

Curriculum Vitae**Bidisha Sengupta, Ph.D**Associate Professor, Chemistry Department
500 W County Line Road, Tougaloo, MS 39174, USA**Telephone:** (601) 977-7779 (w)**Email:** bsengupta@tougaloo.edu / bsgupta.tougaloo@gmail.com**Key Strength:**

- Innovative and enthusiastic teacher. Teaches Biochemistry, Organic Chemistry, Instrumental Analysis, Introduction to Chemistry.
- Strong background in defining novel research concepts, monitoring, evaluating and implementing new scientific and technological advancements.

Professional Experience:May 2016 - present: **Associate Professor (with tenure)**, Chemistry, Tougaloo College.January 2011 - April 2016: **Assistant Professor**, Chemistry, Tougaloo CollegeSeptember 2006 - December 2010: **Post doctoral Research Associate**,
Department of Chemistry, Furman University, USAJuly 2004 - June 2006 **Postdoctoral Research Associate**,
Department of Applied Physics, Chalmers University of Technology, Goteborg, Sweden.March 2002 - March 2004 **Postdoctoral Research Associate**,
Biophysics Division, Saha Institute of Nuclear Physics (SINP), India.**Education:**Ph.D (1995 - 2001) Biophysical Chemistry,
Biophysics Division, Saha Institute of Nuclear Physics, (University of Calcutta) India.
Thesis entitled "Spectroscopic Investigations on some biologically important molecules in different environments".Post-M.S. Associateship Biosciences
Diploma (1994-1995) SINP, Calcutta, IndiaM.S. (1992-1994) Biophysics, Molecular Biology and Genetics.
University of Calcutta. Calcutta, India.B.S. (1989-1992) Chemistry (Major), Physics and Mathematics
Bethune College, University of Calcutta. Calcutta, India.

List of Publications: Total 50

Peer reviewed International Publications: 44

(H-index=21), \$corr. auth.; *undergrad; @high school researcher

1. *The Effects of Hydraulic Fracturing on the Environment and Some Possible Remediation Strategies*, Sen, C.*, **Sengupta, B.**, Zaman, M. S., *Advances in Science and Technology* (2018) accepted.
2. *Differential roles of 3-Hydroxyflavone and 7-Hydroxyflavone against nicotine-induced oxidative stress in rat renal proximal tubule cells*, **Bidisha Sengupta**\$, Mehdi Sahihi, Monireh Dehkhodaei, Darrian Kelly*, Istvan Arany, *PLOS One*, (2017) <https://doi.org/10.1371/journal.pone.0179777>
3. *Chiral Alkylated-Aniline as a Noninvasive Fluorescence Sensor: Spectroscopic and Molecular Modeling Studies*, **Bidisha Sengupta**\$, Chirantan Sen Mukherjee@, Sandipan Chakraborty, Maria Jones Muhammad*, William Gladney Jr.*, George Armstrong, *Spectrochimica Acta, A* 187 (2017) 23-29. doi: 10.1016/j.saa.2017.06.008.
4. *Influence of Aptamer-Enclosed Silver Nanocluster on the Prevention of Biofilm by Bacillus thuringiensis*, **Bidisha Sengupta**\$, Sudarson Sinha, Bianca Garner, Istvan Arany, Christa Corley*, Keith Cobb*, Elrica Brown*, Paresh Ray, *Nanoscience and Nanotechnology Letters*, 2016, 8, 1054-1060.
5. *DNA Scaffolded Silver Clusters: A Critical Study*, **Bidisha Sengupta**\$, Christa Corley*, Keith Cobb*, Anthony Saracino* and Steffen Jockusch, *Molecules* 2016, 21(2), 216; doi:10.3390/molecules21020216
6. *Excited State Proton Transfer of Natural Flavonoids and Their Chromophores in Duplex and Tetraplex DNAs*, **Bidisha Sengupta**\$, Samantha M. Reilly, Donald E. Davis Jr*, Kisa Harris*, Randy M. Wadkins, Denise Ward*, D'Asia Gholar*, and Cari Hampton*, *J. Phys. Chem. B*, 119 (2014), 2546-2556, DOI: 10.1021/jp508599h 2014.
7. *Prospect of Bioflavonoid Fisetin as quadruplex ligand*, **Bidisha Sengupta**\$, Biswapathik Pahari, Laura Blackmon*, Pradeep K. Sengupta, *PLOS One*, 8 (2013) e65383,1-11.
8. *Biophysical characterization of Genistein in its natural carrier human hemoglobin using spectroscopic and computational approaches*, Biswapathik Pahari, Sandipan Chakraborty, **Bidisha Sengupta**\$, Sudip Chaudhuri, William Martin*, Jasmine Taylor*, Jordan Henley*, Donald Davis*, Pradip Biswas, Amit K. Sharma, Pradeep K. Sengupta, *Food and Nutrition Science*, 4 (2013) 83-92.
9. *Interactions of dietary polyphenols with proteins: Insights from fluorescence spectroscopic and other related biophysical studies*, Sudip Chaudhuri, **Bidisha Sengupta**, Jasmine Taylor*, Biswa Pathik Pahari, Pradeep K. Sengupta, *Current Drug Metabolism* 14 (2013) 491-503.
10. *Contrasting Binding of Fisetin and Daidzein in γ -cyclodextrin nanocavity*, Biswapathik Pahari, **Bidisha Sengupta**\$, Sandipan Chakraborty, Briannica Thomas*, Dyffrean McGowan*, Pradeep K. Sengupta, *J. Photochem. Photobiol. B*. 118 (2013) 33-41.
11. *Characterization of Daidzein-Hemoglobin Binding using Optical Spectroscopy and Molecular Dynamics Simulations*, **Bidisha Sengupta**, Sandipan Chakraborty, Maurice Crawford, Jasmine M. Taylor, Laura E. Blackmon*, Pradip K. Biswas, Wolfgang H. Kramer, *Int. J. Biol. Macromol.* 51 (2012) 250– 258.
12. *Mechanistic insight into the Structure and Dynamics of lambda phage DNA*. Sandipan Chakraborty, Takashi Uematsu, Christer Svanberg, Per Jacobsson, Michael Zach, Jan Swenson, Rajender Trehan, George Armstrong and **Bidisha Sengupta**, *J. Physical Chemistry A* 116 (2012) 4274–4284.

13. *A critical study on the interactions of hesperitin with human hemoglobin: Fluorescence spectroscopic and molecular modeling approach.* Sandipan Chakrabarty, Sudip Chaudhuri, Biswapathik Pahari, Jasmine Taylor*, Pradeep K. Sengupta and **Bidisha Sengupta**, *J. of Luminescence* 132 (2012) 1522–1528.
14. *Optical Sensing by Transforming Chromophoric Silver Clusters in DNA Nanoreactors.* Jeffrey T. Petty, Sandra P. Story, Selina Juarez, Samuel Votto, Austin Herbst, Natalya N. Degtyareva and **Bidisha Sengupta**, *Analytical Chemistry*, 84 (1), 2012, pp 356–364.
15. *Binding and antioxidant properties of therapeutically important plant flavonoids in biomembranes: Insights from spectroscopic and quantum chemical studies.* Pradeep K. Sengupta, Biswa P Pahari, Sandipan Chakraborty, Sudip Chaudhuri, **Bidisha Sengupta**. *Chemistry and Physics of Lipids* 165 (2012) 488–496.
16. *DNA Sensing by Amplifying the Number of Near-Infrared Emitting, Oligonucleotide-Encapsulated Silver Clusters.* Jeffrey T. Petty, **Bidisha Sengupta**, Sandra P. Story, and Natalya N. Degtyareva *Anal. Chem.* 83 (15) (2011) 5957-5964.
17. *Optically-Enhanced, Near-IR, Silver Cluster Emission Altered by Single Base Changes in the DNA Template.* Jeffrey T. Petty, Chaoyang Fan, Sandra P. Story, **Bidisha Sengupta**, Matthew Sartin, Jung-Cheng Hsiang, Joseph W. Perry, and Robert M. Dickson. *J. Phys. Chem. B*, 2011, 115 (24), 7996–8003.
18. *DNA Encapsulation of 10 Silver Atoms Producing a Bright, Modulatable, Near-Infrared-Emitting Cluster.* Jeffrey T. Petty, Chaoyang Fan, Sandra P. Story, **Bidisha Sengupta**, Ashlee St. John Iyer, Zachary Prudowsky and Robert M. Dickson. *J. Phys. Chem. Lett.* 1 (2010) 2524–2529.
19. *DNA Templates for Fluorescent Silver Clusters and I-Motif folding.* **Bidisha Sengupta**, Kerianne Springer, Jenna Buckman, Sandra Story, Henry Oluwamuyiwa, Zahiyah Hasan, Zachary Prudowsky, Sheldon Rudisill, Natalya Degtyareva, Jeff Petty, *J. Phys. Chem. C* 113 (45) (2009) 19518-19524.
20. *Ag⁺ Mediated Assembly of 5'-Guanosine Monophosphate.* Kristine Loo, Natalya Degtyareva, Jihae Park, **Bidisha Sengupta**, Andrea Bryant, Michael Reddish, Christopher Johnson, and Jeffrey T. Petty *J. Phys. Chem. B* 114 (12) (2010) 4320–4326.
21. *Context Dependence of Trinucleotide Repeat Structures.* Natalya Degtyareva, Courtney Barber, **Bidisha Sengupta** and Jeffrey T. Petty. *Biochemistry* 49 (14) (2010) 3024–3030.
22. *Structural studies of a trinucleotide repeat sequence using 2-Aminopurine.* Natalya Degtyareva, Michael Reddish, **Bidisha Sengupta** and Jeff Petty, *Biochemistry* 48 (11) (2009) 2340-2346.
23. *Base-Directed formation of fluorescent silver clusters.* **Bidisha Sengupta**, Caroline M. Ritchie, Kenneth Johnsen, Jenna Buckman and Jeffrey T. Petty, *J. Phys.Chem. C.* 112 (48) (2008) 18776–18782.
24. *Ground and excited state proton transfer and antioxidant activity of 3- hydroxyflavone in egg yolk phosphatidylcholine liposomes: absorption and fluorescence spectroscopic studies.* Sudip Chaudhuri, Kaushik Basu, **Bidisha Sengupta**, Anwasha Banerjee, and Pradeep K. Sengupta, *Luminescence* 23(6) (2008) 397 – 403.
25. *Effect of glycation on the structure and dynamics of DNA: A critical spectroscopic approach.* **Bidisha Sengupta**, Takashi Uematsu, Per Jacobsson and Jan Swenson, *J. Phys. Chem. B.* 111(3) (2007) 646-651.

26. *Interaction of flavonoids with red blood cell membrane lipids and proteins: Antioxidant and antihemolytic effects.* Sudip Chaudhuri, Anwasha Banerjee, Kaushik Basu, **Bidisa Sengupta**, Pradeep K. Sengupta, *Int. J. Biol. Macromol.* 41 (2007) 41–48.
27. *Exploring the interactions of therapeutically active plant flavonoids with biological targets: Insights from fluorescence spectroscopy.* Pradeep K Sengupta, Anwasha Banerjee and **Bidisa Sengupta**, *Photo/electrochemistry & Photobiology in Environment, Energy, and Fuel*, (2006) 207-227.
28. *Encapsulation of Prodan in beta-cyclodextrin environments: An experimental and theoretical study via electronic spectroscopy and molecular mechanics.* Anwasha Banerjee, **Bidisa Sengupta**, Sudip Chaudhuri, Kaushik Basu, and Pradeep K Sengupta *J. Mol. Struct.* 794 (2006) 181-189.
29. *Exploring the antioxidant property of bioflavonoid quercetin in preventing DNA glycation: A calorimetric and spectroscopic study.* **Bidisa Sengupta**, Takashi Uematsu, Per Jacobsson and Jan Swenson, *Biochem. Biophys. Res. Commun.* 339 (2006) 355- 361.
30. *Properties of normal and glycated human hemoglobin in presence and absence of antioxidant.* **Bidisa Sengupta** and Jan Swenson, *Biochem Biophys. Res. Commun.* 334 (2005) 954-959.
31. *Interactions of the plant flavonoid fisetin with macromolecular targets. Insights from fluorescence spectroscopic studies.* **Bidisa Sengupta**, Anwasha Banerjee, and Pradeep K. Sengupta, *J. Photochem. Photobiol. B*, 80 (2005) 79-86.
32. *Protein-flavonol interactions: Insights from spectroscopic studies.* **Bidisa Sengupta**, Anwasha Banerjee, and Pradeep K. Sengupta, *Proceedings of the International Seminar on Frontiers of Basic and Applied Molecular Biology*, (2005) 26-31.
33. *Investigations on the binding and antioxidant properties of the plant flavonoid fisetin in model biomembranes.* **Bidisa Sengupta**, Anwasha Banerjee, and Pradeep K. Sengupta, *FEBS Letters*, 570 (2004) 77-81.
34. *Characterization of serotonin in protein and membrane mimetic environments: A spectroscopic study.* **Bidisa Sengupta**, Sudip Chaudhuri, Anwasha Banerjee and Pradeep K. Sengupta, *Chemistry and Biodiversity*, 1 (2004) 868-877.
35. *Binding of quercetin with human serum albumin: A critical spectroscopic study.* **Bidisa Sengupta** and Pradeep K. Sengupta. *Biopolymers (Biospectroscopy)* 72 (2003) 427-434.
36. *Perspectives on some newly emerging luminescence probes for proteins and biomembranes.* **Bidisa Sengupta** and Pradeep K. Sengupta. in *Recent Trends in Biophysical Research* , (ed. M. Maiti, G. S. Kumar, S. Das), publisher; Double a Work Station, Kolkata, (2003) 90-99.
37. *The interaction of Quercetin with Human Serum Albumin: A fluorescence spectroscopic study.* **Bidisa Sengupta** and Pradeep K. Sengupta. *Biochem. Biophys. Res. Commun.*, 299 (2002) 400-403.
38. *Low temperature luminescence behaviours of 7-azatryptophan, 5-hydroxytryptophan and their chromophoric moieties.* **Bidisa Sengupta**, Jayanti Guharay, Ajoy Chakraborty and Pradeep K. Sengupta. *Spectrochim. Acta Part A (Biomolecular Spectroscopy Section)*, 58 (2002) 2005-2012.
39. *Flavonols as novel fluorescence probes: perspectives and emerging frontiers.* **Bidisa Sengupta** and Pradeep K. Sengupta. *Indian Photobiology Society News Letter* 41 (2002) 54-60.
40. *Studies on the interaction of quercetin with bovine serum albumin: A fluorescence spectroscopic approach.* **Bidisa Sengupta** and Pradeep K. Sengupta. *Proceedings of the*

National Seminar on Recent Advances in Molecular Physiology, Kalyani University, Feb 4-6, 2002. Page 151-155.

41. Protein - flavonol interaction: a fluorescence spectroscopic study. Jayanti Guharay, **Bidisa Sengupta** and Pradeep K. Sengupta, *Proteins: Structure, Function and Genetics* 43 (2001) 75-81.
42. 5-hydroxyindole: Usefulness as a novel optical probe. **Bidisa Sengupta**, Jayanti Guharay and P. K. Sengupta. *J. Mol. Struct.* 559 (2001) 347-353.
43. Influence of reverse micellar environments on the fluorescence emission properties of tryptophan octyl ester. **Bidisa Sengupta** and Pradeep K. Sengupta, *Biochem Biophys. Res. Commun.* 277 (2000) 13-19.
44. Characterization of the fluorescence emission properties of prodan in different reverse micellar environments. **Bidisa Sengupta**, Jayanti Guharay and P. K. Sengupta. *Spectrochim. Acta Part A (Biomolecular Spectroscopy Section)*, 56 (2000) 1433 – 1441.
45. Luminescence behaviour of 5-hydroxyindole in different environments. **Bidisa Sengupta**, Jayanti Guharay and P. K. Sengupta. *Spectrochim. Acta Part A (Biomolecular Spectroscopy Section)*, 56 (2000) 1213 – 1221.
46. Reverse micelles of TX-100 in mixed solvents of Benzene and n-Hexane: Fluorescence studies using 7HF as probe. **Bidisa Sengupta**, Jayanti Guharay and Pradeep K. Sengupta, *J. Surface Science and Technology*, 14 (1998) 150 – 156.
47. An assessment of the usefulness of 5-hydroxytryptophan as an optical probe. Jayanti Guharay, **Bidisa Sengupta** and Pradeep K. Sengupta, *Spectrochim. Acta Part A (Biomolecular Spectroscopy Section)*, 54 (1998) 185 - 190.

Selected Conferences attended for invited lectures, and oral presentations:

- i. Mississippi Academy of Science 2012-2018
- ii. Southern Biomedical Engineering Conference 2017
- iii. ACS meeting 2011, 2012, 2013
- iv. I-APS meeting 2014, 2015
- v. MS Biophysics Consortium, 2014, 2018.
- vi. 14th Southern School on Computational Chemistry and Material Science, 2014-2016.
- vii. MS-EPSCoR meeting at USM April, 2013, 2014

Peer Reviewer of International Journals:

- i) Journal of Luminescence, Journal of Photochemistry and Photobiology B., International Journal of Biological Macromolecules, The Protein Journal, Journal of Physical Chemistry, Spectrochimica Acta, Luminescence: The Journal of Biological and Chemical Luminescence,
- ii) Journal of Molecular Structure, RSC Advances, Analytical letters, Molecules.

Honors and Awards:

2004	Research Fellowship, Swedish Foundation
2012	Travel Award for International Collaborations, AAAS
2014	Inclusion, Marquis Who's Who in Science and Engineering
2015	Hendrick Vanguard Award for excellence in Teaching, Tougaloo College
2017	Received full Travel Award from ASM to judge Research Presentations at ABRCMS 2017.

- 2017 Research highlighted in local newspaper, 'Mississippi Link'.
 2018 Received "The Higher Education Appreciation Day, Working for Academic Excellence (HEADWAE)" award, by the State of Mississippi.

Review panelist

- Selected for the 2018 NSF Graduate Research Fellowship Program (GRFP) for Chemistry.
- Selected for the 2018 National Defense Science and Engineering Graduate (NDSEG) Fellowship.

Teaching Experience:

January 2011-present Teaching Organic Chemistry I, II, laboratory, Biochemistry with laboratory, Senior Seminar, Instrumental Analysis, Introduction to Chemistry courses.

2006-2010 Supervised undergraduate and M.S. Students in the daily research work in the laboratory of Prof. Jeffrey T. Petty, at Furman University.

2001-2004 Teaching and conduction of practical course works of post-M.Sc. (Bioscience) students of SINP, Kolkata, and project works of short term visiting students from universities (of both undergraduate and postgraduate levels), in the laboratory of Prof. P. K. Sengupta, at Biophysics Division, SINP, Kolkata.

2000 Part time honorary lecturer of the biophysical and molecular biological courses of Microbiology at R.G. Surendranath College, Kolkata, India.

Membership of Professional Association:

1. American Association for the Advancement of Sciences (AAAS)
2. Indian Biophysical Society (IBS) Life Member
3. Indian Society for Radiation and Photochemical Sciences (ISRAPS) Life Member
4. American Chemical Society (ACS)
5. Sigma Xi
6. Mississippi Academy of Sciences Life Member

Research Support

Ongoing Research Support

- **MS-INBRE seed grant award**

Source: IDEA / NIH / NIGMS (P20GM103476)

Seed grant project title: Exploring the structure-activity relationship of plant flavonoids against stress induced modifications in cancer and neuronal cells using biophysical and molecular modeling approaches

Award Area: Biomedical Research Funding, **\$90,400.00** (6/01/2017-05/31/18), Location: Tougaloo College, MS

- **Research Initiation award, NSF, \$299,714**, (April 2018 - April 2021) (PI).

Title: RIA: Determining the Roles of Cytoskeletal Proteins in the Fibrillation of Amyloid beta-Peptides in the presence of Tryptamines and Flavones.

- **Target Infusion Proposal, NSF, \$400,000**, (May 2018 - May 2020) (Co-PI)

Title: Infusion of POGIL, Technology and Research into the Chemistry Curriculum to Increase Students' Success.

Completed Research Support

Proposal Title: Research Infrastructure in Minority Institutions at Tougaloo College

Source of Support: NIH, RFA-MD-05-004, Department of Health and Human Services. 1P20MD002725,

Role: PI of Subproject, Support: (Aug 2012-July 2013)

Title of subproject: Prospects of flavonoids as drugs for cancers: Studies using optical spectroscopy, chromatography and molecular modeling.

Total Award Period Covered: \$12167, Location of Project: Tougaloo College, MS

Seed Grant Award

Proposal Title: Creating leaders in Scientific Research and medicine: A professional learning community approach

Source of Support : Howard Hughes Medical Institute

Grant # 52007562, Role: PI of Subproject

Support: Jan 2013-May 2013

Seed grant Title: Applications of plant flavonoids against Alzheimer's disease,

Total Award Period Covered: \$23,200, Location of Project: Tougaloo College, MS

Travel Award

Proposal Title: Initiation for International Collaboration for undergraduate research at Minority Serving Institution for Women Scientists

Source of Support: American Association for Advancement of Science, WIRC, funded by NSF
Bidisha Sengupta (PI)

Project Title: Mechanistic studies on the interactions of polyphenols with their physiological targets: Exploitations of Optical Spectroscopy, Calorimetry and Microscopy

Total Award Period Covered: \$20,000, 11/2012- 11/2013, Location of Project: Tougaloo College, MS.

NSF-MS-EPSCoR

Proposal Title: DNA-Based Nanotechnology in Mississippi: a Doorway to Growing Nanotechnology within the State

Seed grant project title: Plant flavonoids that stabilize unusual DNA motifs in gene promoters: a computational and experimental study

Grant # MS- EPS-0903787, Bidisha Sengupta, (PI, subproject)

Award area: Computational Chemistry,

Total award and period covered: \$60,000 (6/1/2012-12/31/16), Location of Project: Tougaloo College, MS.

MS-INBRE seed grant award

Source: IDEA / NIH / NIGMS (P20GM103476)

Seed grant project title: Exploring the structure-activity relationship of plant flavonoids against stress induced modifications in cancer and neuronal cells using biophysical and molecular modeling approaches

Award Area: Biomedical Research Funding

Total award and period covered: \$200,000.00 (6/01/2013-05/31/17), Location of Project: Tougaloo College, MS.

Research Areas:

1. *Studies on the antioxidative properties of plant flavonoids in preventing oxidative stress in biological systems including macromolecules (DNA, peptides), mammalian cells (cancer, lymphoblast cells):*

Flavonoids are polyhydroxy phenolic compounds which are ubiquitously present in fruits and vegetables like apples, grapes, onions, oranges etc. and are gradually emerging as potent therapeutic drugs effective against a wide range of free radical mediated diseases e.g. atherosclerosis, ischemia, diabetes, neuronal degeneration, cardiovascular disorders, cancer. Flavonoids usually contain one or more aromatic hydroxyl groups, which actively scavenge free radicals and are responsible for the antioxidant activity. We are studying the structural variations of protein and DNA which occur by glycation / glycosylation in presence of sugars, as a model of diabetes mellitus. We use spectroscopic, chromatographic and related biophysical techniques in order to prove that plant flavonoids are potent antioxidants to prevent this oxidative glycation in DNA / proteins. We have initiated studies on amyloid beta peptide folding in the presence of tryptamines and flavones.

We have fruitfully exploited the exquisitely sensitive intrinsic fluorescence emission properties of plant flavonoids which possess potential anti-oxidant, anti-cancer, anti-AIDS and other important therapeutic properties with high potency and low systematic toxicity, to explore their interactions with physiologically relevant targets viz proteins, amyloid peptides, DNA, biomembranes and encapsulation in nano-cavities of cyclodextrin based drug delivery vehicles. We found that the flavonoid molecules bind with two distinct sites in human serum albumin, while in membranes they are localized at the interfacial regions. Flavonoids are found to intercalate in DNA. Such works would lead to new avenues for examining 'structure-activity' relationships and 'screening' of flavonoid derivatives with desired therapeutic properties and also provide insights toward future goals for developing effective drug delivery strategies.

2. *DNA Templates for Fluorescent Silver Clusters:*

We are involved in the development of novel nonmaterial's, which are very useful in bio imaging. Silver nanoclusters are a new class of fluorescent labels in biology. I am studying the properties of different sequences of DNA encapsulated, brightly fluorescing photo-activated silver nanoclusters that have much brighter and more robust emission than organic dye molecules. These highly bright, robust nanomaterials should enable direct labeling of proteins to image live cells, study protein-protein interactions, and potentially help to observe individual proteins as they fold to their native conformations. We observed that the secondary and tertiary structure of DNA play an important role in deciphering the emission characteristics of the silver clusters. At neutral or slightly acidic pH cytosine rich DNA folds in unusual non-Watson Crick manner called i-motif, which is found to be important in controlling the size of the silver cluster. We have fruitfully used the nanoclusters in preventing bacterial biofilms. Further studies are underway.