

KIRUBANANDAN (KIRU) SHANMUGAM

Cell: +91 9884 00 3192, kirubanandan.shanmugam@gmail.com

Objective

Having good research experience in Chemical Engineering and Biotechnology, I am actively looking a Researcher/Technologist position in Chemical Engineering/Biochemical Engineering/Biotechnology/Food Processing exclusively in the area of nanomaterials/biomaterials/polymers/process engineering/extraction of biologicals research to implement my research aptitude to convert the concept into novel engineering and technology.

Professional Experience

Senior Project Scientist

2023

National Chemical Laboratory (CSIR-NCL Pune), Maharashtra, India

- Development of Spray coating system to fabricate free standing nanocellulose films for barrier applications.
- Development of free standing nanocellulose films and its composites via casting, vacuum filtration and spraying
- Development and Formulation for improving mechanical strength of the films and crosslinking the films
- Giving Technical Support to the management for nanocellulose film development.
- Patent Search and Drafting for new products.

Research and Development Specialist

2022

Vedia Solutions P Ltd, Palghar, Maharashtra, India

- Development of Nanomedicine formulations for various oral and dental applications.
- Development of Silver based compounds for various biomedical applications
- Development and Formulation of acrylate-based resins for 3D Printing Application of Biomedical Devices
- Giving Technical Support to the management for various product developments.
- Patent Search and Drafting for new products.

Post-Doctoral Research Associate

2021

Abinnvov Consulting P Ltd, Chennai, India.

- Writing Proposals/Research Articles in Nanomedicine
- Worked on Spray Coating for developing cellulose nanofiber scaffolds
- Worked on Electrospinning for Scaffold Development.

Researcher

2021

Anna University, India

Work: Cellulose nanofibre films and their composites as food packaging materials

- Development, construction and commissioning of a lab scale spray coating unit, producing Cellulose nanofibre film.
- Evaluated and validated the packaging performance and characteristics of cellulose nanofibre films and nanocomposites.

Researcher

2020-2021

University of Madras, India

Work: Cellulose nanofibre films and their composites as biomedical materials

- Development, construction and commissioning of a lab scale spray coating unit, producing Cellulose nanofibre film.
- Evaluated and validated the biomedical performance and characteristics of cellulose nanofibre films and nanocomposites.

Research Assistant

2019-2020

University of Melbourne, Australia

Work: Extraction of bioactive molecules from plants and fruits.

- Performed the isolation of bioactive molecules from various plant and fruits and studies on their pharmacological activities.
- Assisted in LCMS analysis of bioactive molecules from the plant source.

Research Assistant

2019

Monash University, Australia

- Performed the recycling of nanocellulose -nanoclay composite and investigated the effect of recycling on the barrier and mechanical properties of the composites.
- Investigated the effect of metal ion in nanoclay on the barrier performance of the nanocellulose -nanoclay composites.

Researcher

2015-2019

Monash University, Australia

Thesis: Spraycoated Nanocellulose Films and their composites as barrier materials

- Performed a BAM I industry project with a group of paper and pulp industries in Australia, focused on nanocellulose based barrier materials.
- Development, construction and commissioning of a spray coating unit, producing uniform nanocellulose films and its composites.
- Evaluated and validated the barrier performance and characteristics of nano-cellulose films and nanocomposites,

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- Developed a sustainable process design for recycling of nano-cellulose into a potential barrier material, an alternative for synthetic packaging materials.
- Analysed HAZARD potential of spraying of nano-cellulose and nanocellulose with nano inorganic and assessed its risks in the spray coating experimental set up.

Research and Development Lab Technician, Biomer Innovation, Halifax, NS, Canada.

2014

- Developed and performed a chemical-based deproteinization and demineralization method for green crab waste, achieving >95% removal of proteins and calcite at a lab scale.
- Characterized Chitin and Chitosan by various instruments, editing and updating SOP's as appropriate to ensure continued collection of quality data.

MASc Graduate Student/ Research Assistant,

2012–2015

Multiphase Process Engineering Lab, Dalhousie University, Halifax, NS, Canada.

- Participated in a NERC Engage project with DSM Nutritional Products focused on the practical extraction of Omega 3 PUFA from fish oil using silver nitrate solution.
- Assisted in the development, construction and commissioning of a mini-fluidics liquid-liquid extraction unit, achieving extraction yields of nearly 80%.
- Assisted in the development, construction and commissioning of an oscillatory flow reactor unit experimented in various hydrodynamic studies.

Other Professional Experience

Faculty in Biotechnology,

Sree Sastha Institute of Engineering and Technology

2021-2022

Teaching Associate and Laboratory Demonstrator,

Monash University, Australia.

2017-2018

Process Engineering Intern -Volunteer

Biofuel Innovation, Dandenong, Melbourne, Australia

2018

Graduate Teaching Assistant,

Dalhousie University, Canada.

2012-2015

Visiting Faculty, Department of Chemical Engineering,

Anna University, Chennai, India.

2012

Assistant Professor, Department of Biotechnology,

Sri Venkateswara College of Engineering, Chennai, India.

2010–2012

Lecturer, Department of Biotechnology,

Sri Venkateswara College of Engineering, Chennai, India.

2008–2010

Graduate Research Assistant,

Bio products Laboratory, Central Leather Research Institute, India.

2005-2008

DBT-Research Associate,

Biological Science and Bioengineering, Indian Institute of Technology, Kanpur, India.

2007

Process Engineer-Apprentice

Central Leather Research Institute, Chennai, India

2003 - 2004

Casual Process Engineer

MMG Process care Engineering Pvt Ltd, Chennai, India.

2012 –2012

Casual Process Engineer (Part Time -weekly ~15 hours),

MMG Process care Engineering Pvt Ltd, Chennai, India.

2010 – 2012

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Senior Technical Associate Officer, Yadhav Facilities Service P Ltd, Chennai, India.	2008
Senior Technical Associate Officer, Yadhav Facilities Service P Ltd, Chennai, India.	2006 – 2007
Process Engineer Ananda engineering and technical service Pvt Ltd, Chennai, India.	2001- 2003
Casual Process and Quality Control Chemist MMG Associates, Chennai, India.	2001
Chemical Engineering Project Intern Tamilnadu Petro products Pvt Ltd, Chennai, India.	2000
Chemical Engineer Intern Petro Araldite Pvt Ltd, Chennai, India.	Jan - Mar 2001
Chemical Engineer Intern Central Electrochemical Research Institute India.	May - June 1999
Chemical Engineer Intern Tamilnadu Petro Products Pvt Ltd India.	Dec 1997- Mar 1998
Volunteer Experience	
Process Engineering Intern -Volunteer (weekly 1-2 hours) Biofuel Innovation, Dandenong, Melbourne, Australia.	Feb 2018 to Sep 2018
Laboratory Manager and Volunteer (Monthly 5 hours) Monash University, Australia	Mar 2016 – May 2019
Student Chapter Volunteer (Monthly 1 hour from Jan 2018 to June 2018) and Floor Warden (on call duty) Monash University, Australia	Mar 2016 – May 2019
Volunteer for Vitamin D Research (Totally 20 hours contributed) Monash Centre for Health Research and Implementation, Monash University	Feb 2016 - July 2016
Education	
PhD in Chemical Engineering Monash University, Australia Thesis: Nanocellulose as barrier materials	2015-2019
MASc in Chemical Engineering, Dalhousie University, Halifax, Nova scotia, Canada. Thesis: Mini-fluidic silver based solvent-based extraction of EPA/DHA from fish oils	2015
Certificate Course in Analytical Chemistry and Instrumentation, Indian Institute of Technology Kanpur, Uttar Pradesh, India.	
M.Tech in Biopharmaceutical Technology, Anna University, India. Project Work: Development of Collagen Based Biomaterials for Soft-Tissue Repair	
B.Tech in Chemical Engineering, University of Madras, Chennai, India. Project Work: Design of Production of Epichlorohydrin and Design of Sieve Tray Column and Hydrogen Chloride Absorber	
Diploma in Chemical Technology, Institute of Chemical Technology, India.	
Skills	

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- Experienced in various spectroscopic analysis of proteins, biopolymers and biodegradable polymers, with prior experience preparing standard operating protocols and procedures.
- Well versed in numerous bio techniques: Colorimetric analysis, Protein Purification, Electrophoresis, Zymography, Western Blotting, Gel-filtration Chromatography, Gel Permeation Chromatography, Immobilized metal affinity Chromatography (IMAC), Gas Chromatography and HPLC –Reverse Phase.
- Well versed in Laboratory instrumentation and equipment: Spinning Drop Tensiometer, Pilot Plant Process Equipments, UV-Visible Spectrophotometer, DSC, TGA, NMR, FTIR, MS, HPLC and CD spectroscopy.
- In Vitro and In Vivo Assays and Animal Cell Culture.
- Good time management skill and ability to multi-task and ensure all projects meet deadlines.
- Resourceful and logical with excellent problem solving, analytical and critical thinking abilities.
- Proficient in Microsoft Office, Minitab and Origin.
- Prior experience identifying research gaps through literature reviews and writing short term funding proposals.

Academic Achievements

- Received Faculty of Engineering Postgraduate Publication Award, Monash University.
- Received Faculty of Engineering International Postgraduate Research Scholarship, Monash University.
- Received Bioprocessing Advanced Manufacturing Initiative (BAMI) for my doctoral research, Monash University, 2015-19.
- Selected Teaching Associate and Demonstrator, Monash University, Australia, 2017.
- National Engineering Research Council funded my graduate studies at Dalhousie University, 2012.
- Performed DSM Nutritional Products, Canada engagement project and also funded my thesis project, 2013.
- Repeatedly selected for Teaching Assistantship, PEAS, Dalhousie University, 2012-2015.
- Best Paper presentation, Asian Bio-ceramics Symposium, Nov 4-6, IIT Madras, 2008.
- DBT–Research Fellowship for a project on Dual Growth factor delivery system in IIT Kanpur, 2007.

Selected Publications:

1. Shanmugam, R., Mayakrishnan, V., Kesavan, R. *et al.* Mechanical, Barrier, Adhesion and Antibacterial Properties of Pullulan/Graphene Bio Nanocomposite Coating on Spray Coated Nanocellulose Film for Food Packaging Applications. *J Polym Environ* (2021). <https://doi.org/10.1007/s10924-021-02311-2>
2. Vitta, S., Kannapiran, S., Shanmugam, K., Rao, G., Balachandran, M., Sridhar, T. ., Balu, R., Rajagopal, V., & Ramakrishnan, P. (2021). Personalized Nanomedicine for Breast Cancer Therapy using Poly (lactic-co-glycolic acid) Nanoscaffolds: A Perspective. *Trends in Biomaterials & Artificial Organs*, 35(3), 287-295. Retrieved from <https://www.biomaterials.org.in/tibao/index.php/tibao/article/view/510>
3. Shanmugam, K., Varanasi, S., Garnier, G., & Batchelor, W. (2017). Rapid preparation of smooth nanocellulose films using spray coating. *Cellulose*, 1-8. Doi: 10.1007/s10570-017-1328-4
4. Kirubanandan Shanmugam, Humayun Nadeem, Christine Browne, Gil Garnier, Warren Batchelor, Engineering Surface Roughness of Nanocellulose Film via Spraying to Produce Smooth Substrates, Colloids and Surfaces A: Physicochemical and Engineering Aspects, December 2019.

Patent Applications:

1. Dr. Dilip Kumar Sharma, Ankit Bhardwaj, Dr. Abdul Hannan Abdul Mannan Shaikh, Swati Saxena Preeti C M, Dr. Arshiya S. Ansari, Raj Kumar Paul, Dr. Saravanan Chandran, Shaba Parveen Khan Dr. Hari Kumar Singh, Dr. Kirubanandan Shanmugam, Pankaj Kunekar, "The CNN approach for the lung cancer detection in image processing" – India Patent Filled - Application Number 202221066497
2. Dr. Dilip Kumar Sharma, Dr. Abdul Hannan Abdul Mannan Shaikh, Mr. Mahesh Lonare, Vipul Bansal Mrs. Yogita Hambir, Dr. Santosh Singh, Mr. Kuldeep Anil Hule, Prof. Kamlesh Vasant Rao Patil, Pralhad Rohidas Sonawane, Pankaj Kunekar, Dr. Kirubanandan Shanmugam, Amruta Mankawade, "The Classification Technique for The Face Spoof Detection In Artificial Neural Networks Using Concepts Of Machine Learning" – Indian Patent Filled - Application Number 202221066095
3. Dr. Indrani Das Sarma, Dr. N.R. Rajagopalan, Mr. Tamijesvelan S, Dr. Kirubanandan Shanmugam, Dr. Pranjit Kumar Bhuyan, Dr. Sivakumar Ponnusamy, Dr. Aishwarya S, "Using A Fluidic Sensor With Plain Radiography To Track Bone Healing" – Indian Patent Filled -Application Number 202221048216.

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PROFESSIONAL REGISTRATION AND AFFILIATION

Professional Engineer, Engineering Council of India, India
Associate Member, Institution of Engineers India
Associate Member, Indian Institute of Chemical Engineers

REFERENCE

Available on request

RESEARCH PROFILES

Selected Publications

1. Natrayan, L., Surakasi, R., Kaliappan, S., Muthu, G., Paramasivam, P., & **Shanmugam, K.** (2024). Effectiveness of natural dye adsorption on ILSS and optical properties of bio synthesised TiO₂ nano particles and reinforced with flax seed fiber/epoxy based hybrid composites. *Discover Applied Sciences*, 6(3), 1-12.
2. Natrayan, L., Chinta, N. D., Teja, N. B., Muthu, G., Kaliappan, S., **Kirubanandan, S.**, & Paramasivam, P. (2024). Evaluating mechanical, thermal, and water absorption properties of biocomposites with Opuntia cladode fiber and palm flower biochar for industrial applications. *Discover Applied Sciences*, 6(2), 30.
3. **Shanmugam, K.**, Chandrasekar, N., Balaji, R. (2023). Nanocellulose as a Sustainable Nanomaterial for Films and Coating Layers via Spray-Coating and Applications. In: Sheikh, F.A., Majeed, S., Beigh, M.A. (eds) Interaction of Nanomaterials With Living Cells. Springer, Singapore. https://doi.org/10.1007/978-981-99-2119-5_17
4. Chandrasekar, N., Balaji, R., Perala, R. S., Nik Humaidi, N. Z., **Shanmugam, K.**, Liao, Y. C., ... & Govindaraju, S. (2023). A brief review of graphene-based biosensors developed for rapid detection of COVID-19 biomarkers. *Biosensors*, 13(3), 307.
5. Subha, V., Ranu, A., Shankar, A., **Kirubanandan, S.**, Satheeshkumar, E., Suresh, S., ... & Ilangovan, R. (2022). Functionalization of spray coated cellulose nanofiber sheet with montmorillonite (MMT) and silver nanoparticles (AgNPs) to biomedical nanocomposite as wound regeneration scaffold. *Progress in Organic Coatings*, 166, 106782.
6. Humayun Nadeem, Mahdi Naseri, **Kirubanandan Shanmugam**, Mostafa Dehghani, Christine Browne, Simin Miri, Gil Garnier, Warren Batchelor, An energy efficient production of high moisture barrier nanocellulose/carboxymethyl cellulose films via spray-deposition technique, *Carbohydrate Polymers*, Volume 250, 2020, 116911, ISSN 0144-8617, <https://doi.org/10.1016/j.carbpol.2020.116911>.
7. Vitta, S., Kannapiran, S., **Shanmugam, K.**, Rao, G., Balachandran, M., Sridhar, T. M., ... & Ramakrishnan, P. (2021). Personalized Nanomedicine for Breast Cancer Therapy using Poly (lactic-co-glycolic acid) Nanoscaffolds: A Perspective. *Trends in Biomaterials & Artificial Organs*, 35(3).
8. **Kirubanandan Shanmugam**, Christine Browne, Chapter 10 - Nanocellulose and its composite films: Applications, properties, fabrication methods, and their limitations, Editor(s): Sabu Thomas, Preetha Balakrishnan, In *Micro and Nano Technologies, Nanoscale Processing*, Elsevier, 2021, Pages 247-297, ISBN 9780128205693, <https://doi.org/10.1016/B978-0-12-820569-3.00010-4>.
9. Nadeem, H., Naseri, M., **Shanmugam, K.** et al. Impact of heat drying on the physical and environmental characteristics of the nanocellulose-based films produced via spray deposition technique. *Cellulose* 27, 10225–10239 (2020). <https://doi.org/10.1007/s10570-020-03473-3>

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10. Shanmugam, K., Ang, S., Maliha, M. *et al.* High-performance homogenized and spray coated nanofibrillated cellulose-montmorillonite barriers. *Cellulose* **28**, 405–416 (2021). <https://doi.org/10.1007/s10570-020-03515-w>
11. Alsaiani, N. S., Shanmugam, K., Mothilal, H., Ali, D., & Prabhu, S. V. (2022). Optimization of spraying process via response surface method for fabrication of cellulose nanofiber (CNF) film. *Journal of Nanomaterials*, 2022.
12. Qureshi, W. A., Radjarejstri, S., Shanmugam, K., Elavarasan, P., Gowrishankar, M., & Gebeyehu, K. B. (2022). Central composite design of spraying process to laminate the paper substrates with cellulose nanofibers (CNF) as green packaging wrap. *Journal of Nanomaterials*, 2022.
13. Ravindran, R. E., Shanmugam, K., Veeramani, S., Ilangovan, R., Ali, D., Almutairi, B. O., ... & Goel, M. (2022). Effect of Phytofabricated Silver Oxide Nanoparticles on Wound Pathogens. *Journal of Nanomaterials*, 2022.
14. Shanmugam, R., Mayakrishnan, V., Kesavan, R. *et al.* Mechanical, Barrier, Adhesion and Antibacterial Properties of Pullulan/Graphene Bio Nanocomposite Coating on Spray Coated Nanocellulose Film for Food Packaging Applications. *J Polym Environ* (2021). <https://doi.org/10.1007/s10924-021-02311-2>
15. Vitta, S., Kannapiran, S., Shanmugam, K., Rao, G., Balachandran, M., Sridhar, T. ., Balu, R., Rajagopal, V., & Ramakrishnan, P. (2021). Personalized Nanomedicine for Breast Cancer Therapy using Poly (lactic-co-glycolic acid) Nanoscaffolds: A Perspective. *Trends in Biomaterials & Artificial Organs*, 35(3), 287-295. Retrieved from <https://www.biomaterials.org.in/tibao/index.php/tibao/article/view/510>
16. Shanmugam, K., Varanasi, S., Garnier, G., & Batchelor, W. (2017). Rapid preparation of smooth nanocellulose films using spray coating. *Cellulose*, 1-8. Doi: 10.1007/s10570-017-1328-4
17. Shanmugam, Kirubanandan, Hamid Doosthosseini, Swambabu Varanasi, Gil Garnier, and Warren Batchelor. "Flexible spray coating process for smooth nanocellulose film production." *Cellulose* 25, no. 3 (2018): 1725-1741.
18. Kirubanandan Shanmugam, Hamid Doosthosseini, Swambabu Varanasi, Gil Garnier, *Warren Batchelor," Smooth nanocellulose films as air and water vapour barrier: a sustainable alternative to polyolefin packaging". *Sustainable materials and technologies*. 22, 2019.
19. Aysu Onur, Kirubanandan Shanmugam, Aaron Ng, Gil Garnier, Warren Batchelor, Cellulose fibre- perlite depth filters with cellulose nanofibre top coating for improved filtration performance, *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 583, 2019.
20. Kirubanandan Shanmugam, Humayun Nadeem, Christine Browne, Gil Garnier, Warren Batchelor, Engineering Surface Roughness of Nanocellulose Film via Spraying to Produce Smooth Substrates, *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, December 2019.
21. Kirubanandan Shanmugam, Maisha Maliha, Vickram Singh, Swambabu Varanasi, Gil Garnier, and Warren Batchelor, Flexible Process to produce Nanocellulose –Montmorillonite Barriers via Spray Coating, *Cellulose*.
22. C. Czibula , C. Ganser , M. Kratzer , F. Brumbauer , M. Kräuter , K. Shanmugam , W. Bachelor , M. Penn , M. Ebner , M. Pramstrahler , F. Pilat , T. Chien , R. Schennach , B. Friedel and C. Teichert, "Silver Nanowires: A Versatile Tool For conductive paper" 16th Fundamental Research Symposium "Advances in Pulp and Paper Research, Oxford 2017".Pembroke College, Oxford, UK. 3rd – 8th September 2017
23. Kirubanandan Shanmugam; Humayun Nadeem; Swambabu Varanasi; Gil Garnier; and Warren Batchelor, Effect of Recycling on the properties of nanocellulose •Barrier and Mechanical Properties, Papercon 2019.
24. Shanmugam, K., & Donaldson, A. A. (2015). Extraction of EPA/DHA from 18/12EE fish oil using AgNO₃ (aq): composition, yield, and effects of solvent addition on interfacial tension and flow pattern in mini-fluidic systems. *Industrial & Engineering Chemistry Research*, 54(33), 8295- 8301.
25. Shanmugam, K., Neima, A., & Donaldson, A. A. (2015). Design and Feasibility Analysis of Commercial Silver-Based Solvent Extraction of Omega-3 PUFA. *Global Journal of Research in Engineering*.
26. Kirubanandan Shanmugam, Omega-3 PUFA from fish oil: Silver based solvent extraction, Chapter 8, Meghwal, M., Goyal, M. R., & Kaneria,
27. M. J. (Eds.). (2017). *Food Technology: Applied Research and Production Techniques*. CRC Press.
28. J. Vaishnav, V. Subha, S. Kirubanandan, M. Arulmozhi, S. Renganathan "Green synthesis of zinc oxide nanoparticles by celosia argentea and its characterization" *Journal of Optoelectronics and Biomedical Materials* Vol. 9, No. 1, January-March 2017 p. 59 - 71
29. Shanmugam, K., & Sahadevan, R. Bio ceramics—An introductory overview. Chapter - 1. Thomas, S., Balakrishnan, P., & Sreekala, M. S. (Eds.). (2018). *Fundamental Biomaterials: Ceramics*. Woodhead Publishing.
30. Megh R. Goyal, Hafiz Ansar Rasul Suleria, Shanmugam Kirubanandan, Technological Processes for Marine Foods, From Water to Fork Bioactive Compounds, Industrial Applications, and Genomics, *Innovations in Agricultural and Biological Engineering Series*, 2019.

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31. Rajesh Vasita, **Kirubanandan Shanmugam**, Dhirendra S. Katti, Degradation behavior of electrospun microfibers of blends of poly(lactide-co-glycolide) and Pluronic® F-108, *Polymer Degradation and Stability*, Volume 95, Issue 9, 2010, Pages 1605-1613, ISSN 0141-3910, <https://doi.org/10.1016/j.polymdegradstab.2010.05.032>.
32. Muthusamy Senthil Kumar, **Shanmugam Kirubanandan**, Ramasamy Sripriya, Praveen Kumar Sehgal, Triphala Promotes Healing of Infected Full-Thickness Dermal Wound, *Journal of Surgical Research*, Volume 144, Issue 1, 2008, Pages 94-101, ISSN 0022-4804, <https://doi.org/10.1016/j.jss.2007.02.049>.
33. Muthusamy Senthil Kumar, **Shanmugam Kirubanandan**, Ramasamy Sripriya, Praveen Kumar Sehgal, Triphala Incorporated Collagen Sponge—A Smart Biomaterial for Infected Dermal Wound Healing, *Journal of Surgical Research*, Volume 158, Issue 1, 2010, Pages 162-170, ISSN 0022-4804, <https://doi.org/10.1016/j.jss.2008.07.006>.
34. Sahadevan, R., Mahendradas, D. K., Shanmugasundaram, V., **Shanmugam, K.**, & Velan, M. (2009). Sorption kinetics and equilibrium analysis for the removal of Reactive Red 2 and Reactive Blue 81 dyes from synthetic effluents using dried soya bean meal. *International journal of chemical reactor engineering*, 7(1).
35. Balaji, S., Senthil Kumar, M., Karthikeyan, R., Kumar, R., **Kirubanandan, S.**, Sridhar, R., & Sehgal, P. K. (2008). Purification and characterization of an extracellular keratinase from a hornmeal-degrading *Bacillus subtilis* MTCC (9102). *World Journal of Microbiology and Biotechnology*, 24, 2741-2745.
36. Katti, D. S., Vasita, R., & **Shanmugam, K.** (2008). Improved biomaterials for tissue engineering applications: surface modification of polymers. *Current topics in medicinal chemistry*, 8(4), 341-353.
37. Prabu, D., **Kirubanandan, S.**, Ponnudurai, K., Nappinnai, M., Jinu, A. J., & Renganathan, S. (2008). Anti-inflammatory and analgesic activities of methanol extract of Triphala—a poly herbal formulation. *Oriental pharmacy and experimental medicine*, 8(4), 423-429.
38. Detchanamurthy, S., **Shanmugam, K.**, Parkunan, S. M. A., Puttananjaiiah, S., Somasundaram, B., & Subramanian, K. (2010). Cloning and expression of S-Adenosyl Methionine Synthetase gene in recombinant *E. coli* strain for large scale production of S-Adenosyl Methionine. *Electronic Journal of Biotechnology*, 13(4), 1-2.
39. Srinivasan, B., Kumar, R., **Shanmugam, K.**, Sivagnam, U. T., Reddy, N. P., & Sehgal, P. K. (2010). Porous keratin scaffold—promising biomaterial for tissue engineering and drug delivery. *Journal of Biomedical Materials Research Part B: Applied Biomaterials: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials, and The Australian Society for Biomaterials and the Korean Society for Biomaterials*, 92(1), 5-12.