# Investigation on the interaction of dietary phenolic acids and their derivatives with biologically significant molecules: A multi spectroscopic analysis

Thesis submitted for the partial fulfillment of the requirements for the degree

Doctor of Philosophy in Science

by

**Prasenjit Mondal**

*Under the Supervision of*

**Dr. Adity Bose**

Department of Chemistry

Faculty of Natural and Mathematical Sciences

Presidency University

Kolkata, India

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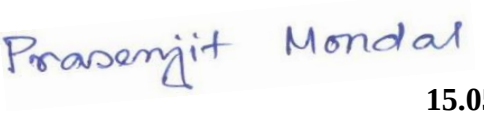
**Thesis Title:** Investigation on the interaction of dietary phenolic acids and their derivatives with biologically significant molecules: A multi spectroscopic analysis

**Name of the Candidate:** Prasenjit Mondal

**Registration Number:** R-17RS205120098

**Date of Registration:** 10/07/2018

**Department:** Department of Chemistry

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"NEVER THINK YOU KNOW EVERYTHING…

ALWAYS TRY TO LEARN MORE"

# DEDICATED
# TO
# MY PARENTS

# ACKNOWLEDGEMENTS

*Preparing a Ph.D. thesis is a collaborative effort that involves multiple people, all of whom I would like to express my gratitude to.*

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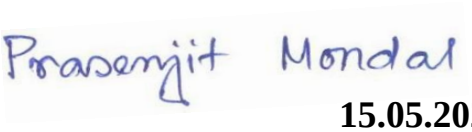
*Finally, this thesis is intended to honor them, the most significant individuals in my life.*



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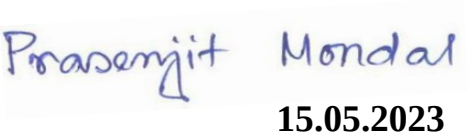
# DECLARATION

I hereby declare that this thesis contains original research work carried out by me under the guidance of Dr. Adity Bose, Assistant Prof. in Chemistry, Department of Chemistry, Presidency University, Kolkata, India as part of the Ph.D. programme.

All information in this document have been obtained and presented in accordance with academic rules and ethical conduct.

I also declare that, as required by these rules and conduct, I have fully cited and referenced all materials and results that are not original to this work.

I also declare that, this work has not been submitted for any degree either in part or in full to any other institute or University before.



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PRESIDENCY UNIVERSITY
KOLKATA

# Presidency University

Hindoo College (1817-1855), Presidency College (1855-2010)

## CERTIFICATE

This is to certify that the thesis entitled **"*Investigation on the interaction of dietary phenolic acids and their derivatives with biologically significant molecules: A multi spectroscopic analysis*"** submitted by Shri Prasenjit Mondal, Registration Number R-17RS205120098 and date of registration 10/07/2018, in partial fulfilment of the requirements for the award of "Doctor of Philosophy", is a record of bonafide research work carried out by him under my supervision. Neither his thesis nor any part of the thesis has been submitted for any degree/diploma or any other academic award anywhere before.

Date: 15.05.2023

Adity Bose
15.05.2023

Dr. Adity Bose
Assistant Professor
Department of Chemistry
Presidency University, Kolkata - 700 073

Place: Kolkata

Signature of the Supervisor with date and official stamp

Dr. ADITY BOSE



86/1, College Street, Kolkata - 700 073, Phone : (033) 2241 1960, Fax : (033) 2241 2738

# List of Publications

1. ***Mondal, P.,*** and Bose, A., 2019. Spectroscopic overview of quercetin and its Cu (II) complex interaction with serum albumins. BioImpacts: BI, 9, 115.
2. ***Mondal, P.,*** Sengupta, P., Pal, U., Saha, S. and Bose, A., 2021. Biophysical and theoretical studies of the interaction between a bioactive compound 3, 5-dimethoxy-4-hydroxycinnamic acid with calf thymus DNA. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 245, 118936.
3. ***Mondol, P.,*** Bose, A. and Chanda, S., 2022. Evaluation of Sinapic acid to ameliorate ionizing radiation induced peripheral blood mononuclear cell death. Stem Cell Research International, 5, 34.
4. ***Mondal, P.,*** Singh, P., Morgan, D., Bose, A. and Sen, K., 2022. Ni-sinapic acid nanocomposite in the selective sensing of permanganate ions. Journal of Photochemistry and Photobiology A: Chemistry, 437, 114458.

## Other publications

1. Sengupta, P., Pal, U., ***Mondal, P.*** and Bose, A., 2019. Multi-spectroscopic and computational evaluation on the binding of sinapic acid and its Cu (II) complex with bovine serum albumin. Food chemistry, 301, 125254.
2. Sengupta, P., ***Mondal, P.,*** Mukherjee, S., Chanda, S. and Bose, A., 2020. Rutin-serum albumin interaction in different media and its effective dose selection in radiation-induced cytotoxicity on human blood cells. Journal of Herbal Medicine, 21, 100322.
3. Sengupta, P., Bhattacharya, S., Das, D., ***Mondal, P***., Sur, R., Bose, A. and Sen, K., 2023. Milk protein micellization for encapsulation of dietary polyphenol rutin for enhanced bioaccessibility and sustained release. International Journal of Biological Macromolecules, (Communicated).

## Manuscripts under preparation

1. ***Mondal, P.,*** Sengupta, P., and Bose, A., Spectroscopic overview of gallic acid and ct-DNA.
2. ***Mondal, P.,*** Sengupta, P., and Bose, A., Beta-casein as an encapsulation tool for a bioactive flavonoid: Interactions and effect on bio-efficacies.

# National & International Seminar

- Research paper presented for the poster presentation on **8-9th January, 2020,** in Two-Day **International Seminar** on "Innovation, Expansion, Impacts and Challenges in Chemical and Biological Sciences," organized by Department of Chemistry, Surendranath College, Kolkata, India.

- Research paper presented for the poster presentation on **December 23-24, 2019** in **4th Regional Science and Technology Congress (Southern Region),** jointly organized by Department of Science and Technology and Bio-Technology, Government of West Bengal & Maulana Abul Kalam Azad University of Technology, West Bengal at Haringhata, Nadia.

- Research paper presented for the poster presentation in the **Frontiers in Modern Biology (FIMB) 2018** organized by the department of Biological sciences, Indian Institute of Science Education and Research Kolkata, Mohanpur Campus, India, between **January 19-21, 2018**.

# List of Abbreviations

| | | |
|---|---|---|
| Å | : | Angstrom |
| ABTS | : | 2,2’ azinobis-3 ethylbenzothiazoline-6-sulfonic acid |
| Ac | : | Acetyl group |
| aq | : | Aqueous |
| Ar | : | Aromatic group |
| b.p. | : | Boiling Point |
| β-CN | : | Beta Casein |
| BSA | : | Bovine serum albumin |
| conc. | : | Concentration |
| cm | : | Centimeter |
| $cm^{-1}$ | : | Wavenumbers (IR/UV spectroscopy) |
| °C | : | Degree Celsius |
| cal | : | calorie |
| CD | : | Circular Dichroism |
| ct-DNA | : | Calf thymus DNA |
| DMSO | : | Dimethyl Sulfoxide |
| deg | : | Degree (°) |
| DLS | : | Dynamic light scattering |
| DSC | : | Differential scanning calorimetrie |
| DNA | : | Deoxyribonucleic acid |
| DPPH | : | 2,2-diphenyl-1-picrylhydrazyl |
| EtBr | : | Ethidium bromide |
| eV | : | Electron volt |
| EtOH | : | Ethanol |
| EDTA | : | Ethylenediaminetetraacetic acid |
| FTIR | : | Fourier transform infrared |
| GA | : | Gallic acid |

| | | |
|---|---|---|
| HSA | : | Human serum albumin |
| HCl | : | Hydrochloric acid |
| ITC | : | Isothermal titration calorimetry |
| KI | : | Potassium Iodide |
| K | : | Kelvin |
| kcal | : | Kilocalorie |
| KBr | : | Potassium bromide |
| kV | : | kilovolt |
| LDH | : | Lactate Dehydrogenase |
| L | : | Litre |
| g | : | gram |
| h/hr | : | hour(s) |
| hν | : | quantum of light/photon |
| Hz | : | Hertz (cycles per second) |
| M | : | concentration in mol/$dm^3$ (c) |
| Me | : | methyl group |
| MeOH | : | methanol |
| mg | : | Miligrams |
| µM | : | Micromolar |
| µg | : | Microgram |
| µl | : | Microlitre |
| µm | : | micrometre |
| mM | : | Milimolar |
| M | : | Mole |
| mol | : | Mole |
| mA | : | Milliampere |
| ml | : | Millilitre |
| MHz | : | Mega Hertz |
| MIC | : | Minimum inhibitory concentration |

| | | |
|---|---|---|
| MTT | : | (3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide) |
| min | : | Minute |
| mJ | | MilliJoule |
| NMR | : | Nuclear magnetic resonance |
| NOS | : | Nitric oxide synthase |
| nM | : | Nanomolar |
| nm | : | Nanometer |
| NPs | : | Nanoparticles |
| PEG-4000 | : | Polyethylene glycol 4000 |
| PXRD | : | Powder X-ray diffraction |
| PBS | : | Phosphate buffer solution |
| PBMC | : | Peripheral blood mononuclear cells |
| PAs | : | Phenolic acids |
| PCs | : | Phenolic compounds |
| pmole | : | Picomoles |
| rpm | : | Revolutions per minute |
| ROS | : | Reactive oxygen species |
| SA | : | Sinapic acid |
| SEM | : | Scanning electron microscopy |
| SAA | : | Serum amyloid A |
| Tris | : | tris(hydroxymethyl)aminomethane |
| TEM | : | Transmission electron microscopy |
| T | : | Temperature |
| Trp | : | Tryptophan |
| Tyr | : | Tyrosine |
| UV-Vis | : | Ultraviolet-visible |
| UV | : | Ultraviolet |
| XPS | : | X-ray photoelectron spectroscopy |

# List of Figures

**Chapter 3B**

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**Chapter 5**



**Chapter 6**