimization For The Production of Sugar For The Bioethanol Industry From Sorghum, a Non-Conventional Source of Starch](#). World Journal of Microbiology & Biotechnology, 17 (4), 411-415.
14. Verma G, Nigam P, Singh D & Chaudhary K (2000) [Bioconversion of Starch to Ethanol in a Single-Step Process by Co-culture of Amylolytic Yeasts & *Saccharomyces cerevisiae* 21](#). Bioresource Technology, 72 (3), 261-266.
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4. Sugarcane Molasses fermentation

16. Farrell EA, Bustard M, Gough G, McMullan G, Nigam P et al (1998) [Ethanol Production at 45 °C by *Kluyveromyces marxianus* IMB3 During Growth on Molasses Pre-Treated With Amberlite® & Non-Living Biomass](#). Bioprocess Engineering, 19 (3), 217-219.
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24. Singh D, Dahiya JS & Nigam P (1995) [Simultaneous Raw Starch Hydrolysis & Ethanol Fermentation by Glucoamylase from *Rhizoctonia solani* & *Saccharomyces cerevisiae*](#). *Journal of Basic Microbiology*, 35 (2), 117-121.
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28. Dahiya Divakar & Nigam P (2018) [Bioethanol Synthesis For Fuel or Beverages From The Processing of Agri-Food By-Products & Natural Biomass Using Economical & Purposely-Modified Biocatalytic Systems](#). *AIMS Energy*, 6, 979-992.
29. Nigam P (2017) [An Overview of Microorganisms' Contribution & Performance in Alcohol Fermentation Processing a Variety of Substrates](#). *Current Biotechnology*, 6 (1), 9-16.
30. Kourkoutas Y, Dimitropoulou S, Marchant R, Nigam P et al (2001) [Whey Liquid Waste of Dairy Industry As Raw Material For Fermentation With The Thermophilic *Kluyveromyces marxianus* IMB3](#). In: Proc 7th International Conference on Environmental Science & Technology, University of The AEGEAN, pp. 226-233.
31. Banat IM, Nigam P, Singh D, McHale AP & Marchant R (1998) [Ethanol Production Using Thermotolerant/Thermophilic Yeast Strains: Potential Future Exploitation](#). In: *Advances in Biotechnology*. Educational Publishers & Distributors, India, 105-119.

Section 5: BIOREMEDIATION -Textile & Distillery effluents (1-20 of 29)

Project 1: Use of agricultural residues

Project 2: Decolourisation

Project 3: Fungal Enzymes

1. Use of agricultural-residues for remediation

1. Robinson T, Nigam P (2008) Remediation of textile dye-waste water using a white rot fungus *Bjerkandera adusta* through solid-state fermentation (SSF). *Applied biochemistry and biotechnology*, 151 (2-3), 618-628.
2. Chandran B, Singh D, Nigam P (2002) Remediation of textile effluent using agricultural residues. *Applied Biochemistry & Biotechnology*, 102, 207-212.
3. Robinson T, Chandran B, Naidu GS, Nigam P (2002) Studies on the removal of dyes from a synthetic textile effluent using barley husk in static-batch mode and in a continuous flow, packed-bed, reactor. *Bioresource Technology*, 85 (1), 43-49.
4. Robinson T, Chandran B, Nigam P (2002) Effect of pre-treatments of three waste residues, wheat straw, corncobs and barley husks on dye adsorption. *Bioresource Technology*, 85 (2), 119-124.
5. Robinson T, Chandran B, Nigam P (2002) Removal of dyes from a synthetic textile dye effluent by biosorption on apple pomace and wheat straw. *Water Research*, 36 (11), 2824-2830.
6. Robinson T, Chandran B, Nigam P (2002) Removal of dyes from an artificial textile dye effluent by two agricultural waste residues, corncob and barley husk. *Environment International*, 28 (1-2), 29-33.
7. Robinson T, Chandran B, Nigam P (2002) Studies on desorption of individual textile dyes and a synthetic dye effluent from dye-adsorbed agricultural residues using solvents. *Bioresource Technology*, 84 (3), 299-301.
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2. Decolourisation of effluents

9. Dahiya J, Singh D, Nigam P (2001) Decolourisation of molasses wastewater by cells of *Pseudomonas fluorescens* immobilised on porous cellulose carrier. *Bioresource Technology*, 78 (1), 111-114.
10. Dahiya J, Singh D, Nigam P (2001) Decolourisation of synthetic and spentwash melanoidins using the white-rot fungus *Phanerochaete chrysosporium* JAG-40. *Bioresource Technology*, 78 (1), 95-98.
11. Robinson T, Chandran B, Nigam P (2001) Studies on the decolourisation of an artificial textile-effluent by white-rot fungi in N-rich and N-limited media. *Applied Microbiology & Biotechnology*, 57 (5-6), 810-813.
12. Shibu AR, Kumar V, Wati L, Nigam P et al (1999) A Bioprocess For The Remediation of Anaerobically Digested Molasses Spent-wash From Biogas Plant & Simultaneous Production of Lactic Acid. *Bioprocess Engineering*, 20 (4), 337-341.
13. Kumar V, Wati L, Nigam P et al (1998) Decolorization & Biodegradation of Anaerobically Digested Sugarcane Molasses Spent Wash Effluent From Bio-methanation Plants By White-Rot Fungi. *Process Biochemistry*, 33 (1), 83-88.
14. Kumar V, Wati L, Fitzgibbon F, Nigam P, et al (1997) Bioremediation & Decolorization of Anaerobically Digested Distillery Spent Wash. *Biotechnology Letters*, 19 (4), 311-313

15. Banat IM, Nigam P, McMullan G et al. (1997) Isolation of thermophilic bacterial cultures capable of textile dyes decolorization. *Environment International*, 23 (4), 547-551.
16. Meehan C, Banat IM, McMullan G, Nigam P et al. (2000) Decolorization of Remazol Black-B using a thermotolerant yeast, *Kluyveromyces marxianus* IMB3. *Environment International*, 26 (1-2), 75-79.
17. Robinson T, McMullan G, Marchant R, Nigam P (2001) Remediation of dyes in textile effluent: a critical review on current treatment technologies with a proposed alternative. *Bioresource Technology*, 77 (3), 247-255.
18. McMullan G, Meehan C, Conneely A, Kirby N, Robinson T, Nigam P et al. (2001) Microbial decolourisation and degradation of textile dyes. *Applied Microbiology & Biotechnology*, 56 (1-2), 81-87.

3. Fungal Enzymes for decolourisation

19. Chatha S, Mallhi A, Hussain A, Asgher M, Nigam P (2014) A Biological Approach for Colour-Stripping of Cotton Fabric Dyed with C.I. Reactive Black 5 Using Fungal Enzymes from Solid State Fermentation. *Current Biotechnology*, 3 (2), 166-173.
20. Robinson T, Chandran B, Nigam P (2001) Studies on the production of enzymes by white-rot fungi for the decolourisation of textile dyes. *Enzyme & Microbial Technology*, 29 (8-9), 575-579.

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21. Nigam P, Banat IM, Singh D, Marchant R (1996) Microbial process for the decolorization of textile effluent containing azo, diazo and reactive dyes. *Process Biochemistry*, 31 (5), 435-442.
22. Nigam P, McMullan G, Banat IM, Marchant R (1996) Decolourisation of effluent from the textile industry by a microbial consortium. *Biotechnology Letters*, 18 (1), 117-120.
23. Nigam P, Banat IM, Oxspring D, et al. (1995) A new facultative anaerobic filamentous fungus capable of growth on recalcitrant textile dyes as sole carbon source. *MICROBIOS*, 84 (340), 171-185.
24. Nigam P, Marchant R (1995) Selection of a Substratum For Composing Biofilm System of A Textile-Effluent Decolorizing Bacteria. *Biotechnology Letters*, 17 (9), 993-996.
25. Kumar V, Wati L, Nigam P, et al (1997) Microbial Decolorization & Bioremediation of Anaerobically Digested Molasses Spent Wash Effluent by Aerobic Bacterial Cultures. *Microbios*, 89 (359), 81-90.
26. Fitzgibbon F, Nigam P, Singh D et al (1995) Biological Treatment of Distillery Waste For Pollution-Remediation. *Journal of Basic Microbiology*, 35 (5), 293-301.
27. Banat IM, Nigam P, Singh D, Marchant R (1997) Microbial decolorization of textile-dye-containing effluents. *Bioresource Technology*, 58 (1), 217-227.
28. Banat IM, McMullan G, Kirby N, Nigam P et al. (1999) Overview of work at University of Ulster on Microbial decolourisation of textile dyes present in textile industries effluent. Proc. The Industrial waste technical conference, Water Environment Federation/ Purdue, Indianapolis, Indiana pp16.
29. Marchant R, Nigam P, Banat IM (1994) An Unusual Facultative Anaerobic Filamentous Fungus Isolated Under Prolonged Enrichment Culture Conditions. *Mycological Research*, 98 (Part 7), 757-760.

Section 6: BIOACTIVITY - Antibacterial, Antioxidant in natural resources

[1-19 full papers attached of total 32]

Project 1 – Study with several types of Honey

Project 2 – Study with Pomegranate

Project 3 – Study with medicinal plants

Project 4 – Study with natural materials (Turmeric, Neem, Tea etc.)

1. Study with several types of Honey

1. Yusof HIM, Owusu-Apenten RK, Nigam P (2018) [Determination of Iron \(III\) Reducing Antioxidant Capacity for Manuka Honey and Comparison with ABTS and Other Methods.](#) J. of Advances in Biology & Biotechnology 18 (1), 1-9.
2. Wong LY, Nigam PS, Owusu-Apenten RK (2018) Effect of Iron and Hydrogen Peroxide Supplementation on the Total Phenols Content and Cytotoxicity of Honey for MCF-7 Breast Cancer Cells. J. of Advances in Biology & Biotechnology, 1-10.
3. Chau TC, Owusu-Apenten RK, Nigam P (2017) [Total Phenols, Antioxidant Capacity and Antibacterial Activity of Manuka Honey Extract.](#) J. of Advances in Biology & Biotechnology, 15 (4), 1-6
4. Kirkpatrick G, Nigam P, Owusu-Apenten RK (2017) [Total Phenols, Antioxidant Capacity and Antibacterial Activity of Manuka Honey Chemical Constituents.](#) J. of Advances in Biology & Biotechnology, 15 (4), 1-7.
5. Henderson K, Aldhirgham T, Nigam P, Owusu-Apenten RK. (2016) Evaluation of Manuka Honey Estrogen Activity Using the MCF-7 Cell Proliferation Assay. J. of Advances in Biology & Biotechnology, 10 (3), 1-11.
6. Kwok TH, Kirkpatrick G, Mohd YHI, Portokalakis I, Nigam P, Owusu-Apenten RK (2016) Rapid Colorimetric Determination of Methylglyoxal Equivalents for Manuka Honey. J. of Advances in Biology & Biotechnology, 7 (1), 1-6.
7. Portokalakis I, Mohd YHI, Ghanotakis DF, Nigam P, Owusu-Apenten R (2016) Manuka Honey-induced Cytotoxicity against MCF7 Breast Cancer Cells is Correlated to Total Phenol Content and Antioxidant Power. J. of Advances in Biology & Biotechnology, 8 (2), 1-10.
8. Bolanos de la Torre, Amparo AS, Henderson T, Nigam P, Owusu-Apenten R (2015) [A universally calibrated microplate ferric reducing antioxidant power \(FRAP\) assay for foods and applications to Manuka honey.](#) Food Chemistry, 174 (1), 119-123.

2. Study with Pomegranate

9. Wan HC, Sultana B, Nigam P, Owusu-Apenten RK (2018) [Comparison of Iron \(III\) Reducing Antioxidant Capacity \(iRAC\) and ABTS Radical Quenching Assays for Estimating Antioxidant Activity of Pomegranate.](#) [Beverages](#) 4 (3), 1-10
10. Mushtaq M, Sultana B, Akram S, Adnan A, Owusu-Apenten RK, Nigam P (2016) Enzyme-assisted Extraction of Polyphenols from Pomegranate (*Punica granatum*) Peel. J. of Microbiology and Biotechnology, 5 (2). pp. 27-34.

3. Study with Medicinal plants:

11. Barlow R, Barnes D, Campbell A, Owusu-Apenten R, Nigam P (2015) [Antioxidant, Anticancer and Antimicrobial, Effects of *Rubia cordifolia* \(Manjistha\) Aqueous Root Extract](#). J. of Advances in Biology & Biotechnology, 5 (1), 6-14.
12. Barnes, DA, Barlow R, Nigam P, Owusu-Apenten R (2015) [Antioxidant, Anticancer and Antibacterial Activity of *Withania somnifera* \(Ashwagandha\) Aqueous Root Extract](#). J. of Advances in Biology & Biotechnology, 5 (1), 1-6.

4. Study with natural materials (Turmeric, Neem, Tea-leaves etc.)

13. Aldhirgham T, Henderson K, Nigam P, Owusu-Apenten RK (2016) [A Combination of Curcumin from Turmeric and Alpha-linolenic Acid Shows Antagonism with MCF-7 Breast Cancer Cells in Phenol-red Free Medium](#). J. of Applied Life Sciences International, 10 (1), 1-12.
14. Chan YM, Cheng NK, Nigam P, Owusu-Apenten RK (2016) [Effect of pH on the Radical Quenching Capacity of Tea Infusions Using the ABTS•+ Assay](#). J. of Applied Life Sciences International, 6 (2), 1-8.
15. Cheung T, Nigam P, Owusu-Apenten RK (2016) [Antioxidant Activity of Curcumin and Neem \(*Azadirachta indica*\) Powders: Combination Studies with ALA Using MCF-7 Breast Cancer Cells](#). J. of Applied Life Sciences International, 4 (3), 1-12.
16. Yasir M, Sultana B, Nigam P, Owusu-Apenten R (2016) [Antioxidant and genoprotective activity of selected cucurbitaceae seed extracts and LC–ESIMS/MS identification of phenolic components](#). Food Chemistry, 199, 307-313.
17. Dwivedi A, Nomikou N, Nigam P, McHale A. (2012) [The effects of microencapsulated *Lactobacillus casei* on tumour cell growth: *in vitro* and *in vivo* studies](#). International J. of Medical Microbiology, 302 (7-8), 293-299.
18. Efstratiou E, Hussain AI, Nigam P, Moore JE, Ayub M, Rao JR, (2012) [Antimicrobial Activity of *Callendula officinalis* petal extracts against fungi, as well as Gram-negative and Gram-positive clinical pathogens](#). Complementary Therapies in Clinical Practice, 18 (3), 173-176.
19. Hussain AI, Anwar F, Nigam P, Sarker SD, Moore JE, Rao, JR, Mazumdar A (2011) [Antibacterial activity of some Lamiaceae essential oils using resazurin as an indicator of cell growth](#). LWT - Food Science and Technology, 44 (4), 1199-1206.
- Above 19 full papers attached -----
20. Alagumuthu, M., Arumugam, S. K., Nigam, P. & Napoleon, A., (2020) Anticancer Effects of Novel Tetrahydro-Dimethyl-Xanthene-Diones. Anti-Cancer Agents in Medicinal Chemistry. 20, (7), 909-916
21. Hussain AI, Anwar F, Nigam P, Sarker S (2011) [Composition, antioxidant and chemotherapeutic properties of the essential oils from two *Origanum* species growing in Pakistan](#). Brazilian J. of Pharm., 21(6), p. 943-952.
22. Das AJ, Chalil S, Nigam P, Magee P, Janneh O, Owusu-Apenten R (2011) [Glutathione transferase-P1-1 binding with naturally occurring ligands: assessment by docking simulations](#). J. of Biophysical Chemistry, 2 (4), 401-407.
23. Abichandani M, Nahar L, Nigam P, Chitnis R, Nazemiyeh H, Delazar A, Sarker SD (2010) [Antibacterial and free-radical-scavenging properties of *Stachys schtschegleevii* \(Lamiaceae\)](#). Archives of Biological Sciences, 62 (4), 941-945.

24. Hussain AI, Anwar F, Chatha SAS, Jabbar A, Mahboob S, Nigam P (2010) [Rosmarinus officinalis essential oil: antiproliferative, antioxidant and antibacterial activities](#). Brazilian J. of Microbiology, 41 (4), 1070-1078.
 25. Sauvage S, Samson E, Granger M, Majumdar A, Nigam P et al. (2010) [Assessment of free-radical-scavenging and antibacterial activities and brine shrimp toxicity of Scutellaria pinnatifida \(Lamiaceae\)](#). Oriental Pharmacy and Experimental Medicine, 10 (4). 304-309.
 26. Hussain AI, Anwar F, Nigam P, Ashraf M, Gilani AH (2010) [Seasonal Variation in Content, Chemical Composition and Antimicrobial and Cytotoxic activities of Essential Oils from Four Mentha Species](#). J. of the Science of Food and Agriculture, 90, 1827-1836.
 27. Granger M, Samson E, Sauvage S, Majumdar A, Nigam P, et al. (2009) [Bioactivity of Extracts of Centaurea polyclada Dc. \(Asteraceae\)](#). Archives of Biological Sciences, 61 (3), 447-452.
 28. Genest S, Kerr C, Shah A, Rahman MM, Saif-e-Naser GMM, Nigam P, Nahar L, Sarker SD (2008) [Comparative bioactivity studies on two Mimosa species](#). Boletin Latino americano Y Del Caribe De Plantas Medicinales Y Aromaticas, 7 (1), 38-43.
 29. Chitnis R, Abichandani M, Nigam P, Nahar L, Sarker SD (2007) [Antioxidant and antibacterial activity of the extracts of Piper cubeba \(Piperaceae\)](#). ARS Pharmaceutica, 48 (4), 343-350.
 30. Johnston M, McBride M, Dahiya D, Owusu-Apenten RK, Nigam P (2018) [Antibacterial activity of Manuka honey and its components](#). AIMS Microbiology. 4, 655-664
 31. Hussain AI, Anwar F, Nigam P (2009) Variations in The Biologically Active Compounds of The Volatile Oils of Three *Ocimum* Species Grown at Hilly and Plane Regions. Annals of Nutrition and Metabolism 55, 129
 32. Hussain A, Anwar F, Nigam P, Sarker S (2009) Antimicrobial and Antioxidant Activities of the Essential Oils of Selected Species of the Lamiaceae. Annals of Nutrition and Metabolism 55, 130
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VI. Statement of contribution of published research

On *“Biotechnology for processing natural resources employing microbial-catalysts and fermentation systems”*

Microbial-Biotechnology in applied and industrial aspect is – the integrated use of following:

1. Microorganisms - mainly Bacteria, yeasts and fungi
2. Microbial-Biochemistry - related to microbes’ growth-characteristics, and study/optimisation of factors regulating their growth pattern and metabolism
3. Process-Engineering - including upstream and downstream processing

The main OBJECTIVE of Microbial-Biotechnology:

“To achieve technological and industrial application of the capabilities of microorganisms”.

This technology is currently used on different scales in Food and industrial processes for a wide range of purposes, and several processes have been commercialised.

*** (refs my Books 2010, 2009, 2001).

Important Microbial Cultivations can be categorised as below:

1. For the production of microbial Biomass
(e.g. Single Cell Protein more precisely Bioprotein, yeast, and starter cultures);
- 2 - For the production of Enzymes
(e.g. Amylases, Cellulase, Ligninase and Pectinase etc.);
- 3 - For the production of Metabolites
(e.g. Antibiotics; amino acids; organic acids);
- 4 - To perform Biotransformations
(e.g. Steroids and sterols).

Microbial technology can be performed and optimised using two types of Microbial Cultivations, depending on type of substrate is being used in the process:

1. Liquid or Submerged Fermentations (SmF)
2. Solid State Fermentations or Surface (SSF)

Solid substrate fermentation (SSF) is the microbial transformation of biological materials in their natural state, in contrast with liquid or submerged fermentation, which is carried out in dilute solutions or slurries.

***Reference biotechnology books co-authored and co-edited by Poonam Nigam:

1. Book Title "Biotechnology for Agro-Industrial-Residues-Utilisation" (2009)
Nigam Poonam & Pandey A Publisher-Springer Netherlands pp.1-466 ISBN 978-1-4020-9941-0; e-ISBN: 978-1-4020-9942-7
<http://www.springer.com/biomed/book/978-1-4020-9941-0>
2. Book Title "Comprehensive Food Fermentation Biotechnology" (2010) Pandey A, Soccol CR, Larroche C, Gnansounou E, **Nigam Poonam**, ISBN 81:87680-23-7 Asiatech publishers Inc. pp 1-795
3. Book Title "Solid State Fermentation in Biotechnology: Fundamentals and Applications" (2001) Pandey A, Soccol CR, Rodriguez-Leon JA and **Nigam Poonam** ISBN 81-87680-06-7 Asiatech Publishers Inc. pp. 1-222 (Best Biotechnology Reference book award winner)

The research work submitted in this thesis has been conducted and published after the award of my PhD degree in 1985 in **India**, and therefore, only includes some of my postdoctoral work 1986-1989 in **Germany**, but mainly the research work completed during my full-time employment as a research-active academic member of staff at Ulster University since Jan 1990-present in **UK**.

The contribution of my research and published work in public domain has been to advance the study of subject, in the area of applied Microbial-Biotechnology, on following aspects:

Fermentation-technology using cultivation of microorganisms in submerged and solid-state/substrate systems;

- Microbial Bio-Processes for Bioremediation of effluents from distillery and textile industry,
- Bioconversion of renewable bioresources, industrial residues and by-products from food and drink industries for added-value products,
- Biodegradation and Biotreatment of agricultural residues for useful products, etc.

Publications (Appendix 3) are the result of my research projects funded by following Industries, Research Institutes and Higher Education Institutes:

[A] Industries-funded Projects

- 1985-1988 Süddeutsche Zucker - AG (Largest Sugar Industry in EU, Germany)
Project: **Process Optimization for the recycling of by-products Sugar beet pulp and molasses for animal feed production.** *Process Patented*
- 1981-85, 1988-90
National Sugar Institute, The only Sugar Research Institute in Asia

- Project: Processing of by-products- Sugarcane Bagasse & Molasses from Sugar Factory
- 1990-1993 Radox Laboratories, International Pharmaceutical Co. in N. Ireland, UK
Project: Development of manufacturing process of Diagnostic Enzymes
- 1990-1993 Fruit of the Loom International, American Textile Co. in Republic of Ireland
Project: Textile Effluent Treatment using biological systems
- 1990-1993 Desmonds & Sons, Ireland
Project: Treatment of water effluent from Jean fabric's stone-washing
- 1990-1998 Associate Distillery in Haryana state & Modinagar Distillery in U.P. state, India
Project: Thermo-tolerant yeast Bio-Ethanol production & Distillery-Effluent treatment

[B] HEI Funded Research Projects (1981-1990)

- July 1988 - Jan 1990 1. "Bioconversion of Lignocellulosic Agricultural Wastes"
2. "Utilisation of Starch Waste of Potato Processing Industries"
3. "Utilisation of Whey Waste of Dairy Industry"
Principal-Investigator Sponsored by Council of Scientific & Industrial Research, India
Jan 1988 - Jul 1988 "Utilisation of Sugar Industry by-products sugarcane bagasse & molasses for Animal Feed production"
Project-Scientist Sponsored by Ministry of Food & Civil Supplies, Government of India
- Dec 1985 - Dec 1987 "Bio-conversion of Sugar Beet Pulp into Protein-enriched Feed in Submerged & Solid-state Fermentations" in R & D Company, Germany
Principal Investigator Sponsored by Ministry of Education, Government of India
- Jan 1985 - Dec 1985 "Studies on Solid-state Fermentation of Bagasse for Enzymes & Feed Production"
Principal Investigator Sponsored by Council of Scientific & Industrial Research, India
- May 1981 - Dec 1984 "Studies on Microbial Decomposition of Cellulosic Agricultural Wastes"
PhD Research Funded by Ministry of Food & Civil Supplies, Govt. of India
- Jan 1981 - May 1981 "Production of Biogas from Cellulosic Agricultural Wastes in Pilot Plants"
Research-assistant Funded by Department of Science & Technology, Govt. of India

[C] Research Projects at Ulster University, UK (1990- present)

- 1990-1992 [1]. "Process Development of Salicylate Hydroxylase Enzyme Production from Salicylate Utilising Bacterium *Pseudomonas putida*" for Diagnostic kits
[2]. "Process Development of Dihydrofolate Reductase Enzyme from Methotrexate Resistant Organisms " for use in Food & Pharmaceutical Companies Funded by Radox Company and International Fund for Ireland
- 1992-1993 "Isolation and Characterisation of Naphthalene Degrading Bacterial Cultures".
- 1993-1997 "Biological Treatment of Distillery Effluent", EU-International collaboration with Haryana Agricultural University, India
- 1993-1996 "Development of Biological Processes for the Treatment of Textiles Wastewater",

Funded by International Fund for Ireland and International Textile Company-Fruit of the Loom.

- 1994-1999 "**Identification of microorganisms & system to improve primary fermentation and effluent treatment during ethanol production from molasses in India**" Funded by European Commission, Brussels, (INCODC: International Co-operation between Developing country & UK)
- 2012-contd "**Strategies development for enhancement of probiotic viability and applications in selected food system**", administered by the General Secretariat for Research and Technology-Hellas (GSRT) Greece
- 1996-2001 "**Solid state fermentation of dye-adsorbed agricultural residues**", Funded by Department of Education, N. Ireland
- 1999-2001 "Studies on fermentative production of chiral compounds for optically active pharmaceuticals" Funded by CVCP-ORS (Overseas Research Scholarship) & Vice-Chancellor Research Scholarship)
- 1996-2001 "**Microbial bio-transformations for drug synthesis**" Funded by CVCP-ORS (Overseas Research Scholarship & University of Ulster (Vice-Chancellor Research Scholarship)
- 1996- contd. "**Production of Industrial Enzymes - Xylanase, Lipase, amylase**" collaboration, with India and Brazil
- 1996-contd. **Food Fermentation; Bioprocesses** for food industries with Greek Collaborators
- 2008-contd. "**Bioactivity in plant and natural materials**".

In relation to the title of this thesis "Biotechnology for processing natural resources employing microbial-catalysts and fermentation systems", for this evaluation, I have selected following publications for consideration in the general area of Process Biotechnology. More specifically, I have worked in the study and optimisation of several Bioprocesses, using microorganisms and their derivatives as biocatalysts, for a wide range of applications in different industries. These bioprocesses were designed and optimised, for two growth conditions or the states of cultivation of selected microorganisms, depending on the substrates used in the process and system:

1. Solid-state or Solid-Substrate Fermentation (SSF) Bioprocess,
2. Liquid-state or Submerged Fermentation (SmF) Bioprocess.

The published work & outputs have been arranged in six **BIO....** groups as summarised in **Part V** according to specified subject area, the last section includes most recent project on bioactivity in natural material for the objective of search for natural antibacterial materials.

Section 1: Bioprocesses - Food Biotechnology

Section 2: Biosynthesis - Microbial Enzymes

Section 3: Bio -Conversion & -Treatment – of Industrial Residues & By-Products

Section 4: Bioproduction - Ethanol (Biocatalysts & Fermentation-System)

Section 5: Bioremediation- Effluents from Textile & Distillery

Section 6: Bioactivity – Antibacterial and other activities in natural-resources

A short description of work in each section has been presented as below indicating how far and in what respect the contributions have advanced the study in microbial biotechnology:

Section 1: Bioprocesses - Food Biotechnology [1-15 publication {details in Part V}]

The work is concerned with the development of fermentation processes performed in liquid-state and solid-state, related to food industry. The studies included the optimisation of processes for the formation & improvement of several products using microbial biocatalysts and fermentation system, e.g. Bread, Cheese, Probiotic drinks and yogurts, Wines etc. The raw substrates used in studies were taken from agriculture and certain by-products. The project was completed in collaboration with partners in two Greek universities, which started in 1995 after a contact established by a Professor in Greek University after he read my publications and Patent from 2-year post-doctoral research completed in R & D lab of a German company. This published research was on bioconversion of sugar beet pulp by solid-state fermentation for protein-enriched animal feed on pilot plant scale for commercial production.

Through this collaboration and efforts made by the Head of Department Applied & Biological Sciences at Ulster University, a joint-degree taught Program MSc in Food-Biotechnology was designed and validated in 1998 between Ulster and two Greek Universities. The papers submitted in this section are from the research projects completed by students on MSc-Food biotechnology program under the joint supervision of staff at Ulster and Greek Universities. Some publications are from the work of PhD and Postdoctoral Greek student supervised by me as an external co-supervisor funded under ERASMUS mobility program.

*[The names of all co-authors are included in the **Appendix 1.1** under different sections, and the statement of collaborative work signed by two heads of department in Greek University on behalf of all Greek students- co-authors is included in **Appendix-5**].*

The publications have been put in three categories:

1. **Fermented Food** - Publication 1-7 in list

The research in this project provided optimised processes for the production of functional *Myrithra*-cheese and feta-type cheese, using probiotic bacteria *Lactobacillus casei* and a

resin *Pistacia* for the entrapment of bacterial cells. Yogurts of improved aromatic profile and enhanced probiotic viability could be prepared using immobilised bacteria on wheat bran. A Greek Chios mastic gum was found useful in such fermentation for its antimicrobial property. Nano/micro tubular cellulose (TC) were found useful in development and optimisation of processes for food industry, e.g. a process for the preservation of apple juice through microbial adsorption on TC.

2. **Sourdough making** - publications 8-12 in list.

The research in this project was conducted provided information that the biocatalyst yeast and probiotic bacteria like *Lactobacillus delbrueckii* and *helveticus* kefir grains could be used in making sourdough, if the aroma volatiles were required in bread on storage. Kefir grains could be prepared cheaply using a variety of substrates for their use as novel biocatalysts in sourdough making.

3. **Food additives** - publications 13-15 in list. These publications have reported information on three additives widely used in food industries- pigments, lactic acid and a sugar substitute-xylitol. The information is discussed on types of microbial fermentation processes and biocatalysts, which could be used in production of these food-additives.

Section 2: Biosynthesis - Microbial Enzymes [1-19 {details in Part V}]

Research presented in these papers is concerned with the biosynthesis of microbial enzymes in specifically designed and optimised fermentation system. The papers in this section are put in three categories.

1. **Hydrolytic enzymes** – Papers 1-8

Papers included in this part are the work related to synthesis and study of their specific properties of some enzymes of industrial importance for their biotechnological applications (Paper 1); such as cellulase (paper 8), pectinase, cellulase-free xylanase, amylase and laccase/ligninase, for their application in different industries. Work published in paper 2 on pectinase enzyme production was approached by an overseas research institute for setting a technology transfer for the clarification of fruit juices using pectinase enzyme. Work in paper 3 was undertaken for application in paper/pulp

industry, for the production of cellulose for paper making free from hemicellulose from plants. Since most of microorganisms produce enzyme rich in cellulase, hydrolysing cellulose content of plant material, we had to find a specific microorganism, efficient in xylan-hydrolysing enzyme at higher temperature. This study optimised a process for an enzyme production capable of removing hemicellulose (Xylan) content, from plant tissues but leaving cellulose part unhydrolyzed for paper production.

Paper 4, 6 reported work on biosynthesis and characterisation of laccase enzymes, for their application in decolourisation of textile dyes-effluents.

2. **Diagnostic Enzymes** – Papers 9-13

The work completed and published is the result of my three-year full-time job as a senior research officer at Ulster University during 1990-1992. This project was funded by Radox pharmaceutical company, N. Ireland. The funding for three years permitted working on microbial biosynthesis of two enzymes: 1. Salicylate hydroxylase, 2. Dihydrofolate reductase, which were required by Radox Co. for incorporation into diagnostic kits.

Papers 9,10,13 present work that a salicylate hydroxylase producing bacterial strain *Pseudomonas putida* was isolated, its cultivation was scaled up from batch flasks to 5-litres to 60-litre fermenters. The enzyme could be purified, partially characterised and used in the construction of a biosensor for the estimation of salicylate (aspirin) in blood samples.

Papers 11 and 12 present work undertaken for the isolation of bacterial strain capable of growing in presence of methotrexate. This strain was cultivated in batch and continuous process in 5-litre fermenters for the biosynthesis of di-hydro folate reductase enzyme. Studies produced results showing this enzyme had a potential for estimation of Methotrexate in blood samples, and it could be incorporated in biosensors for the diagnostic kits.

3. **Biotransformation Enzymes** – papers 14-19

These publications are from the work of two overseas PhD students supervised by me as first supervisor funded under ORS+VCRS scheme. The work was published related to enzymatic bio-transformation of chiral compounds for application in pharmaceutical industry. The papers relate to microbial catalysts - enzymes in bench-top batch and continuous systems optimised for the synthesis of enzymes Lipase and esterase, and

subsequent studies for their purification and characterisation. Several yeast strains known for lipase synthesis were purchased from culture collection and screened for enzyme production and specific activities, but one strain of *Candida cylindraceae* proved to be the most efficient, and therefore, it was used for the resolution of compound (RS)- proglumide.

*[The statement signed by this PhD student {now working in US} is included in **Appendix-5**].*

Section 3: Bio-conversion & Bio-treatment - Industrial residues & by-products (1-16{details in Part V})

The papers included in this section are put in two categories:

1. Biorefinery Papers 1-12

Work reported in these papers provide information concerned with the utilisation of agricultural residual substrates in bioconversion process either in submerged liquid-state, or solid-state/solid-substrate fermentation systems. The output 2 describes the results obtained in studies performed for the pre-treatment of lignocellulosic substrates for making them suitable for microbial-saccharification, and fermentation of the hydrolysed (saccharified) substrates to obtain products of added-value and commercial-importance.

Papers 5-10 are related to information available on work conducted for biofuel production from renewable resources including agricultural residues, and by-products of sugar industry. Papers 5, 8 and 9 have presented information on use of algae for biodiesel production, instead of using land-based resources.

on the treatment of by-products generated in distillery and food industry using microbial catalysts as whole microorganisms, or the enzymes prepared in fermentation employing selected microbes.

Papers 11 and 12 provide an extensive information on potential of sugarcane bagasse and cassava bagasse for biotechnological applications, which are generated in large amounts annually.

2. Utilisation agri-residues Papers 13-15

Papers 13 and 14 reported work on direct utilisation of some specific agricultural material and fruit-peels for their ability to inhibit aflatoxin synthesis by two fungi namely *Aspergillus niger* and *A. flavus*. This work is useful for the biotreatment of cereals and rice grains for their long-term storage.

Paper 15 reported that bioreactors can be specifically designed for the protein-enrichment of natural bioresources available in form of agricultural crop residues globally, using the biotechnology of solid-state fermentation for the bioconversion on larger-scale in an economical process.

Section 4: Bioproduction - Ethanol synthesis (using biocatalysts & Fermentation-systems) (papers 1-18 {details in Part V})

The published work submitted in this section is concerned with the Biosynthesis of Ethanol completed under four projects:

1. Industrial production (papers 1-3)

The publications are based on result of pilot scale experiment of higher temperature fermentation using thermotolerant and thermophilic yeasts. Strains of yeast with the characteristic of thermotolerance were purposely isolated from the soil samples exposed to hot climatic conditions, collected from grounds of two Distilleries in India,. This project was funded by the European commission under INCO-DC program {International Cooperation with Developing countries} jointly to research groups at Ulster University UK and in India (HA University and Associate Distillery & Modinagar distillery in two different states). The selected strains were tested through research collaboration for commercial ethanol production under hot climatic conditions without cooling of fermenters, in one distillery in India and one distillery in Egypt.

2. Immobilised yeasts (papers 4-11)

Papers 4-7 report the work completed by PhD, Postdoc funded by ERASMUS mobility and Greek Higher Education program in collaboration with two Greek partner universities (Ref section 1 Food Biotechnology). For each PhD project different yeast and bacterial strains were used under immobilised forms to achieve specific purposes. In these projects

delignified cellulose prepared in lab was used as the support material for the immobilisation of yeast and bacteria, instead of using conventional alginate beads.

Papers 8 and 9 report the results from a project completed at Ulster University using thermotolerant yeast immobilised on a volcanic highly porous material, called Kissiris obtained from Greece.

Paper 10 reports the use of thermotolerant yeast immobilised in alginate for ethanol production from sucrose. Whereas paper 11 reports the project completed with collaborators in India, using immobilised distiller's yeast in a continuous fermentation system.

3. **Starch conversion** (papers 12-14)

This work completed in collaboration with partners in India reported on bioconversion of two non-conventional sources of starch, sorghum and tapioca, widely grown in India. A single-step process was optimised for the saccharification of starch by amylolytic culture and fermentation of saccharified starch to alcohol by distiller's yeast *S. cerevisiae* simultaneously.

4. **Sugarcane molasses conversion** (papers 15-17)

papers in this section are from the work of PhD students who used thermophilic and thermo-tolerant yeast strains for the fermentation of sugarcane molasses as substrate for ethanol production. The results include the optimisation of biocatalysts, cultural-factors and study of immobilisation system.

Paper 16 reports the process development for continuous ethanol production from sugarcane molasses collected from same distillery in India as mentioned in paper 3 of this section 4. A column reactor was designed on lab scale using immobilised cells of yeast, used for commercial production in Indian distillery.

*[The names of these co-authors are included in **Appendix 1.1** and the statements from co-authors Prof Banat and Prof McHale are included in **Appendix 5**].*

Section 5: BIOREMEDIATION -Textile & Distillery effluents (1-20 {details in Part V})

This project was initially started in 1993 by me as a senior research officer in Biotechnology in a project Bioremediation of wastewater and effluents generated in Textile industry. This 3-year project was funded by two textile companies - Fruit of the Loom and Desmond & sons, in Buncrana Ireland, and International fund for Ireland. The experiments were optimised for the bio-treatment of actual effluent collected from both companies' printing and washing areas. Part of work was also conducted to understand the biochemistry of microbial degradation of individual dyes for the optimisation of microbial decolourisation process. For this purpose, few most commonly used dyes in commercial printing process were also selected (e.g. blue, green, red and yellow) and used for study in microbial-decolorisation process {these publications are in the list paper no 21-29 but not present as full papers.

Later work completed by my PhD and postdoctoral researchers is presented in following categories:

1. **Use of agricultural residues** (papers 1-8 {details in Part V})

Based on work completed earlier by me (as in above paragraph), Further studies were undertaken using agricultural residual substrates for the remediation of textile effluents. These papers report the process optimisation using cheaply available materials, such as barley husk, corncob, wheat straw, and apple pomace etc.

2. **Decolourisation of distillery & Textile effluent** (papers 9-18 {details in Part V})

Papers 9,10,12-14 report the results obtained from the project completed for the decolourisation of molasses waste water, primary effluent-spent wash generated in Associate distillery India after ethanol production, and for the treatment of the secondary effluent generated from a Bio-gas plant after anaerobic digestion of primary spent wash used for biomethane production (used as fuel in same distillery).

3. **Fungal enzymes in decolourisation** (papers 19-20 {details in Part V})

Papers 19 and 20 report the cultivation of white-rot fungi in solid state fermentation of agricultural solid residues for the production of fungal enzymes consisting of laccase, lignin and manganese peroxidase. These enzymes having similar activity as in the breakdown of

lignin, a dark coloured component of lignocellulosic polymer, were used in the decolourisation of textile dyes. Paper 19 work was done in collaboration with a university in Pakistan, where enzymes were produced in solid state fermentation, and crude preparations of enzyme were used in the excess colour removal/stripping from cotton fabrics dyed with synthetic reactive dyes, instead of chemical washing.

*[The statement of collaborative work signed by Prof Banat is included in **Appendix-5**].*

Section 6: BIOACTIVITY - Antibacterial, Antioxidant in natural resources [papers 1-20, {details in Part V}]

I started this work after I was included as a research-active academic staff in Nutrition Innovation Centre for Food and Health (NICHE) for REF (Research Excellence Framework, UK).

Output in this section is concerned with the analysis of bioactivities in materials available in nature, including underground and over-ground parts of some medicinal plants; few commonly used culinary herbs, and natural products like international varieties of honey, turmeric and tea leaves, etc. The research output in this section is the experimental work where the materials of interest were subjected to the chemical and aqueous extraction of biomolecules, using polar and non-polar solvents, and the extracts were concentrated for storage and subsequent use after dilution, as appropriate. The studies optimised preparation of samples/extracts as per requirement and their suitability for analytical methods.

The outputs describe the estimation of certain bioactivities, mainly Antimicrobial, Antioxidant and Anticancer. The standard assays for each activity were followed either as published by other researchers or modified by us for the optimisation with possible improvement of process. The some of the results and methods as optimised in these studies were published and have been included in this submission.

Most of the work was completed by Master students on Biotechnology and Food-Nutrition courses, and by few overseas researchers supervised by me and other staff. Some work included in this section incorporates the result of a doctoral overseas visiting researcher, who brought the samples of native plant material and essential oils.

*[The names of all co-authors are included in **Appendix 1.1** under different sections; and the statement of collaborative work, signed by visiting doctoral student is included in **Appendix-5**].*

Appendix -1

Appendix 1.1 - Researchers supervised

Supervision of PDF, PhD, PG, UG [Sections A-H]

[1.1A] Post-Doctoral & Visiting Researchers:

- 2012-16 Loulouda Bosnea (EC Greek Project) Probiotic cultures characterization
- 2006 Stavros Plessas (Greek Partnership) Sour dough microbiology
- 2000-02 Bennett Chandran (ERDF Project) Bioprocess designing for textile effluent remediation
- 2002 Lucy Ndip (UNESCO project) - Penicillin-Acylase enzyme production from *E. coli* bacteria
- 2000 Yiannis Kourkoutas (Greek Partnership) - Immobilised bioethanol production
- 2000 Sofia Dimitripoulou (Greek Partnership)
- 2001 Vicky Dritsa (Greek Partnership)
- 2001 Colum McErlean (Ulster funded)
- 2001, 06 Argyro Bekatorou (Greek Partnership) Bioethanol production

[1.1B] PhD Supervision (First/second supervisor):

- 2013-15 Ganatsios Vasilis Greek Government funded 'SCP, Edible Fungi and Food Additives from Biotechnological Exploitation of Food & Agro-industrial Wastes' (with Prof Koutinas, Greece)
- 2008-12 Mazumdar A (Overseas Self-Funding) Analysis of extracts from higher plants to treat disease (with Prof AP McHale)
- 2008-12 Dwivedi A (Overseas Self-Funding) Bacteriolytic therapy of tumors (with Prof AP McHale)
- 2008-09 Hussain, Ijaz (International Higher-Education funded split-site PhD 1-year in UK); Bioactivity in plant materials
- 2007-08 Gupta, Nutan (Commonwealth Uni funded split-site PhD 1-year in UK); Bioremediation of textile wastewater
- 2008-11 Hughs Paul (DEL Northern Ireland); Electro-biosorptive recovery of economic metals from waste streams (with Prof AP McHale)
- 2005-08 Nomikou N. (VCRS); Electric field-mediated biosorption - Assessing potential applications (with Prof AP McHale)
- 2001-04 Xue Yuanchen (VCRS) Isolation structural characterisation and molecular cloning of novel polypeptides from frog venom (with Prof Chris Shaw)
- 1999-02 Chirumamilla R.R. (ORS+VCRS) Studies on Fermentative Production of Chiral Compounds for Optically Active Pharmaceuticals (with Prof R. Marchant)
- 1999-02 Reddivari M. (ORS+VCRS) Microbial Biotransformations For Drug Synthesis (with Prof R. Marchant)
- 1999- 02 Robinson T (DEL Northern Ireland) Solid-state fermentation of dye-absorbed agricultural residues (with Prof R. Marchant)

- 1998-01 Meehan CM (DEL Northern Ireland) Biotreatment of textile industry wastewater (with Prof G. McMullan)
 Prof AP McHale academic supervisor; as a FT Research staff until 1995 and later as academic staff, I assisted following PhD researcher) [*the statement from Prof McHale is included in Appendix 2*]
- 1994-98 Susan Gough - Ethanol fermentation
 1994-98 Brady D - Bioethanol production
 1993-97 Barron N - Immobilised systems for alcohol fermentation

[1.1C] International Researcher - Supervision:

- 2007-15 Terpou Antonia (PhD + PDF) Production of probiotic sour milk, yogurts, cheese and liqueurs with immobilized cells at low temperatures. European Cooperation, University of Patras, Greece
 2011-15 Gialleli Angelika-Ioanna (PhD) Production of wine and beer making in a domestic refrigerator European Cooperation, University of Patras, Greece
 2007-12 Loulouda Bosnea (PhD +PDF) European Social Fund Project, Greece
 2013-14 Cecilia de Souza Cordeiro, Utilisation of Barley waste from Bushmills Distillery, N.Ireland. Research Trainee under Science without Borders programme - (Federal University of Lavras, Brazil, UK Higher Education International Unit)

[1.1D] Exchange Researchers (agreement with Polytech Clermont, France)

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- 2009 - Coline Saunier – [Bioactivity in essential oils from Lameacea Family- Extraction A]
 2009 - Laura Blanc – [Bioactivity in essential oils from Lameacea Family- Extraction B]
 2008 - Sauvage Severine – [Bioactivity of *Scutellaria pinnatifida* Extract]
 2008 - Granger Melanie – [Bioactivity of The Extracts of *Centaurea Polyclada* - Extraction A]
 2008 - Samson Emilie - Bioactivity of The Extracts of *Centaurea Polyclada* Dc. - Extraction B
 2007 - Samuel Genest - Bioactivity Studies on Two *Mimosa* Species
-

[1.1E] European Social Funded - Master of Research:

- 1997-98 Gillian Armour – [Solid-state Fermentation of Textile-dye Occupied Biomass]
 2000-01 Theodora Raftopoulos –[Rhamnolipids production under batch and continuous culture conditions (with Prof Banat)]
 2000-01 Raftopoulos Odysseas – [Lipids production under batch and continuous culture conditions (with Prof Banat)]
 2005-06 S. Dimitriadis – [Electric field-mediated biosorption- medical applications (with Prof AP McHale)]

[1.1F] MSc Research Dissertations

[Biotechnology; Food-Biotechnology; Food & Nutrition] supervision]

- (3 in 2017-18) Michael McBride, Matthew Johnston; Nichola Ejaz [Effects of components of Manuka honey (UMF 5-20), Methotrexate on MCF7 cancer cells].
 (3 in 2015-16) [2 MSc Human Nutrition students] Tahir Aldhirgham- [Curcumin and ALA], Kathlene Henderson – [Manuka honey- estrogenic activity]; Robert Gregg [Methyl Glyoxal-Manuka honey].

- (5 in 2014-15) Ioannis Portokalakis; Mohd HIY [Food Nutrition- Manuka Honey]
 Cheung Tsz Ki– [Dietetics - Antioxidant curcumin & *Azadirachta indica*]
 Dylan Barnes – [Antioxidant act of *Rubia cordifolia*];
 Ryan Barlow [Antioxidant act of *Withania somnifera* Medical Healthcare Biotech].
- (4 in 2013-14) Grainne McKeown; T. Henderson [Honey of 5 Manuka factors]
 Adam Campbell [*Rubia cordifolia*]; Aaron Hendricks [*Withania somnifera*].
- (1 in 2011-12) S. Roy [Immobilized wine production].
- (4 in 2010-11) N. Camacho; A. Nithavrianakis [Immobilized wine production]
- Efstratios Efstratiou; George Argyropoulos [Lactic acid Bacteriocins].
- (2 in 2009-10) A. Jain antibiotic in Aloe vera; Jemima Manuel [Antioxidant Biotech].
- (2 in 2009-10) Shreedha Chalil; Anupam Dass [Downstream processing of Glutathione Biotech].
- (3 in 2008-09) Ciaran Ward - Business & Information Innovation [Topic European Social Funding]; Archana Juyal [Microbial-Glutathione production]; Soni Audhish- [Yeast-Glutathione production].
- (8 in 2007-08) M. Kumar [Biotech]; K. Leonidas; S. Nikolou; S. Theodoras; Z. Evangelia; V. Dionysia; A. Papadatou; P. Lamprini [Food Biotech].
- (8 in 2006-07) M. Abichandani; R. Chitnis; A. Shah; Conor Kerr [Biotech]; N. Droushiotis; KM Kapetanakis; G. Kastaniotis; P. Lymnaiou [Food-Biotech].
- (5 in 2005-06) C. Baras; A. Damaskinou; V. Verdood; D. Agiomirgiannaki; SG. Leonard [Biotech].
- (3 in 2004-05) A. Kapaklis; P. Kandyli; A. Koureta; Ann Fisher; A. Konstantina [Food-Biotech].
- (3 in 2002-03) N. Agouridis; Olivia Harta; M. Iconomopoulou; Colm McErlean; C. Psarianos; M. Trantallidi- [Food-Biotech].
- (2 in 2001-02) Lorna Pherson; P. Panas [Food-Biotech].
- (4 2000-01) Olaf Sunnotal; Xue Yuanchen [Biotechnol]; C. Elezi; E. Bezirtzoglou [Food-Biotech].
- (2 in 1993-94) Catherine White; Imelda Swords [Biomedical Sc.].
- [1.1G] 1 (1995-96) Diploma in Industrial studies 1-year Placement Ms. Gillian Love - Solid State Fermentation

[1.1H] Undergraduate Research Dissertations

Since 1996-current I've been supervising laboratory-based research-projects, on average 5-6 students per academic year in on-campus Ulster university taught courses - BSc Hons Biology, BSc Biotechnology, BSc Biomedical sciences.

Appendix 1.2: Ph.D. Thesis Examined (57 till date)

1. 2020 Anette Jansson, Licentiate **University of Borås, Sweden**
2. 2020 Thi Nguyen "Screening and evaluating enzymes produced by actinobacteria growing on seaweed and their bioproducts" **Flinders University, Australia**
3. 2020 "Phenolic Profile and Biological Activities of Some Species of Zygothrixaceae" By Hina Anwar, Government College University, **Faisalabad**
4. 2019 "Development of non-hydrolytic oxidative proteins for enhancement in saccharification of lignocellulosic biomass". By Dixit Pooja. **Deakin University, Australia**
5. 2019 "A Comprehensive Study on Various Activities and Biotechnological Applications of Novel *Pseudomonas Aeruginosa* 6A (bc4)" by Rajendra J. Marathe, **Kalinga Institute of Industrial Technology, India**
6. 2019 "Biocontrol of Pomegranate Bacterial Blight Using Bacteriophages" by Jagdale Smita B., University of Pune, **India**
7. 2019 "Design, Development And Evaluation Of Nanoformulations On Green Matrix For Sustained Drug Release In Cancer Therapy" by M F Tahir, Govt College University, **Faisalabad**
8. 2018 "Development of metal based antimicrobial polyamide 11 composites for medical application" Athlone Institute of Technology, **AIT Ireland**
9. 2018 "Prevalance of ticks and tick-borne pathogens from Punjab, Pakistan", by Marium Batool, Govt College University, **Faisalabad**
10. 2017 "Ethanol production by novel thermophilic anaerobic isolate/s via consolidated bioprocessing". By Neesha S. **Deakin University, Australia**
11. 2017 "Exploration of medicinal plants potential for reproductive system and hormones" M. Riaz University of Agriculture, **Faisalabad**
12. 2017 "Functional characterization of a novel ribosome inactivating protein from *Momordica* species" Parminder Kaur Ajji, **Deakin University, Australia**
13. 2017 "Characterisation and biological activities of essential oils from some Myrtaceae species" by Mohammad U Hanif, Govt College University, **Faisalabad**
14. 2017 "Integrated strategies for the control and prevention od dengue and malarial vectors" by Imran Ahmad, Govt College University, **Faisalabad**
15. 2017 "Studies on molecular determinants of stem rust in wheat *Triticum aestivum*" by Shahzad Bashir, Govt College University, **Faisalabad**
16. 2017 "Probing the efficiency of biological and biomagnetic seeds treatment upon vigour & metabolism of *Momordica charantia*" by Nanila Farah, Govt College University, **Faisalabad**
17. 2016 "Purification Characterisation and mode of action of plantaricin K25 produced by *Lactobacillus plantarum*". By Lim Sue Wen, University of Malaya, **Kuala Lumpur, Malaysia**
18. 2016 "Production of biofuels from seaweeds followed by the generation of bioelectricity from industrial wastewater". By MS Hussain, Fed. University of Arts, Science & Technology, **Karachi**.
19. 2016 "Chemical composition, biological and pharmaceutical potential of essential oils from Native medicinal plants." By Arfaa Sajid, University of Agriculture, **Faisalabad**
20. 2016 "Pharmaceutical activities in locally grown plants" by Rozina Aslam, University of Agriculture, **Faisalabad**
21. 2015 "Edible Filamentous Fungi-based bio-refineries", Jorge A. Ferreira, Swedish Centre for Resource Recovery, University of **Borås, Sweden**
22. 2015 "Deoxynivalenol: Toxicological profile & potential for reducing cereal grain contamination using bacterial additives in fermented animal feed" by William F. Vevers, **Plymouth University, UK**
23. 2015 "Fermentation of omega-3 and carotenoid producing marine microorganisms" by

Tamilselvi Thyagarajan, **Deakin University, Australia**

24. **2015** "Biochemical and nutraceutical analysis of commercial and wild mushrooms" by Sumaira Sharif, University of Agriculture, **Faisalabad**
25. **2015** "Pharmacokinetics and bioequivalence of cefixime in healthy male and female volunteers" by Muhammad M Ashraf, Institute of Pharmacy, Physiology & Pharmacology, **PK**
26. **2015** "Chemical composition, biological and pharmaceutical potential of essential oils from native medicinal plants" by Arifa Sajid University of Agriculture, Faisalabad
27. **2015** "Determination of Neonicotinoids in selected fruits and vegetables & their impact on nutritional attributes" by Sumia Akram University of Agriculture, Faisalabad
28. **2014** "Biochemical Profiling and synergistic potential of medicinal plants as hepatoprotective" by Abid Ali, **PK**
29. **2014** "Optimization of Enzyme-assisted Extraction Protocol for Recovery of Potent Phenolic Antioxidants from Agro-processing Wastes". University of Agriculture, **PK**
30. **2014** "Investigation on the antioxidant and antimutagenic potential of selected indigenous medicine plants" University of Agriculture, **PK**
31. **2014** "Epidemiology of cervical cancer and antigenotoxic activity of green tea on cervical cancer cells" Geetha B. Avinashilingam University, Instt for H Education for Women, **Coimbatore, India.**
32. **2014** "Antioxidant and antimicrobial properties and phenolic composition of selected species of Capparis from Pakistan" by Tehseen Gull, University of Agriculture, **PK**
33. **2014** "Design Aspects of Solid State Fermentation" by Musaalbakri Abdul Manan, University of **Manchester, UK** joint with Malaysian Agricultural Research and Development Institute (MARDI) Government of **Malaysia.**
34. **2014** "Modification and characterization of wild and commercial gums for the pharmaceutical potential" University of Agriculture, **PK**
35. **2014** "Production and characterization of Bacteriocins from Lactic acid bacteria" by Mehwish Salman University of Agriculture, **PK**
36. **2014** "In vitro and in vivo toxicological study of selected medicinal plants" by Mazhar Abbas University of Agriculture, **PK**
37. **2014** A. Periyayaya Gasamy, Bharathiar University Coimbatore, **India**
38. **2014** "Antioxidant and antimicrobial activities of selected plants of pothohar plateau" by Huma Munir University of Agriculture, **PK**
39. **2013** "The identification and characterisation of Salmonella enterica subspecies enterica serovars that exist in Pigs and Pork in Northern Ireland", by David Egan University of **Ulster, UK**
40. **2013** "Characterization of dextran-sucrase and dextran from W. cibaria and in vitro analysis of dextran as Prebiotic", by T. Jagan Mohan Rao, I. Institute of Technology, **Guwahati, India**
41. **2013** "Effect of Natural Growth Promoters on the Nutritive quality and antioxidant attributes on leafy green vegetables" by Maryam Aslam University of Agriculture, **PK**
42. **2013** "Analysis of medicinal and chemical properties of honeys collected from some selected locations of Pakistan" by Nadia Noor **PK**
43. **2013** "Analytical characterisation of lipids and antioxidant components in Flaxseeds (Linum usitatissimum)" by Nazia Yaqoob University of Agriculture
44. **2010** "Studies on Microbial bio-preservatives to prolong shelf life of vegetables", Shivaji Jagannath Sathe University of **Pune, India**
45. **2009** "Microbial decolourisation of textile dye effluent" by Bella Debassy **Thapar University, India**
46. **2009** "Reutilisation of grape pomace in Solid state fermentation for enzyme production" by

Ana Belén Díaz Sánchez, Departamento de Ingeniería Química, Universidad de Cádiz Puerto Real, **Spain**

47. **2008** "Purification, Characterisation and heterologous expression of fungal xylanases" by Mark A. Gaffney, National University of Ireland, **Maynooth, Rep. of Ireland**
 48. **2008** "Cloning expression & characterisation of alpha amylase of *Bacillus subtilis*" by R. Jayakamaraj, **Madurai Kamaraj University, India**
 49. **2007** "Particulate Bioprocessing: a novel Process strategy for Biorefineries." by Carolina Botella Franco, sponsored by European Commission Marie Curie Fellowship **Manchester University, UK.**
 50. **2007** "Production, characterisation & application of alkaline xylanase from *Aspergillus fischeri*" by S.R. Senthilkumar, **Madurai Kamaraj University, India**
 51. **2006** "Microbial acidification & decolourisation of distillery effluent..." by Mr. P. Chaudhari, **Pune University, India**
 52. **2006** "Production of L-Asparaginase enzyme....." by Mr. R. Chandra, Birla Institute of Technology, **Ranchi, India**
 53. **2005** "Reductive Decolorisation of Dyes by Thermophilic Anaerobic Granular sludge" by Mr A. B. dos Santos, **Wageningen University, Netherlands**
 54. **2002** "Some aspects of the Risk from *E. coli* 0157 in Foods in Dubai" by Ms M. Al-Sayegh, Reading University, **Reading, UK**
 55. **2002** "Studies on biosensing of phenol using potentiometric organic phase enzyme electrodes" by Mr M. Karunakaran, Anna University, **Chennai, India**
 56. **1999** "Bioremediation of Textile Industry wastewater by white-rot fungi" by Ms Niamh Kirby, University of **Ulster, UK.**
 57. **1997** "Production of Lactic acid from Lactic acid Bacteria" by Mr A.R. Sharma Haryana Agriculture University **India**
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Appendix 2: Curriculum Vitae

Name: Dr. Poonam Singh NIGAM

*MSc PhD CBiol SFHEA FRSB FBRSI FCHERP FIFIBiop FAMSc PGCUT DYEd DNSc SP
SR*

Affiliation: School of Biomedical Sciences, Ulster University, UK (since Jan 1990)

<https://www.ulster.ac.uk/staff/p-singh>

<http://orcid.org/0000-0001-8505-5382>

Research Output in Public Domain: 300+

<https://pure.ulster.ac.uk/en/persons/poonam-singh-nee-nigam/publications/>

[Citations 29955; h-index 64; i10-index 139]

http://scholar.google.co.uk/citations?user=-Pkpe_cAAAAJ&hl=en

Academic & Professional Qualifications:

- 1976-78 BSc Botany, Chemistry, Zoology (Distinction), Kanpur University India
- 1978-80 MSc Biochemistry, Organic, Inorganic, Physical Chemistry (Distinction), Christ Church College, Kanpur University India
- 1981-85 PhD Industrial Microbiology, National Sugar Institute, funded by Council of Scientific & Industrial Research, India
- 1985-88 Post-Doctoral Research -Applied Biotechnology at Süddeutsche Zucker, Germany
- 1997-98 PGCUT (Postgraduate Certificate in University Teaching), Ulster University, UK
- 1992 International Training in Industrial Biotechnology (Aug-Oct 8 weeks) UNESCO-funded Microbiological Resource Centres at Gesellschafts fur Biotechnologische Forschung, Braunschweig, Germany.
- 1987 FEMS Laboratory-Training (July, 2weeks) funded by Federation of European Microbiological Society on "Continuous Cultivation of Microorganisms" at Czechoslovak Academy of Sciences, Prague, Czechoslovakia
- 1983-84 DYEd (Diploma in Yoga Education), Dev International Yoga centre, India
- 1984-85 DNSc (Diploma in Naturopathy Science), Dev International Yoga centre, India
- 1984-85 Satyartha-Prakash course-1 exam, Satyartha-Ratna course-2 exam, Arya Samaj India

Affiliation to International Societies

- FAMSc** 2018 Fellow & Member - Academy of Microbiological Sciences, India
- FRSB** 2016 Fellow & Member - Royal Society of Biology, UK
- SFHEA** 2014 Senior Fellow - The Higher Education Academy, UK
- FCHERP** 2014 Fellow - Centre of Higher Education Research & Practice, UK
- FIFIBiop** 2014 Fellow - International Forum on Industrial Bioprocesses, France
- FBRSI** 2013 Fellow & Life Member - The Biotechnology Research Society of India
- FHEA** 2007 Fellow - The Higher Education Academy, UK
- CBIOL** 1993 Chartered Biologist - Institute of Biology (Royal Society of Biology), UK

Career at Ulster University, UK

- 2000-present** Director of 4 MSc Programs: **1.** Biotechnology (2000-15), **2.** Food-Biotechnology (2000-12), **3.** Medical & Healthcare Biotechnology (2012-15), **4.** Biotechnology-Research (2015-present), **5.** Directed BSc course in Biology 2016-17
- 2001-present** Senior Lecturer in Biotechnology
- 1996-2001** Lecturer in Biotechnology
- 1990-1996** Senior Research officer Biotechnology

Teaching Disciplines: Industrial Microbiology & Microbial-Biotechnology

Course or Subject-related Responsibilities at Ulster University, UK:

Course Director MSc Biotechnology courses; Module coordinator & Tutor in UG and PG modules

Professional Activities outside the Institution

Associate Advisor Biotechnology, British Council (2001-2011)

Editorial Board member – 7 International Journals

Research Experience: Fermentation-Technology; Microbial-synthesis of value-added compounds, Bioconversion of Ligno-cellulosics

Research Supervision: [Appendix 1.1](#)

Ph.D. Examiner: 57 PhD thesis (National and International) [Appendix 1.2](#)

Awards based on national/international competition:

Research Funds and Grants at Ulster University

Number of successful Grant-applications: 16; Total Amount Awarded **1,065,478.00 GBP**

2018 “Association of Commonwealth Universities-Bursary” {winner of 1 of total 3 granted for members in 52 CW countries} to delegate in British Council-Going Global 2018 Event, in Kuala Lumpur, Malaysia; and visiting Hong Kong University & Nanyang Technological Univ Singapore.

<https://www.acu.ac.uk/about-us/blog/going-global-2018-a-truly-valuable-experience>

2013 “Academic Enterprise best Business Plan award from Santander Universities Fund” with Enterprise in Biotechnology module MSc students

2012 “Academic Enterprise best Business Plan award from Santander Universities Fund” as above

2008 “Innovation Award-HEIF” from Higher Education Innovation fund for Academic Enterprise Initiatives, UK for inter-faculties collaborative project.

2002 “Best Scientific Achievement of the Year”, from Ministry of Sugar of Cuba (MINAZ) for Book “Solid state fermentation in Biotechnology: Fundamentals and Applications”

Honours Memento received for Guest/Invited lectures

- (details in section Conferences attended)

Research Experience with Industries, Research-Institutes, HEI [A-C]

*** [Most of following work published & presented in conferences – Refs in **Appendix 3** of Research output]

[A] Associated with Industries

1985-1987 **Süddeutsche Zucker** - AG (Largest Sugar Industry in EU, Germany)

Project: Process Optimization for the recycling of by-products Sugar beet pulp and molasses for animal feed production. ***Process Patented***

1981-1990 **National Sugar Institute**, The only sugar Research Institute in Asia

Project: Processing of By-products- Sugarcane Bagasse & Molasses from Sugar Factory

1990-1993 **Radox Laboratories**, Pharmaceutical Co. N. Ireland, UK

Project: Development of manufacturing process of Diagnostic Enzymes

1990-1993 **Fruit of the Loom**, American Textile Co. in Republic of Ireland

Project: Textile Effluent Treatment using biological systems

1990-1993 **Desmonds & Sons**, Ireland

Project: Textile Effluent generated from Denim stone-washings Treatment

1990-1998 **Associate & Modinagar Distilleries**, India

Project: Thermo-tolerant yeast Bio-Ethanol production & Distillery Effluent treatment

[B] Research Projects (1981-1990)

- July 1988 - Jan 1990** Principal-Investigator
Sponsored by **Council of Scientific & Industrial Research**, India
- i. " Bioconversion of Lignocellulosic Agricultural Wastes "
 - ii. " Utilisation of Starch Waste of Potato Processing Industries "
 - iii. " Utilisation of Whey Waste of Dairy Industry "
- Jan 1988 - Jul 1988** Project-Scientist
Sponsored by **Ministry of Food & Civil Supplies**, Government of India
"Utilisation of Sugar Industry By-products sugarcane bagasse & molasses for Animal Feed production"
- Dec 1985 - Dec 1987** Principal Investigator
Sponsored by **Ministry of Education, Govt. of India under "Higher Studies Abroad" Program**
"Bio-conversion of Sugar Beet Pulp into Protein-enriched Feed in Submerged & Solid-state Fermentations" in R & D Company, West Germany
- Jan 1985 - Dec 1985** Principal Investigator
Sponsored by **Council of Scientific & Industrial Research**, New Delhi
"Studies on Solid-state Fermentation of Sugarcane Bagasse for Enzymes & Feed Production"
- May 1981 - Dec 1984** Doctoral Research
Funded by **Ministry of Food & Civil Supplies**, Govt. of India
"Studies on Microbial Decomposition of Cellulosic Agricultural Wastes"
- Jan 1981 - May 1981** Research-assistant
Funded by **Department of Science & Technology**, Govt. of India
"Production of Biogas from Cellulosic Agricultural Wastes in Pilot Plants"

[C] Research Projects at Ulster University (1990- present)

- 1990 - 1992** Funded by Radox Company & International Fund for Ireland
- [1]. "Process Development of Salicylate-Hydroxylase Enzyme Production from Salicylate Utilising Bacterium *Pseudomonas putida*" for Diagnostic kits
 - [2]. "Process Development of Dihydrofolate-Reductase Enzyme from Methotrexate Resistant Organisms" for use in Food & Pharmaceutical Companies
- 1992-1993** "Isolation and Characterisation of Naphthalene Degrading Bacterial Cultures".
- 1993-1997** "Biological Treatment of Distillery Effluent", EU collaboration with Haryana University, India
- 1993-1996** "Development of Biological Processes for the Treatment of Textiles' Wastewater", Funded by International Fund for Ireland and International Textile Company-Fruit of the Loom.
- 1994-1999** "Identification of microorganisms & system to improve primary fermentation & effluent treatment during ethanol production from molasses in India" Funded by European Commission, Brussels, (INCODC: International Science Co-operation between India & UK)
- 2012- cont** «**Strategies development for enhancement of probiotic viability and applications in selected food system**», administered by the General Secretariat for Research & Technology-Hellas, Greece
- 1996-2001** Solid state fermentation of dye-adsorbed agricultural residues, Funded by Department of Education, N. Ireland) 1 PhD, 1 Postdoc
- 1999-2001** Studies on fermentative production of chiral compounds for optically active pharmaceuticals" Funded by CVCP-ORS (Overseas Research Scholarship) & Vice-Chancellor Research Studentship 1 PhD
- 1996-2001** "Microbial bio-transformations for drug synthesis" Funded by CVCP-ORS (Overseas Research Scholarship & Vice-Chancellor Research Studentship 1 PhD
- 1996-10** Production of Industrial enzymes –Xylanase, Lipase, amylase" collaboration with India & Brazil
- 1996-contd** Bioactivity in plant and natural materials, UG PG Projects; Food Fermentation Bioprocesses.

Visiting Overseas Researcher/Academic

- 2015 Feb 2 weeks Teaching B.Eng. course “Downstream Processing in Biotechnology” at Rhein-Hochschule Kleve, **Germany**
- 2015 Nov 13-15 University of Boras, **Sweden** seminar on **Industrial Biotechnology**
- 2015 Nov 16 Instt of Biotechnology AMITY, Jaipur **India**, Seminar “Global Biotechnology...”
- 2015 Nov 18 AMITY University, Manesar **Haryana, India**, Seminar “Global Biotechnology...”
- 2012 **Research talks to Biotechnology faculty + Researchers (as overseas academic)**
 29-30 March a.m. Ruhilkhand University; p.m. Invertis University **Bareilly, India**
 02 April **Jaipur, Rajasthan**
 a.m.: Jaipur National University, Postgraduate Biosciences department
 p.m.: Jaipur National University, Undergraduate Biotechnology department
 Evening: Insight international Education Consultancy Centre, Jaipur
- 2012 **04 April** Sam Higginbotham University/Allahabad Agriculture University, **Naini India** seminar on **Industrial Biotechnology**
- 2012 **09 April** Isabella Thornton Women College, **Lucknow**, seminar on **Industrial Biotechnology**
- 2004 **Oct 15-23** Osaka University **Japan**, Department of Biotechnology, UNESCO centre [lectures on Fermentation Technology & Solid-state fermentation]

Research-Informed Higher Education Teaching & Modules developed based on Research Experience: Validation/Revalidation of courses comprising of Research Projects

- 2017 - validation of MSc in Biotechnology-Research, 100% CW assessment based on Professional-development, Research Design & Scientific Communication, Grant proposal and independent Research project
- 2015 - MSc in Medical & Health Care Biotechnology
- 2016-2014 Associate Advisor in Biotechnology, British Council, Manchester UK
- 2016 Feb 29-March 1, Liverpool John Moors University, as External Advisor for validation of curriculum of MSc in Industrial Biotechnology
- 1999 Panel member as external advisor for course validation BSc Bioprocess engineering and Biotechnology 4-years course at University of Parana, Brazil
- 1996 Modules developed and delivered (100%) based on Research expertise for new course BSc in Biotechnology at Ulster, 1. Industrial Microorganisms, 2. Agricultural Biotechnology

Member of Editorial Boards – International Publisher Journals

- 2000-12 Journal of Chemical technology & Biotechnology – **SCI London John Wiley**
- 2000-06; 2013- cont. Bioresource Technology - **Elsevier Science Publisher**
- 2014- cont. Current Biotechnology - **Bentham Science Publishers**
- 2009- cont. Biofuels, Bioproducts & Biorefining - **Wiley Interscience**
- 2000-04 World Journal of Microbiology & Biotechnology – **Kluwer Academic Publisher**

Member of Panel of Peer Reviewers

- Process Biochemistry - Elsevier Science Publisher
- Biotechnology Progress – American Chemical Society
- Enzyme & Microbial Technology – Butterworths

Guest Editor – Scientific Journals - Special Issues:

- 2015 **Elsevier - Bioresource Technology** “Emerging Trends in Biotechnology Vol 188
- 2015 **Elsevier - Biochemical Engineering** “Emerging Trends in Biotechnology Vol 102
- 2015 **BioMed Research International:** “Stress Biology and Biotechnology of Microorganisms”
- 2015 **Bentham Science Current Biotechnology**, "Bioconversion of agro-industrial wastes for economical use"

Reviewer of International Book Proposals:

2019 Elsevier “Emerging Technologies & Biological systems for biogas upgrading and methane enrichment”

2018 Cambridge University Press a textbook, entitled “Principles of Biotechnology”

2014 Elsevier “Life-Cycle Assessment of Bio-refineries”

2014 CRC Press Taylor & Francis “Microbial Technology: Progress and Trends”

2014 Elsevier “Biotechnology in Food and Beverages Industry”

2014 Springer UK “Green Fuels Technology: Biofuels”

Grants & Funding Received [A-G]

	<u>Project-Title: Funding Agency</u>	<u>Duration</u>	<u>Amount</u>
[A]	Higher Education Academy, UK Travel Funds	2012	£900
[B]	<u>Academic (Department of Education & Learning)</u> Teaching Grants from European Social Fund MSc in Biotechnology course £472,251 + MSc in Food Biotechnology course £428,413 (received as Course Director for EU students as below)	2000-2008	£900,664
	1. MSc in Biotechnology course	2006-2008	£ 111,516
	2. MSc in Food Biotechnology course	2006-2006	£ 29,194
	3. MSc in Biotechnology course	2004-2006	£ 128,339
	4. MSc in Food Biotechnology course	2004-2006	£ 160,779
	5. MSc in Biotechnology course	2002-2004	£ 132,989
	6. MSc in Food Biotechnology course	2002-2004	£ 136,703
	7. MSc in Biotechnology course	2000-2002	£ 99,407
	8. MSc in Food Biotechnology course	2000-2002	£ 101,737
[C]	Department for International Development, UK Overseas tuition fee + subsistence for MSc students	1999-2005	£ 80,000
[D]	<u>External Contract Research:</u>		
	1. Analysis of essential oils for medicinal properties Under International Research Support Initiative, Higher Education Commission, Pakistan	2008-09	US\$3500
	2. Bioremediation of Textile wastewater - Commonwealth Scholarships Commission UK	2006-07	£1000
	3. Production of Penicillin Acylase enzyme from <i>E. coli</i> . UNESCO, France	2001-2002	\$ 4000
	4. A novel approach for the remediation of textile-industry wastewater: Dept. of Environment, Interreg	1999-2002	£ 126,739
	6. Bioremediation of textile dye contaminated dye effluent Through the application of electric field to a biomass: IRTU-START	1997-1999	£68,970
	7. A novel remediation system for the treatment of leachate from municipal solid waste landfill sites: British Council	1996-1998	6,100
	8. Development of treatment processes for dyestuff effluent from the textile industry: International Fund for Ireland + Fruit of the Loom	1994-1997	£194,852
	9. Identification of microorganisms and systems to improve	1994-1997	£92,100

primary fermentation & effluent treatment: European Comm.
(International Scientific Co-operation)

[D] Research -Visit Grants:

1.	International Conference Grant Royal Society, London	March 2003	£ 1230
2.	International Exchange - visit Grant: nominated by Royal Society, UK Academy of Sciences, London to Indian National Science Academy (INSA)	March 2001	£ 1045
3.	"Conference-Grant": Royal Society, London	April 2001	£ 1450
4.	International collaboration-Visit Grant : Royal Society, UK Academy of Sciences, London to Universidad de Oriente, Santiago de Cuba	4-12 Dec 1999	£ 1520
4.	International Exchange - visit Grant: nominated by Royal Society, UK Academy of Sciences, London to Indian National Science Academy	Nov 97 – Feb 98	£ 895
5.	"Conference-Grant": Royal Society, London to India	Nov 1997	£ 935
6.	Research collaboration with University of Patras, Greece: European Regional Development Fund, IRTU EU FFP	Feb 1995	£ 960
7.	"FEMS + UNESCO Grant" International Conference "Global Impacts of Microbiology and Biotechnology-X", at University of Copenhagen, Denmark and Visit to University of Lund, Sweden.	Aug 5 -12, 1995	£ 1100
8.	"Conference Grant" International Society for Environmental Biotechnology, University of Waterloo, Canada	Aug 13-16, 1995 July 4-8, 1994	£ 1350
9.	Conference grant to Pasteur Institute Paris, Sudeutsche Zucker-AG	Aug 1987	DM500

[E] Research-Training Grants:

1.	UNESCO`s MIRCENS "International Training in Biotechnology - Scholarship" 8 weeks at GBF, Braunschweig, Germany	30.8.92-16.10.92	DM10,000
2.	UNESCO-ROSTE Financial Assistance" in Biotechnology for European Workshop & Postgraduate Training in Biotechnology at Prague, Czechoslovakia	Sept 16 - 27, 1991	\$800
3.	"Grant for FEMS 2-week Laboratory Course " at Prague, Czechoslovakia, funded by Ministry of Education, Government of India	July 6 - 17, 1987	\$1000

[F] Postdoctoral Research Grants:

1.	"Post-Doctoral Fellowship (West Germany)", 2 years Ministry of Education, Government of India, under the scheme Higher Studies-Abroad	23.12.85-22.12.87	\$14,000
2.	"Postdoctoral Senior Research Fellowship", 3 years Council of Scientific & Industrial Research, India (Resigned on 22.12.85 to avail No.1)	1.1.85 - 31.12.87	INR51,000
3.	"Senior Research Fellowship", 3 years Ministry of Food & Civil Supplies, Government of India, (Resigned on 1.1.85 to avail No. 2)	10.12.84-9.12.87	INR34,200

[G] Doctoral Grant:

"Junior Research Fellowship" (3.5 years) Ministry of Food & Civil Supplies, Government of India	9.5.81 - 10.11.84	INR 25,200
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[H] Postgraduate/ Degree Study Grants:

1.	"Bursary (M.Sc. II year scholarship)", Kanpur University	1.7.79 - 30.6.80	INR 6,000
2.	"Meritorious student Fees-Grant"	1.7.76 - 30.6.79	INR 14,400

3. (B.Sc. & M.Sc. 1 year), Kanpur University
"Merit scholarship", (U.P. Education Board, India) 1.7.74 - 30.6.76 INR 1,200
-

End of doc

Poonam Nigam

February 2020

Appendix 3: Scientific Outputs - Total 348

Contents

-
- [1] Outputs in Part V – (183)
 - [2] Research-Informed Review articles - (1-26)
 - [3] Research-Informed Chapters in Encyclopaedia & Books - (1-43)
 - [4] Biotechnology Books – (3)
 - [5] Patent- 1 Technology-Transfers - 2
 - [6] Conference contributions - (91)
-

[1] **As in Part V Details of Published work & Outputs to be considered**

[2] **Review Articles**

1. Dahiya, D. & Nigam, P., (2020) Waste Management by Biological Approach Employing Natural Substrates and Microbial Agents for the Remediation of Dyes' Wastewater. Applied Sciences (Switzerland). 10, 8, 2958.
2. Alagumuthu, M., Dahiya, D. & [Nigam P \(2019\) Phospholipid—the dynamic structure between living and non-living world; a much obligatory supramolecule for present and future. AIMS Molecular Science.](#) 6, 1, 19 p.
3. M Johnston, M McBride, D Dahiya, RK Owusu, PSN Nigam 2018 [Antibacterial activity of Manuka honey and its components: An overview.](#) AIMS Microbiology 4 (4), 655-664
4. Rathore, D., Singh, A., Dahiya, D., [Nigam P \(2019\) Sustainability of biohydrogen as fuel: Present scenario and future perspective. AIMS Energy.](#) 7, 1, p. 1-19
5. Dahiya, D. & [Nigam P, \(2018\) Bioethanol synthesis for fuel or beverages from the processing of agri-food by-products and natural biomass using economical and purposely modified biocatalytic systems. AIMS Energy.](#) 6, 6, p. 979-992
6. Nigam P (2017) [An Overview of Microorganisms' Contribution and Performance in Alcohol Fermentation Processing a Variety of Substrates.](#) Current Biotechnology, 6 (1). pp. 9-16.
7. Nigam P (2017) [An overview: Recycling of solid barley waste generated as a by-product in distillery and brewery.](#) Waste Management, 62. pp. 255-261.
8. Nigam P (2013) [Microbial Enzymes with Special Characteristics for Biotechnological Applications.](#) Biomolecules - Special Issue Enzymes and Their Biotechnological Applications, 3 (3). pp. 597-611.
9. Singh, A., Pant, D., Olsen, S. Irving and Nigam P (2012) [Key Issues to Consider in Microalgae Based Biodiesel Production.](#) Energy Education Science and Technology Part A: Energy Science and Research, 29 (1). pp. 687-700.

10. Pant, D, Singh, A, Van Bogaert, G, Olsen, SI Nigam, P, et al (2011) [Bioelectrochemical systems \(BES\) for sustainable energy production and product recovery from organic wastes and industrial wastewaters.](#) RSC (Royal Society of Chemistry) Advances, 2(4), 1248-1263
11. Singh, A., Olsen, SI and Nigam P (2011) [A viable technology to generate third generation biofuel.](#) Journal of Chemical Technology and Biotechnology, 86 (11). pp. 1349-1353.
12. Nigam P(2011) [Mechanism and Challenges in Commercialisation of Algal Biofuels.](#) Bioresource Technology, 102 . pp. 26-34.
13. Singh - Nee Nigam, Poonam, Singh A (2011) [Production of liquid biofuels from renewable resources.](#) Progress in Energy and Combustion Science, 37 . pp. 52-68.
14. Nigam, Poonam, Singh A (2011) [Renewable fuels from Algae: An answer to debatable land based fuels.](#) Bioresource Technology, 102 . pp. 10-16.
15. Muralidhar, RV, Chirumamilla, RR, Marchant, R, Ramachandran, VN, Ward, OP, Nigam P (2002) [Understanding lipase stereoselectivity.](#) World Journal of Microbiology and Biotechnology, 18 (2). pp. 81-97.
16. Robinson, T, McMullan, G, Marchant, R, Nigam P (2001) [Remediation of dyes in textile effluent: a critical review on current treatment technologies with a proposed alternative.](#) Bioresource Technology, 77 (3). pp. 247-255.
17. Banat, IM, Singh - Nee Nigam, Poonam, Singh, D and Marchant, R (1996) [Microbial decolorization of textile-dye-containing effluents: A review.](#) Bioresource Technology, 58 (3). pp. 217-227.
18. Nigam P and Singh, D (1996) [Processing of agricultural wastes in solid state fermentation for cellulolytic enzymes production.](#) Journal of Scientific and Industrial Research, 55 (5-6). pp. 457-463.
19. Nigam P and Singh, D (1996) [Processing of agricultural wastes in solid state fermentation for microbial protein production.](#) Journal of Scientific and Industrial Research, 55 (5-6). pp. 373-380.
20. Nigam P and SINGH, D (1995) [processes for fermentative production of xylitol - a sugar substitute.](#) Process biochemistry, 30 (2). pp. 117-124.
21. Nigam P (1990) [Mixed sweetener functionality in food system.](#) Journal of Beverage and Food World 17 (2), 33-38.
22. Nigam P (1989) [Status of sucrose in present civilization.](#) Co-operative Sugar, 20 (6), 413 -418.
23. Nigam P (1989) [An overview of some aspects: co-ordination of waste treatment processes with the fertility improvement of agricultural lands.](#) Journal of Bhartiya Sugar, Sept. 23 -28.
24. Pandey, A and Nigam P (1987) [Non Nutritive sweeteners in food system.](#) Indian Food Industry, 6 (4), 157 -165.

25. Nigam P and Pandey, A (1987) [Nutritive sweeteners in food system](#). Co-operative Sugar, 18(12), pp. 821-826.
 26. Nigam P and Pandey, A (1986) [Utilisation of by-products of cane sugar industry](#). Co-operative Sugar, 17(7), pp. 529-533.
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[3] Research-Informed Chapters in Encyclopaedia & Books (42)

1. Nazar N, Al Hussain, SM Hussain, Poonam Nigam 2020 Natural Products as Economical Agents for Antioxidant Activity. In: Phytochemicals from Medicinal Plants, Scope, Applications, and Potential Health Claims: eds. HAR Suleria, MR Goyal, MS Butt, CRC Press Taylor & Francis. pp 201-232 ISBN 9781771887953 (2019)
2. Dahiya, D., Chettri, R. & Nigam, P., 30 Apr 2020, Biosynthesis of polyglutamic acid (γ -PGA), a biodegradable and economical polyamide biopolymer for industrial applications: Chapter 26 in "Microbial and Natural Macromolecules: Synthesis and Applications" Elsevier reference B978-0-12-820084-1.00026-0: Das, S. (ed.). 1 ed. USA: Academic Press, Vol. 1
3. Nigam, P, Dahiya Divakar, Owusu-Apenten, R (2019) Current Aspects of Medicinal Properties and Health Benefits of Plant *Withania somnifera*. Chapter 14 In book - Plant Biotechnology: Progress in Genomic Era. Springer-Nature, ISBN: 978-981-13-8498-1
4. Nigam P (2016) [Microbial Enzymes with Special Characteristics for Biotechnological Applications](#). In: "Enzymes and Their Biotechnological Applications" - Special Issue of Journal Biomolecules. (Eds: Rampelotto, Pabulo H.), CC-MDPI AG, Basel, Switzerland, pp.597-611. ISBN 978-3-03842-147-4 (electronic); ISBN 978-3-03842-148-1
5. Nigam P and Owusu-Apenten, R (2016) [Studies on Biosynthetic Production of Antioxidant Glutathione Using Microbial Cultures](#). In: Frontier Discoveries and Innovations in Interdisciplinary Microbiology. (Ed. Shukla, P), Springer New York, pp. 1-6. ISBN 978-81-322-2609-3 (Print) 978-81-322-2610-9 (Online)
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- Tortorello ML), Elsevier Ltd, Academic Press, UK, pp. 792-803. ISBN 9780123847300
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 10. Nigam P and Singh, A (2014) [Metabolic Pathways: Production of Secondary Metabolites - Fungi](#). In: Encyclopedia of Food Microbiology, Edition 2. (Eds: Batt CA, and Tortorello ML), Elsevier Ltd, Academic Press, UK, pp. 570-578. ISBN 9780123847300
 11. Nigam P and Singh, A (2014) [Single Cell Protein: Mycelial Fungi](#). In: Encyclopedia of Food Microbiology. (Eds: Batt CA, and Tortorello ML), Elsevier Ltd, Academic Press, UK, pp. 415-424. ISBN 9780123847300
 12. Singh, Anoop and Nigam P (2014) [Microbial Biofuels Production](#). In: Microbial Technology: Progress and Trends. (Eds: Darvishi Farshad Harzevili, Hongzhang Chen), CRS Press Taylor & Francis Group, USA, pp. 428-440. ISBN 9781482245202
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 14. Nigam, P (2011) [Microbiology of winemaking](#). In: Handbook of Enology: Principles and Practices. Ed. VK Joshi, Publisher Asiatech, pp. 383-404. ISBN 81-8760-35-3
 15. Thavasi, R, Banat, Ibrahim and Nigam, P (2010) [Microbial toxins](#). In: Comprehensive Food Fermentation and Biotechnology. Asiatech, pp. 344-370. ISBN 81-87680-23-7
 16. Nigam P (2009) [Production of Bioactive Secondary Metabolites](#). In: Biotechnology for Agro-Industrial Residues Utilisation . (Eds: Nigam P and Pandey, A), Springer, pp. 129-146. ISBN 978-1-4020-9941-0
 17. Nigam P (2009) [Production of Organic Acids from Agro-Industrial Residues](#). In: Biotechnology for Agro-Industrial Residues Utilisation. (Eds: Nigam P and Pandey, A), Springer book, 37 -60. ISBN 978-1-4020-9941-0
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 19. Nigam P and Pandey, A (2009) [Solid-State Fermentation Technology for Bioconversion of Biomass and Agricultural Residues](#). In: Biotechnology for Agro-Industrial Residues Utilisation. (Eds: Nigam P and Pandey, A), Springer, pp. 197-221. ISBN 978-1-4020-9941-0

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22. Koutinas, A. A., Bekatorou, A., Nigam, P, et al (2008) [Whey utilization and Single Cell Protein production](#). In: Advances in Cheese Whey Utilization. (Eds: Esperanza Cerdán, M. and Isabel González-Siso, Ma.), Manuel Bacerra, p. 147-161. ISBN: 978-81-7895-359-5.
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42. Barron N, Brady D, Love G, Marchant R, Nigam, P, McHale L, McHale AP (1996) [Alginate immobilised thermotolerant yeast for conversion of cellulose to ethanol](#). In: Progress in Biotechnology, Vol 11 - Immobilised cells: Basics & Applications. (Eds: Wijffels RH, Buitelaar RM, Bucke C, Tramper, J), Elsevier Science BV - Progress in Biotechnology, pp. 379-383.
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[4] **Books edited, authored** - for Researchers at HEI and Industries

1. (2009) Title **“Biotechnology for Agro-Industrial-Residues-Utilisation”**

Publisher- Springer Netherlands pp.1-466 ISBN 978-1-4020-9941-0; e-ISBN: 978-1-4020-9942-7 <http://www.springer.com/biomed/book/978-1-4020-9941-0>

In top 25% most downloaded eBooks in its respective eBook Collection in 2018. Since its online publication on Jun 26, 2009, there have been **a total of 10,3267 chapter downloads**

2. (2010) **“Comprehensive Food Fermentation Biotechnology”**

Pandey A, Soccol CR, Larroche C, Gnansounou E, Nigam, Poonam, ISBN 81:87680-23-7 Asiatech publishers Inc. pp 1-795

3. (2001) **“Solid State Fermentation in Biotechnology: Fundamentals and Applications”**

Pandey A, Soccol CR, Rodriguez-Leon JA and Nigam, Poonam ISBN 81-87680-06-7 Asiatech Publishers Inc. pp. 1-222

[5] **Patent & Technology Transfer to Industry**

5.1 Patent:

Nigam, Poonam and Vogel, M Süddeutsche Zucker AG, Mannheim Ochsenfurt, Germany (1.3.1990) **"Process for the production of Beet Pulp Feed by Fermentation"**. [European Patent] no DE 38 12 612.5-41 Deutsches Patentamt, Bundesrepublik Deutschland (Germany)

5.2 New Methodology/Technology: (for Food Industry – on large scale)

“Producing A Probiotic Multi-Purpose Starter Culture Using Whey as Raw Material”

Research Team Leaders/Partners:

Koutinas Athanassios (Greece); Poonam Singh Nigam (Ulster, UK)

Details in certificate below

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Patras, 30 May 2014

Subject : Research collaboration and technology transfer with Dr. Poonam Singh Nigam

This is to state that the research collaboration between Dr. Poonam Nigam of the University of Ulster, UK and Professor Athanasios A. Koutinas and his research group at the University of Patras, Greece through Joint research projects over 15 years has produced many scientific research publications. The joint research resulted in some very useful new technologies in the area of food and fermentation technology, which have **been transferred to Greek industries for Industrial Manufacturing.**

Recently, one of these technologies entitled **“Production of a starter culture for multiple uses in food production using whey as raw material”**, was distinguished in the **Top 21 among 297** by the Greek Organization of Manufacturers and Eurobank, in the frame of the 1st GREECE INNOVATES-Applied Research & Innovation Competition. Please see the link of the completion album (2010-2011): http://issuu.com/unfoldstudio/docs/the_album_of_the_competition_2010-2011

Research joint publications of both Partners related to Technology-Transferred

1. O. Harta, M. Iconomopoulou, A. Bekatorou, P. Nigam, M. Kontominas and A. A. Koutinas. Effect of various carbohydrate substrates on the production of kefir grains for use as a novel baking starter. Food Chemistry, 88,237-242, 2004.
2. S. Plessas, L. Pherson; A. Bekatorou; P. Nigam; A. A. Koutinas. Bread making using kefir grains as baker’s yeast. Food Chemistry, 93 (4): 585-589, 2005.
3. S. Plessas, M. Trantallidi, A. Bekatorou, M. Kanellaki, P. Nigam, A. A. Koutinas. Immobilization of kefir and Lactobacillus casei on brewery spent grains for use in sourdough wheat bread making. Food Chemistry 105, 187–194, 2007.
4. A. A. Koutinas, A. Bekatorou, P. Nigam, I. M. Banat and R. Marchant. “Whey utilization and SCP production”. In: Advances in Cheese Whey Utilization. Editors: Ma Esperanza Cerdán, Ma Isabel González-Siso and Manuel Bacerra. Research Signpost, Trivandrum - 695023, Kerala, India. ISBN: 978-81-7895-359-5, 2008

5. Kourkoutas, Y.; Kandylis, P.; Panas, P.; Dooley, J. S. G.; Nigam, P.; Koutinas, A. A. Evaluation of freeze-dried kefir coculture as starter in feta-type cheese production. *Applied and Environmental Microbiology*, 72, 9, 6124-6135, 2006

Yours faithfully,



Professor Athansios A. Koutinas

Food Chemistry and Biotechnology

5.3 New Concept developed:

2002-03 "Production of Pectinase Enzymes for fruit-juice clarification" for Laboratory Practical training on this concept to staff at Universidad de Antioquia, COLOMBIA.

Reference Publication: Based on a research project completed by Dr P. Nigam

Sunnotel O, Nigam P (2002) Pectinolytic activity of bacteria isolated from soil, two fungal strains during submerged fermentation. *World Journal of Microbiology & Biotechnology*, 18 (9), 835-839.

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[6] Conference contributions (91)

1. **2019** Nigam P. Evaluation of biocatalysts for their efficient use and re-use in bioprocesses Annual Conference-AMI and International Symposium on "Microbial Technologies in Sustainable Development of Energy, Environment, Agriculture and Health Nov 15-18, Central University of Haryana Mahendragarh, India
2. **2018** Nigam P. International cooperation in Higher Education academic and Research, May 2-6 British Council "Going Global-2018", International Convention Centre, Kuala Lumpur Malaysia
3. **2017** Bosnea Loulouda, Moschakis T, Biliaderis C and Nigam P [Complex coacervates of encapsulated probiotic bacteria: role of polymer-ratio and concentration on their viability](#). In: 58th Annual Conference of Association of Microbiologists of India & International Symposium on, Babasaheb Bhimrao Ambedkar University, India.
4. **2016** Bosnea Loulouda, Moschakis T, Biliaderis CG and Nigam P [Polymer ratio and concentration effect on viability of encapsulated probiotic bacteria in complex coacervates](#). In: International conference on Current trends in Biotechnology ICCB-2016, Vellore Institute of Technology, India. School of Biosciences and Technology,
5. **2016** Rathore D, Singh A and Nigam P [Sustainability of Bio-hydrogen Fuel: Present Scenario and Future Prospective](#). In: International Conference on Strategies for Environmental Protection and Management, JawaharLal Nehru University Delhi, Biotech Research Society, India.

6. **2016** Nigam P [Strategic Transformation of Biocatalysts for their Effective Employability in Bioprocessing](#). In: Bioprocessing India-2016: Sustainable Bioprocessing Products for Food, Nutrition, Health and Environment, Centre of Innovative and Applied Bioprocessing, Knowledge City, Mohali, India.
7. **2015** Bosnea Loulouda A, Moschakis T, Nigam P and Biliaderis CG [Strategies Development for Enhancement of Probiotic Viability](#). In: International conference on New Horizons in Biotechnology & XII Annual Convention of The Biotechnology Research Society, National Institute of Interdisciplinary Science & Technology, India.
8. **2015** Wilson Lau WH, Apenten Richard KO and Nigam P [Evaluation of effect of unique Manuka factor \(UMF\) honey on the stability of fish oil emulsions towards auto-oxidation](#). In: First International conference on advances in food science and technology, Institute of macromolecular science & engineering, Kerala India and Ayurveda und Venen klinik, Klagenfurt, Austria.
9. **2015** Yusof Hasif IM, Apenten Richard KO and Nigam P [Studies on correlation of methylglyoxal \(MG\) contents and anticancer properties of unique Manuka factor \(UMF\) honey](#). In: International conference on New Horizons in Biotechnology & XII Annual Convention of The Biotechnology Research Society Nov 22-25, National Institute of Interdisciplinary Science & Technology, Trivandrum, India.
10. **2014** Bekatorou A, Koutinas AA, Nigam Poonam, Aggelopoulos T and Kanelaki M [Bioconversion of Food Waste Mixtures for Single Cell Protein, Yeast Extract, Flavour Compounds and Fat Production in a Biorefinery Manner](#). In: 10th European Symposium on Biochemical Engineering Sciences (10th ESBES) & the 6th International Forum of Industrial Bioprocesses (6th IFIBiop), University of Lille, France.
11. **2014** Bosnea LA, Moschakis T, Billiaderis C and Nigam P [Technological properties of lactobacillus isolated from traditional Greek dairy products](#). In: International Conf on Emerging Trends in Biotechnology, XI Convention Biotechnology Research Society, Jawaharlal Nehru Univ India.
12. **2014** Ganatsios V, Bekatorou A, Schiza V, Kanellaki M, Nigam P and Koutinas AA [A novel Food wastes biorefinery concept for simultaneous production of succinic, lactic, citric acids and ethanol using two layers composite biocatalysts](#). In: International Conf on Emerging Trends in Biotechnology, XI Convention Biotechnology Research Society, Jawaharlal Nehru University India.
13. **2014** Nigam P Plenary lecture on [Modification of biocatalysts for their efficient re-use to perform economical & practical bio-processes](#). In: 10th European Symposium on Biochemical Engineering Sciences (10th ESBES) & the 6th International Forum of Industrial Bioprocesses (6th IFIBiop), Lille University, France.
14. **2014** Nigam P [Optimization of efficiency of biocatalysts for their economical & long-term use in bio-processes](#). In: Intl Conference Biotechnology & Bioengineering (ICBB 2014), Birla Instt of Technol & Science, Dubai Intl Academic City
15. **2013** Bosnea LA, Moschakis T, Billiaderis C and Nigam P [Studies on viability and technological properties of lactobacillus isolated from traditional Greek dairy products](#). In: International Conference on Advances in Biotechnology & Bioinformatics; X Convention Biotechnology Research Society, Biotechnology & Bioinformatics Institute, D.Y. Patil Vidyapeeth, Pune, India.

16. **2013** Chalil S, Das AJ, Nigam P and Aparenten Richard KO [Novel Approaches for production and downstream processing of glutathione from microbial sources.](#) In: The Society for General Microbiology, Irish Division Autumn Meeting, Gut Microbes - Friend, or Foe? University of Ulster, Coleraine, Northern Ireland, UK. SGM, Irish Branch Coleraine.
17. **2013** Ganatsios V, Koutinas AA, Bekatorou A, Kanellaki M, Soupioni M and Nigam P [Solid orange waste as yeast immobilization support in brewing and for yeast extract production for industrial cell growth media.](#) In: International Conference on Advances in Biotechnology & Bioinformatics; X Convention Biotechnology Research Society, Biotechnology & Bioinformatics Institute, D.Y. Patil Vidyapeeth, Pune, India.
18. **2013** Ganatsios V, Koutinas AA, Bekatorou A, Kopsahelis N, Kanellaki M and Nigam P [Improvement of microbial fat production by *Lipomyces starkeyi* entrapped in tubular cellulose.](#) In: International Conference on Health, Environment and Industrial Biotechnology (BioSangam-2013) Allahabad University India.
19. **2013** Nigam P and Aparenten Richard KO [Biosynthesis of a Pharmaceutically important antioxidant - Glutathione using Microbial cultures.](#) In: Platinum Jubilee Celebration of Association of Microbiologists of India (AMI) & 54th Annual Convention of AMI, Maharishi Dayanand University, Rohtak, India.
20. **2013** Nigam Poonam, Kapaklis A, Tataridis P, Nerantzis E and Voulgaris I [The study of encapsulated and entrapped yeast for bioethanol production.](#) In: The Society for General Microbiology Irish Division Autumn Meeting Gut Microbes - Friend, or Foe? University of Ulster, Coleraine, Northern Ireland UK. The Society of General Microbiology.
21. **2012** Ganatsios V, Koutinas AA, Bekatorou A, Kanellaki M and Nigam P [Production of *Agaricus bisporus* Mushroom using mixture of food wastes in submerged and solid state fermentation - Evaluation of Nutritional value and yeast extract.](#) In: 8th Asian Conference for information technology in Agriculture, Taipei, Taiwan, AFITA/WCCA 2012.
22. **2011** Ganatsios V, Koutina AA, Bekatorou A, Kanellaki M and Nigam P [Promotion of maltose fermentation at extremely low temperatures by yeast immobilised on nano and micro-tubular cellulose.](#) In: New Horizons in Biotechnology, National Institute of Interdisciplinary Science, Trivandrum, India.
23. **2011** Nigam P [Production and downstream processing of glutathione from microbial sources.](#) In: International conference on New Horizons in Biotechnology & 8th annual convention of the Biotech Research society, India,, Trivandrum, India.
24. **2010** Bekatorou A, Aggelopoulo T and Nigam P [Applied Biorefinery Concept in the Food Industry and Valorization of Liquid And Solid Wastes: Production of Single Cell Protein and Other Compounds.](#) In: International Congress in Bioprocesses in the Food Industries (ICBF 2010), 5-8 Oct, University of Parana, Curitiba, Brazil.
25. **2010** Chalil S, Das AJ, Nigam P and Owusu Richard [Novel approaches of production & Downstream Processing of Glutathione from Microbial resources.](#) In: International Congress in Bioprocesses in the Food Industries (ICBF), University of Parana, Curitiba, Brazil.

26. **2010** Koutinas AA, Bekatorou A, Kandylis P, Servetas I, Li X and Nigam P [Nano-Tubular Cellulose Structure As A Carrier For Food Nano-Biotechnology Development](#). In: International Congress in Bioprocesses in the Food Industries (ICBF), University of Parana, Curitiba, Brazil.
27. **2009** Nigam Poonam, Bekatorou A and Aggelopoulo T [Biotechnological Utilisation of waste cereal grains and food industry by-products](#). In: Biospectrum-2009, International symposium on second green revolution: Priorities, programs, social & ethical issues, Rajiv Gandhi Centre for Biotechnology, India. Mar Athanasios College for Advanced Studies, Tiruvalla, Kerala, India.
28. **2008** Bekatorou A, Nigam Poonam, Komatis M and Unyayar A [Valorisation of Brewer's Solid Wastes through Microbial Treatment](#). In: International Conference: PRE9: Protection and Restoration of the Environment, Kefalonia (Ionian Sea), Greece. University of Patras, Greece and Stevens institute of Technology Greece.
29. **2008** Gupta N. and Nigam P ["Bioremediation of wastewater from dye industry using fungi"](#). In: British Ecological Society Annual Symposium 2008 on Ecology of Industrial Pollution: Remediation, Restoration and Preservation, Birmingham, U.K. British Ecological Society.
30. **2008** Gupta N. and Nigam P [Capability of some white-rot fungi to decolorize textile effluent](#). In: Annual meeting Society of General Microbiology on 8-11 Sept. 2008. pp 44, Dublin, Republic of Ireland. Society of General Microbiology.
31. **2008** Nigam Poonam, Bekatorou A. and Koutionas, AA. [Biotechnological Exploitation of Brewery Solid Wastes](#). In: International Congress in Bioprocesses in the Food Industries (ICBF 2008), Osmania University Hyderabad, India.
32. **2008** Nigam P and Kumar, M. [Transesterification of Non-edible Oils to Biodiesel](#). In: International Workshop on Biofuels Research & Development, Calabria, Italy. ECI Conference USA
33. **2007** Bekatorou, A, Kanellaki, M, Banat, IM and Nigam P [Animal feed production by solid state fermentation of brewer's spent grains and malt spent rootlets with *Aspergillus awamori*, *A. oryzae* and *Phanerochaete chrysosporium*](#). 10th International Conference on Environment Science & Technology. Greece, Kos island Greece 5/9/07
34. **2007** Nigam P [Bioremediation of Textile waste water through solid-state fermentation systems](#). In: International conference on New Horizons in Biotechnology 2007, Trivandrum, India. RRL, Council of Scientific & Industrial Research.
35. **2007** Nigam P and Kapaklis, A [Studies on Encapsulated and entrapped yeast for Bioethanol production](#). In: Biospectrum 2007, International Symposium on Advances in Food Biotechnology & Nutrition, Mar Athanasios College for Advanced Studies, Tiruvalla, Kerala, India.
36. **2006** Bekatorou, A., Kanellaki, M. and Nigam P [Treatment of brewery spent grains by *Aspergillus oryzae* and *A. awamori* for animal feed production](#). In: 2nd International Congress in Bioprocesses in the Food Industries (ICBF 2006), University of Patras, Greece.
37. **2006** Nigam P [A process for physical decolourisation of textile dyes and solid-state fermentation of dye-adsorbed agricultural residues](#). In: XIII Biennial International

- Conference on Environmental Biotechnology, 9-13 July, Centre for Environmental Research Leipzig-Halle, Germany.
38. **2006** Nigam P and Kapaklis, A [Comparative study of encapsulated and entrapped yeast for fermentation purposes](#), In: 2nd International Congress on Bioprocess in Food Industries; 18-21 June, University Patras, Greece. Department of Chemistry.
 39. **2005** Nigam P [Solid State Fermentation: Application in Environmental Biotechnology for Bioremediation](#), In: Conference Industrial Bioprocessing and Biotechnology, March 17-19, Birla Institute of Technology, Ranchi, India.
 40. **2004** Nigam P and Reddivari Muralidhar [A Clean Technology for Deacylation of Racemic Ester of \(Rs\)- Propranolol Acetate in Aqueous-Organic Mixtures Catalysed by a Microbial Lipase](#), In: 7th Biennial International Conference on Environmental Biotechnology, University of Illinois, Chicago, USA 18-21 June.
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Poonam Nigam

February 2020

Appendix 4: 15 Top cited output with Total citations = 19,729

Details of output	Citations	Year	Impact-factor
Remediation of dyes in textile effluent: a critical review on current treatment technologies with a proposed alternative T Robinson, G McMullan, R Marchant, P Nigam Bioresource technology 77 (3), 247-255	5209	2001	6.669
Microbial decolorization of textile-dyecontaining effluents: a review IM Banat, P Nigam, D Singh, R Marchant Bioresource technology 58 (3), 217-227	2358	1996	6.669
Production of liquid biofuels from renewable resources PS Nigam, A Singh Progress in energy and combustion science 37 (1), 52-68	2047	2011	26.467
Advances in microbial amylases. A Pandey, P Nigam, CR Soccol, VT Soccol, D Singh, R Mohan Biotechnology and applied biochemistry 31, 135-152	1399	2000	1.559
Biotechnological potential of agro-industrial residues. I: sugarcane bagasse A Pandey, CR Soccol, P Nigam, VT Soccol Bioresource technology 74 (1), 69-80	1295	2000	6.669
Solid state fermentation for the production of industrial enzymes A Pandey, P Selvakumar, CR Soccol, P Nigam Current science, 149-162	1088	1999	0.833
Microbial decolourisation and degradation of textile dyes G McMullan, C Meehan, A Conneely, N Kirby, T Robinson, P Nigam, ... Applied microbiology and biotechnology 56 (1-2), 81-87	1046	2001	3.670
The realm of microbial lipases in biotechnology A Pandey, S Benjamin, CR Soccol, P Nigam, N Krieger, VT Soccol Biotechnology and applied biochemistry 29 (2), 119-131	881	1999	1.559
Physical removal of textile dyes from effluents and solid-state fermentation of dye-adsorbed agricultural residues P Nigam, G Armour, IM Banat, D Singh, R Marchant Bioresource technology 72 (3), 219-226	813	2000	6.669
Removal of dyes from a synthetic textile dye effluent by biosorption on apple pomace and wheat straw T Robinson, B Chandran, P Nigam Water research 36 (11), 2824-2830	752	2002	8.424

A response surface approach for the comparison of lipase production by <i>Candida cylindracea</i> using two different carbon sources	660	2001	3.371
RV Muralidhar, RR Chirumamila, R Marchant, P Nigam Biochemical Engineering Journal 9 (1), 17-23			
Renewable fuels from algae: an answer to debatable land based fuels	642	2011	6.669
A Singh, PS Nigam, JD Murphy Bioresource technology 102 (1), 10-16			
Microbial process for the decolorization of textile effluent containing azo, diazo and reactive dyes	545	1996	3.089
P Nigam, IM Banat, D Singh, R Marchant Process biochemistry 31 (5), 435-442			
Biotechnological potential of agro-industrial residues. II: cassava bagasse	505	2000	6.669
A Pandey, CR Soccol, P Nigam, VT Soccol, LPS Vandenberghe, ... Bioresource technology 74 (1), 81-87			
Biotechnological potential of coffee pulp and coffee husk for bioprocesses	499	2000	3.371
A Pandey, CR Soccol, P Nigam, D Brand, R Mohan, S Roussos Biochemical Engineering Journal 6 (2), 153-162			
	19,729		

Appendix 5: Collaborators Statements



collaborator 1
Liverpool Univ UK Pr



collaborator 2
Ulster Univ Prof Ban



collaborator 3 USA
Dr Murali.pdf



collaborator 4
Patras Univ Greece F



collaborator 5
Ulster Univ Prof McF