



Government of West Bengal
Office of the Principal
Darjeeling Government College
Darjeeling-734 101, West Bengal, INDIA

Phone / Fax: (0354) 2254078
(0354) 2254019
Email : dgc.principal@gmail.com

Criteria 3 - Research, Innovations and Extension

3.5.1. Number of functional MoUs/linkages with institutions/ industries in India and abroad for internship, on-the-job training, project work, student / faculty exchange and collaborative research during the last five years

Collaborative Research Activities Index:

Sr. No	Name of the institution / industry with whom the Collaborative Research with contact details	Name of the Activity	Page No.
1	Indian Institute of Tropical Meteorology (An Autonomous Institute of the Ministry of Earth Sciences, Government of India) Dr. Homi Bhabha Road, Pune 411 008, India	Collaborative Research Activity	3
2	Burdwan University, Burdwan, 713104, W.B. India.	Collaborative Research Activity	4-5
3	Chemical Signal and Lipidomics Laboratory, Department of Botany, Centre of Advanced Study, University of Calcutta, Kolkata, 700019, India	Collaborative Research Activity	6-7
4	Dept. of Botany, Saldiha College, Saldiha-722 173, Bankura, West Bengal, India.	Collaborative Research Activity	
5	Dept. of Zoology, School of Life Sciences, Sikkim University, Gangtok, Sikkim-737 102.	Collaborative Research Activity	8-9
6	Department of Chemistry, Jadavpur University, Jadavpur, Kolkata 700032, India	Collaborative Research Activity	10-13
7	Dept. of Geography and Environment Management, Vidyasagar University, Medinipur, W. B. 721102, India.	Collaborative Research Activity	14
8	Department of Botany, Govt. General Degree College, Keshiary, Tilaboni-Mahisamura, Paschim Midnapur-721135.	Collaborative Research Activity	15
9	Department of Tea Science, North Bengal University, Darjeeling- 734013, West Bengal, India	Collaborative Research Activity	16-18
10	Department of Physics, Aliah University, Newtown Campus, Kolkata - 700156, India.	Collaborative Research Activity	19-20
11	Dept. of Geography, University of Gour Banga, Malda, West Bengal, India	Collaborative Research Activity	21-23
12	Variable Energy Cyclotron Centre, 1/AF Bidhan Nagar, Kolkata 700064, India.	Collaborative Research Activity	24


Officer-in-Charge
D, Darjeeling Govt. College





Government of West Bengal
Office of the Principal
Darjeeling Government College
Darjeeling-734 101, West Bengal, INDIA

Phone / Fax: (0354) 2254078
(0354) 2254019
Email : dgc.principal@gmail.com

Sr. No	Name of the institution / industry with whom the Collaborative Research with contact details	Name of the Activity	Page No.
13	Dept. of Chemistry, University of Kalyani, Kalyani 741235, India and Dept. of Chemistry, JIS College of Engineering, Kalyani 741235, India	Collaborative Research Activity	25-26
14	Department of Botany, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh 791112, India.	Collaborative Research Activity	27-28
15	Regional office, Eastern Himalaya-Northeast India, Ashoka Trust for Research in Ecology and the Environment, Gangtok, Sikkim, India.	Collaborative Research Activity	29
16	Ecology and Toxicology Laboratory, Department of Zoology, University of North Bengal, Darjeeling- 734013, West Bengal, India.	Collaborative Research Activity	30

Principal / Officer-in-Charge
Darjeeling Government College
Officer-in-Charge
Darjeeling Govt. College



Officer-in-Charge
D, Darjeeling Govt. College





Government of West Bengal
Office of the Principal
Darjeeling Government College
Darjeeling-734 101, West Bengal, INDIA

Phone / Fax: (0354) 2254078
(0354) 2254019
Email : dgc.principal@gmail.com

1. Collaborative Research Activities of by **Dr. Sonam Lama**, Assistant Professor in Geography with **Indian Institute of Tropical Meteorology** (An Autonomous Institute of the Ministry of Earth Sciences, Government of India) Dr. Homi Bhabha Road, Pune 411 008, India.



भारतीय उष्णदेशीय मौसम विज्ञान संस्थान
(पृथ्वी विज्ञान मंत्रालय का एक स्वायत्त संस्थान, भारत सरकार के अधीन)
डा. होमी भाभा मार्ग, पुणे ४११ ००८

INDIAN INSTITUTE OF TROPICAL METEOROLOGY
(An Autonomous Institute of the Ministry of Earth Sciences, Government of India)
Dr. Homi Bhabha Road, Pune 411 008, India

Phone: +91-20-2590-4535 • Fax: +91-20-2586 5142 • <http://www.tropmet.res.in> • Email: mujum@tropmet.res.in

CCCR/Rain_Isotope/May/1

Date: 22/05/23

To,
Dr. Projjwal Ch. Lama,
Officer-In-Charge, Darjeeling Govt. College
Richmond Hill, Darjeeling, WB-734101

CC:
Dr. Sonam Lama,
Assistant Professor in Geography,
Darjeeling Govt. College

Sub: Rainwater sample collection for stable isotope analysis

Dear Sir
Indian Institute of Tropical Meteorology, Pune (Ministry of Earth Sciences, Govt. of India) is involved in rainwater collection and its stable isotopic analysis from various locations throughout India. Isotopic analysis of rainwater helps study the hydro-meteorological processes and some aspects of short term monsoon variability.
As per previous interactions with Dr. Sonam Lama it is understood that Darjeeling Govt. College is interested in this project. IITM team would be pleased to involve Darjeeling Govt. College in the said activity.
Please note that all the material required for sample collection (Rain sampler, bottles, Record books etc.) will be provided by IITM. Similarly charges for dispatching samples will be borne by IITM. Due credit in the form of authorship in relevant publications will be given to Dr. Sonam Lama. Other details regarding observations and further research work will be discussed later.

Looking forward to a fruitful collaboration

Thanking You

Sincerely Yours

मिलिन्क मुजुमकार
Dr. Milind Mujumdar
Scientist-F, In charge- Metflux Project
Mo. 9921001064

Officer-in-Charge
D, Darjeeling Govt. College





2. Collaborative Research Activities of by Mr. Samir Halder, Assistant Professor in Botany, Darjeeling Govt. College with Burdwan University, Burdwan, 713104, W.B. India.

Kundu et al., IJPSR, 2018; Vol. 9(12): 5294-5300.

E-ISSN: 0975-8232; P-ISSN: 2320-5148

IJPSR (2018), Volume 9, Issue 12

(Research Article)



INTERNATIONAL
OF
PHARMACEUTICAL SCIENCES
AND
RESEARCH



Received on 24 March, 2018; received in revised form, 18 June, 2018; accepted, 02 July, 2018; published 01 December, 2018

SALICYLIC ACID-INDUCED MODULATION OF GROWTH AND METABOLISM OF A MEDICINAL PLANT *MENTHA SPICATA* L.

M. Kundu¹, S. Halder² and A. Bhattacharjee^{*1}

Plant Physiology and Biochemistry Section¹, UGC Centre for Advanced Study, Department of Botany, Burdwan University, Burdwan - 713104, West Bengal, India.

PG Department of Botany², Darjeeling Government College, Darjeeling - 734101, West Bengal, India.

Keywords:

Salicylic acid,
Plant growth regulator, Medicinal
plant, *Mentha spicata*, Antioxidants,
Growth and biochemical attributes

Correspondence to Author:

Prof. Aloke Bhattacharjee

Professor,

Plant Physiology and Biochemistry
Section, UGC Centre for Advanced
Study, Department of Botany, Burdwan
University, Burdwan - 713104,
West Bengal, India.

E-mail: alokebc@yahoo.co.in

ABSTRACT: Salicylic acid is a phenolic plant growth regulator found in plants with various important physiological roles. This investigation was aimed to study the effect of exogenous application of salicylic acid on the growth, metabolism and health status of *Mentha spicata*, an aromatic medicinal plant having several monoterpenes and antioxidants which show various kinds of medicinal properties. In the present work, some growth and biochemical parameters were recorded at 30 and 60 days after treatment with different concentrations of salicylic acid (0, 100, 200 and 300 µg ml⁻¹). Results clearly revealed that salicylic acid particularly at 200 µg ml⁻¹ concentration significantly enhanced most of the growth and some of the biochemical attributes as well as the antioxidant property when compared with that of control plants. It can be concluded that exogenously applied salicylic acid at particular doses can enhance the biomass production as well as the medicinal potential of *M. spicata* as evidenced from some reliable physiobiochemical parameters.

INTRODUCTION: First and certainly the oldest system of human health care is herbal medicine. Herbs are used for the treatment of human ailments by almost all civilizations and cultures. In recent years, both in developed and developing countries, the demand of medicinal plants has increased rapidly. Mint (*M. spicata*) is one of the most commonly used essential oil bearing medicinal herbs. India is the largest mint oil producer, with an annual production of essential oil of 15,000 - 20,000 tons¹. The genus *Mentha* under the family Lamiaceae includes 18 species and 11 named hybrids².

Plant extracts of mint species are used in cosmetic industry, food industry, pharmaceutical industry and are generally considered safe to use^{3, 4, 5}. This plant especially the leaves contains several monoterpenes including menthol, and carvone is the main volatile component⁶. Various kinds of medicinal properties of this plant include: carminative, antispasmodic, anti-vomiting, anti-hysterical, anti-irritant, antibronchitis, antioxidative, antifungal action etc.

The plant needs profuse foliar biomass production for utilizing this biomass as potential source of essential oil which are mainly used for treatment of various human-ailments. Like some traditional growth regulators, salicylic acid (SA), an established non-traditional plant growth regulator (NTPGR) is reported to enhance the biomass production as well as to increase the quality of essential oil in plants^{7, 8, 9}.

<p>QUICK RESPONSE CODE</p> 	<p>DOI: 10.13040/IJPSR.0975-8232.9(12).5294-00</p> <p>Article can be accessed online on: www.ijpsr.com</p> <p>DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.9(12).5294-00</p>
--	---



E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 2293-2299
Received: 03-01-2018
Accepted: 04-02-2018

Samir Halder
Post-graduate Department of
Botany, Darjeeling Government
College, Darjeeling, West Bengal,
India

Moitreyee Kundu
Plant Physiology and
Biochemistry Section, UGC
Centre for Advanced Study,
Department of Botany, The
University of Burdwan,
Burdwan, West Bengal, India

Aloke Bhattacharjee
Plant Physiology and
Biochemistry Section, UGC
Centre for Advanced Study,
Department of Botany, The
University of Burdwan,
Burdwan, West Bengal, India

Correspondence
Aloke Bhattacharjee
Plant Physiology and
Biochemistry Section, UGC
Centre for Advanced Study,
Department of Botany, The
University of Burdwan,
Burdwan, West Bengal, India

Paclobutrazol-induced augmented productivity of an endangered medicinal plant safed musli (*Chlorophytum borivilianum* Sant. et Fernand.)

Samir Halder, Moitreyee Kundu and Alope Bhattacharjee

Abstract

In the present investigation an attempt was made to improve productivity of safed musli by using paclobutrazol (PBZ), a potent growth regulating chemical having promising influence on tuber yield. Foliar application with 100 and 200 $\mu\text{g ml}^{-1}$ of PBZ was found to improve plant potential of safed musli and this was measured in terms of some reliable physio-biochemical parameters along with some selective yield attributes. Our results showed that the foliar application of PBZ reduced plant height, increased number of branches and leaves per plant. PBZ-induced enhanced growth parameters were associated with augmented metabolic status of the plant species as evidenced from higher chlorophyll and protein contents, significantly enhanced catalase along with reduced protease activities in leaves. The positive influence of PBZ was also recorded from the yield attributes as evidenced from the increased number and fresh weight of tubers per plant as well as length and circumference of the tubers, in comparison to control ones. Thus, it can be concluded that the PBZ may be used as a potent chemical for augmented productivity of this high-value endangered plant.

Keywords: *Chlorophytum borivilianum*, safed musli, paclobutrazol, physiochemical changes, productivity

Introduction

The genus *Chlorophytum* Ker Gawl., under the family Asparagaceae (formerly in family Liliaceae), includes more than 215 species, 6 subspecies and 8 varieties which are distributed throughout the tropical and subtropical parts of the world [1]. In India the genus is represented by 21 species among which 2 are ornamental plants, 18 are strictly wild and only *Chlorophytum borivilianum* is wild as well as cultivated as medicinal plant.

Fleshy tubers of *C. borivilianum* are used in Ayurvedic medicines and widely used as a natural sex tonic and is an integral part of more than 100 herbal drug formulation [2]. Their aphrodisiac properties have proved very much useful for the people suffering from erectile dysfunction. Drugs prepared from safed musli are potential enough to increase general body immunity, curative of natal and post-natal problems, increase working capacity, delay aging process, possess anti-inflammatory and anti-oxidant activity. It is also useful in rheumatoid arthritis, diabetes mellitus and post-menopausal syndrome [3-4]. At present, the estimated global demand of safed musli is approximately 40,000 tons per year but current production is 5500 tons per year only [5]. Its huge demand and inadequate supply, makes it a very costly herb. The Department of Indian System of Medicines and Homoeopathy, Ministry of Health and Family welfare, National Medicinal Plants Board (NMPB) identified safed musli as a high value and high demand medicinal crop, and thus it is rightly called the 'root of gold'. NMPB, New Delhi also identified safed musli as the sixth important herb among 28 medicinal plants to be protected, promoted and preserved. Keeping these in mind an attempt was made to undertake a comprehensive research work to address the problems of safed musli in our laboratory and agricultural field, and the present communication deals with the efficacy of a potent PGR paclobutrazol (PBZ) on augmentation of its tuber productivity.

Paclobutrazol (2RS, 3RS)-1-(4-chlorophenyl)-4, 4-dimethyl-2-(1H-1, 2, 4-triazol-1-yl)-pentan-3-ol] is a triazolic group of plant growth regulator. The growth regulating properties of paclobutrazol are mediated by reduced stem elongation [6], increasing root length and diameter as well as dry matter accumulation [7]. Reduced stem elongation may be due to inhibitory effect of paclobutrazol on oxidative reactions of gibberellins biosynthesis [8]. Paclobutrazol also can influence the chlorophyll biosynthesis, delay the senescence and prolong the metabolic activity of many plants [9].

As the global demand of safed musli is increasing day by day and it is depleting rapidly from the Indian forests conservation, mainstream cultivation in different agroclimatic zones of India

Officer-in-Charge
D1 Darjeeling Govt. College





3. Collaborative Research Activities of by Souvik Mitra, Assistant Professor in Botany, Darjeeling Govt. College with Chemical Signal and Lipidomics Laboratory, Department of Botany, Centre of Advanced Study, University of Calcutta, Kolkata, 700019, India.

Lipids (2018)
DOI 10.1002/lipd.12054



COMMUNICATION

“Dicranin” in the Membrane Phospholipids of a Dicranaceae and Pottiaceae Moss Member of the Eastern Himalayan Biodiversity Hotspot

Sumedha Roy Chowdhuri¹ · Anashuya Biswas Raha¹ · Souvik Mitra² · Jayashree Datta¹ · Mousumi Poddar Sarkar¹

Received: 12 February 2018 / Revised: 19 May 2018 / Accepted: 5 June 2018
© 2018 AOCS

Abstract The phospholipids of two moss samples *Oreoweisia laxifolia* (Hookf.) Kindb. (family-Dicranaceae Schimp.) and *Leptodontium viticulosoides* (P. Beauv.) Wijk & Margad (family-Pottiaceae Schimp.) of the Eastern Himalayan Biodiversity Hotspot were investigated to find out any peculiarity in their fatty acid profiles. Detailed analysis of phospholipid classes and the respective fatty acids was performed using high-performance thin-layer chromatography and gas chromatography-mass spectrometry. An array of different saturated and unsaturated fatty acids were detected in both the samples. Although it has been proposed previously that acetylenic fatty acids are associated only with triacylglycerol of storage lipids, the most striking observation of the present investigation is the abundance of an acetylenic fatty acid, octadeca-6-yn-9,12,15-trienoic acid (18:4a), or Dicranin, in the phospholipids of both the mosses. The position of the triple bond in the hydrocarbon chain of the fatty acids was confirmed by dimethylloxazoline derivatization of fatty acids and their characteristic mass fragmentation pattern. The occurrence of Dicranin in phospholipids and in the Pottiaceae family is reported for the first time, with substantial explanations of the observed

results. This may raise the issue of rethinking “Dicranin” as a chemotaxonomic marker of Dicranaceae.

Keywords Acetylenic fatty acids · Dicranin · Eastern Himalaya · Gas chromatography–mass spectrometry · *Leptodontium viticulosoides* · Moss · *Oreoweisia laxifolia* · Phospholipids

Lipids (2018).

Abbreviations

AFA	acetylenic fatty acid(s)
DMOX	dimethylloxazoline
FA	fatty acid(s)
FAME	fatty acid methyl ester(s)
GC–MS	gas chromatography–mass spectrometry
Gro3P	glycerol-3-phosphate
HP-TLC	high-performance thin-layer chromatography
NL	neutral lipid(s)
PL	polar lipid(s)
PtdCho	phosphatidylcholine
PtdEtn	phosphatidylethanolamine
PtdIns	phosphatidylinositol
PUFA	polyunsaturated fatty acid(s)
TLC	thin-layer chromatography

Supporting information Additional supporting information may be found online in the Supporting Information section at the end of the article.

✉ Mousumi Poddar Sarkar
mousumpsarkar1@gmail.com

¹ Chemical Signal and Lipidomics Laboratory, Department of Botany, Centre of Advanced Study, University of Calcutta, 35, Ballygunge Circular Road, Kolkata, 700019, India

² Department of Botany, Darjeeling Government College, Leborg Cart Rd, Richmond Hill, Darjeeling, 734101, India

Introduction

Mosses, a member of the bryophyte group of plants, have been under scrutiny for their heterogeneous fatty acid (FA) content in both membrane polar lipid (PL) and storage neutral lipid (NL) fractions. A progressive study on lipids and FA of different plant groups, including mosses had

Officer-in-Charge
D₁ Darjeeling Govt. College





Ecological Impact on Fatty Acid Composition of Mosses from Two Biodiversity Hotspots of Hungary and India

Anashuya Biswas-Raha¹ · Souvik Mitra² · Mousumi Poddar Sarkar¹

Received: 2 August 2018 / Revised: 14 January 2019 / Accepted: 1 February 2019
© The National Academy of Sciences, India 2019

Abstract Mosses, the pioneer member among the terrestrial plants, acquired remarkable adaptive advantages for their habitat transition and thus enjoy a global distribution even under diverse ecological conditions. Lipids are assumed to play a significant role in the development of various adaptive strategies that favour evolution. The present paper is an attempt to understand the possible reorientation of fatty acid machinery by the cellular system of the mosses that can be relevant in view of their eco-geographical diversity and distribution. Six abundant mosses were collected from dry, low lands of Hungarian plain, and six representative species belonging to similar systematic positions were collected from high-altitude, humid places of Eastern Himalayan Biodiversity Hotspot depending on

their availability for experimentation. Total lipids of the plant samples were extracted, and the fatty acid compositions were analysed using gas chromatography–mass spectrometry and gas chromatography–flame ionizing detector. Chemical analyses revealed a diverse array of saturated, monounsaturated, long-chain polyunsaturated fatty acids in Eastern Himalayan mosses but abundance of saturated fatty acids in Hungarian mosses. One-way analysis of variance and principal component analysis based on various parameters of total fatty acid fingerprints clearly distinguished these two groups of mosses. Thus, this investigation concluded that fatty acid dynamicity has a possible role for adaptation of mosses under different climatic conditions.

Significance Statement This investigation explores the adaptive strategy in mosses, grown in two different ecology and climatic conditions of two biodiversity hotspots at Hungary and India. It was a part of an initiative for conservation of bryophytes under the aegis of “8th European Committee for Conservation of Bryophytes”, 2012.

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s40011-019-01080-2>) contains supplementary material, which is available to authorized users.

✉ Mousumi Poddar Sarkar
mousumipsarkar1@gmail.com
Anashuya Biswas-Raha
anashuyabiswas88@gmail.com
Souvik Mitra
souvikmitra1687@yahoo.com

- ¹ Chemical Signal and Lipidomics Laboratory, Department of Botany (Centre of Advanced Study), University of Calcutta, 35, Ballygunge Circular Road, Kolkata, West Bengal 700019, India
- ² Post Graduate Department of Botany, Darjeeling Government College, Darjeeling, West Bengal 734101, India

Keywords Hungary (H) · Eastern Himalayas (EH) · Moss · Gas chromatography–mass spectrometry (GCMS) · Fatty acid signature · Principal component analysis (PCA)

Introduction

Mosses, the amphibian members of the plant kingdom, are known to economize their resources in order to acclimatize under different ecological and environmental conditions, thereby efficiently perpetuating even under acute environmental stress [1, 2]. Mosses, with their poikilohydric nature, simplicity in tissue structure and efficient osmoregulatory mechanism, gained adaptive advantage over desiccation tolerance and in their transition from aquatic to terrestrial habitat [3]. Thus, mosses underwent preferential selection even under extreme climatic conditions to spread over a diverse range of habitats throughout the Universe from desert to alpine, tropic to temperate, arctic to antarctic. Moreover, owing to their pioneer status



4. Collaborative Research Activities of by Mr. Subhojit Ojha, Assistant Professor in Botany, Darjeeling Govt. College with Dept. of Botany, Saldiha College, Saldiha-722 173, Bankura, West Bengal, India.



EFFECT OF CCC AND IAA ON VIABILITY EXTENSION OF LENTIL SEEDS

Subhojit Ojha^{1*}, Chandan Kumar Pati² and Trisha Choudhury³

^{1,3}Plant Physiology and Biochemistry Section, U.G. & P.G. Department of Botany, Darjeeling Govt. College, Darjeeling-734 101, West Bengal, India.

²Department of Botany, Saldiha College, Saldiha-722 173, Bankura, West Bengal, India

*Corresponding Author Email: subhojitojha2014@gmail.com

ABSTRACT

The present investigation was carried out by using two plant growth regulatory substances (PGRs) where one is plant growth promoter (IAA) and one is plant growth retardant (CCC) on lentil seeds to evaluate the efficacy of the chemicals in respect to germinability and metabolism of the experimental seeds. The major problem of the lentil is its poor seed germination capacity under natural condition which leads to impaired plant growth due to loss of seed vigour and viability status. Initially, percentage germination was recorded by using different concentrations of IAA and CCC, where CCC shows inhibitory effect on percentage germination of lentil seeds. Metabolic status of seeds pre-soaked with the CCC shows reduced status of the dehydrogenase activity, amino acid contents and soluble carbohydrate levels of *Lens culinaris*. Thus, PGRs potentially modulate the activities of the beneficial enzymes of the seeds over control samples.

KEY WORDS

CCC, IAA, seed viability, *Lens culinaris*, PGRs, seed germination

INTRODUCTION

In this present investigation, chemical manipulation technique is employed to lentil (*Lens culinaris* L.) seeds by using one growth promoter indole acetic acid (IAA) and one growth retardant chlorocholine chloride (CCC). Lentil seeds exist some problems related to seed germinability, poor seedling establishment and loss of vigour and viability under storage as well as ambient environmental condition. To overcome this impairment of germinability of lentil, growth promoter IAA was employed and growth retardant CCC was treated to the seeds for healthy plant establishment.

Seed vigour and viability is an important index for plant health and thus various physiological and biochemical parameters like percentage germination, TTC stainability, some metabolic status of seeds as well as growth parameters was analysed using chemically hardened lentil seeds. This comprehensive work on chemical-induced modulation of seed vigour and viability status to alleviate the specific problems and

improve metabolic status of seeds leads to enhanced growth of the experimental plant.

In fact, reports available in the literature where growth promoters and retardants potentially enhance productivity of many crop plants (1,2,3,4,5,6). Some reliable physiological and biochemical parameters was critically analysed to get an insight of the metabolic status of seeds which includes free amino acid leaching, soluble carbohydrate level, dehydrogenase activity of lentil by chemically treated seeds. Metabolic status of seeds reveals a clear concept about the efficacy of the chemicals as well as the storage potentiation of seeds in ambient environmental condition.

MATERIALS AND METHODS

Experiments of the present investigation were carried out with the fully viable, freshly harvested lentil seeds (*Lens culinaris* L.) are collected from local market of Darjeeling, West Bengal. The chemical manipulating



E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(4): 3274-3276
Received: 05-05-2018
Accepted: 10-06-2018

Subhojit Ojha
Plant Physiology and
Biochemistry Section, U.G. &
P.G. Department of Botany,
Darjeeling Govt. College,
Darjeeling, West Bengal, India

Chandan Kumar Pati
Department of Botany, Saldaha
College, Saldaha, Bankura, West
Bengal, India

Indira Mondal
Plant Physiology and
Biochemistry Section, U.G. &
P.G. Department of Botany,
Darjeeling Govt. College,
Darjeeling, West Bengal, India

Correspondence
Subhojit Ojha
Plant Physiology and
Biochemistry Section, U.G. &
P.G. Department of Botany,
Darjeeling Govt. College,
Darjeeling, West Bengal, India

Seed potentiation of lentil by herbal manipulation

Subhojit Ojha, Chandan Kumar Pati and Indira Mondal

Abstract

Effect of *Gleichemia* leaves on lentil (*Lens culmaris*) seeds was evaluated by physiological and biochemical approaches. Some reliable indices were taken as the major findings of the experimental plant species. It was concomitant from the detailed experimental results that the concentrations of leaf extracts (1:1 and 1:2) exert positive allelopathic effect. The plant extracts (1:1 and 1:2) of *Gleichemia* reduced the percentage germinability of lentil seeds. The plant extract-induced biochemical changes associated with enhanced leaching of free amino acids and soluble carbohydrate contents followed by reduced insoluble carbohydrates, RNA contents and dehydrogenase enzyme activity from the seed species were also analysed.

Keywords: herbal manipulation, *Gleichemia*, lentil, seed germination, leaf extract

Introduction

In natural or man managed agroecosystems, neighbouring plant sp. may interact with the growth and development of other species. Weeds cause a number of harms in agroecosystems. They are unwanted plants which interfere with agricultural operations, compete with crop plants for light, water, nutrients and space and also reduce crop growth and yield through the release of phytotoxins as leachates, exudates, volatiles and de-composition products (Rice, 1984) [1]. Allelopathy may be explained as "Any process involving secondary metabolites produced by plants, microorganisms, viruses, fungi that influence the growth and development of agricultural and biochemical systems (including animals), including positive and negative effects". It signifies that interacting or inhibition of growth both crop and weed species, by the release of chemicals from plant parts by leaching, root exudation, volatilization residue decomposition and other processes (Molish, 1937) [2]. These interactions are widely known in different groups of plants such as algae, lichens, crops, as well as annual and perennial weeds (Chatterjee *et al.*, 2012; Ojha *et al.*, 2013) [3,4].

In Darjeeling hills, West Bengal, India an abundance of *Gleichemia* sp. found growing on the road side as well as on the hilly area. There are some common indices for evaluating the allelopathic action of plants and plant parts; these include germination behaviour and other physiobiochemical parameters for responses of test species (Dogra *et al.*, 2011) [5].

In the present investigation an attempt was made to assess the herbal potential of *Gleichemia* leaf extracts by using lentil seeds as bioassay materials.

Materials and Methods

Experiments of the present investigation were carried out with fully viable healthy seeds of lentil as the test material. Healthy mature leaves of *Gleichemia* sp. were collected from Darjeeling Govt. College Campus, Darjeeling, W.B. Leaves were detached and washed with distilled water to remove the adherent dust particles. Leaves of *Gleichemia* (500 g) were thoroughly homogenized by mortar and pestle using 250 ml distilled water. The homogenate was strained using fine cloth and then centrifuged at 4000g for 10 minutes. The supernatant was then made up to 500 ml using distilled water and this were considered as 1:1 (w/v) proportion stock solution of leaf extract. From this stock solution another concentration grade in the proportion of 1:2 (w/v) was prepared using distilled water and thus two concentrations of solution were prepared. These two concentration grades of leaf extracts were used for experimental purposes (Maity *et al.*, 2015) [6].

Fully viable 200 g of lentil seeds were surface sterilized with 0.1% HgCl₂ solution for 90 seconds. The seed lots were then separately pre-soaked in this two concentration grades of leaf extracts for 12 hours. From the treated seed samples germination behaviour (percentage and T₅₀ of seed germination), leaching of free amino acids, soluble carbohydrates, insoluble carbohydrates, RNA contents and dehydrogenase activity were recorded.

Officer-in-Charge
D₁ Darjeeling Govt. College





5. Collaborative Research Activities of by **Rewati Pradhan**, Assistant Professor in Zoology, Darjeeling Govt. College with Dept. of Zoology, School of Life Sciences, Sikkim University,, Gangtok, Sikkim-737 102.

JAST ©2018 M.U.C. Women's College, Burdwan ISSN 2395-4353
-a peer reviewed multidisciplinary research journal Vol.-04, Issue-01

ASSESSMENT OF THE EFFECT OF PESTICIDES ON TEA PEST INFESTATION

Kumar Basnet^{1*} and Rewati Pradhan²

¹Department of Zoology, School of Life Sciences, Sikkim University, 5th Mile Tadong, Gangtok, Sikkim - 737 102

²P.G Department of Zoology, Darjeeling Government College, Lebong Cart Road, Darjeeling, West Bengal - 734 101

*kbasnett@rediffmail.com

Abstract: Commercially tea is grown as monoculture plantation across the world. The plantation crop is mostly grown between the latitudes of 41°N to 16°S in as many as 34 countries in over 2.71 million hectares. In India, about 57% of the total states grow tea as an industrial crop, covering an area of about 563.98 thousand hectares, producing about 1208.78 million Kg, providing employment and livelihood to 112,2419 individuals. She is the second highest producer and fourth in export, earning foreign exchequer of 736.42 million USD a year. In the foothills and the plain of northern West Bengal, tea is cultivated in about 1, 22, 620 hectares. About 25% of the total tea produced by India is contributed by the region. Over a thousand species of arthropod pests are known from tea plantations all over the world. A comparative study was done to find out the effect of pesticide application on the infestation of tea by *H. theivora* and *O. coffeae*, the two most common and severe arthropod pests. The result indicates that the exposure to synthetic pesticide leads to a significant reduction in the population of the pest. But there are various reports of development of tolerance in many tea pests against pesticide following extensive application of synthetic pesticides. In view of the rapid development of tolerance, prophylactic and 'no threshold' spray of pesticides should be completely abandoned. Regular monitoring of pesticide tolerance level should be done and choice of the most effective pesticide for management of the pest under IPM is necessary. Pests of the tea plantations in the plains and the foothills of the northern West Bengal may be largely managed if the biocontrol potential of the predatory spiders like *O. javanus* is fully realised, especially in bio-organically managed tea plantations.

Keywords: Tea, *Helopeltis theivora*, *Oligonychus coffeae*, IPM, Pest

INTRODUCTION:

Tea (*Camellia sinensis* L. O. Kuntze) is grown in various parts of the world as monoculture plantation crop in diverse climatic and topographic conditions of the tropical world. Tea grows with great adaptation in areas having annual precipitation between 1,000 and 5,000 mm, in temperature ranging from -8°C to 35°C and at day length varying from 9.4 to 15.0 hours. Tea is commercially grown in the region extending from 41°N to 16°S, in approximately 2.71 million hectares across 34 countries in varied agro-climatic conditions ranging from sea level to 2,300 m amsl in the Himalayas [1,2].

In India, the British colonizers for their irredeemable habit of drinking tea started tea cultivation (Assam variety) as a plantation crop as early as 1830s as an alternative to the lone Chinese source to the United Kingdom. The commercial cultivation was started in 1850s in the hilly terrain of Darjeeling. Today in India, tea is grown in as many as 16 out of 29 (55.17%) states as industrial crop, covering an area of about 563.98 thousand hectares, producing about 1208.78 million Kg, providing employment and livelihood to 112,2419 individuals [3]. Presently, India is the second largest producer, next to China contributing about 24.46% to the world production and fourth largest exporter of tea [3,4] earning foreign

[Article History: Received on 17.08.2018, Accepted on 26.10.2018]

[45]


Officer-in-Charge
D₁ Darjeeling Govt. College





6. Collaborative Research Activities of by **Debraj Saha**, Assistant Professor in Chemistry, Darjeeling Govt. College with Department of Chemistry, **Jadavpur University**, Jadavpur, Kolkata 700032, India.

Quinoline derivative containing monomeric and polymeric metal carboxylates: Synthesis, crystal structure and gas adsorption study over a 2D layered framework

Saikat Gayen[‡], **Debraj Saha^{‡,§}** and Subratanath Koner^{**}

[‡]Department of Chemistry, Jadavpur University, Jadavpur, Kolkata 700032, India, E-mail: snkoner@chemistry.jdvu.ac.in (S. Koner), Fax: (+91) 33-2414-6414

[§]Present address: Darjeeling Government College, West Bengal 734101, India

Abstract: A new supramolecular metal-carboxylate framework $[\text{Co}(\text{mqc})_2]_n$ (**1**), and another monomeric compound $[\text{Zn}(\text{mqc})_2(\text{H}_2\text{O})]$ (**2**) (mqcH = 4-methoxy 2-quinolinecarboxylic acid) have been synthesized solvothermally and characterized by single crystal X-ray diffraction, elemental analysis, IR spectra, UV-vis spectra, powdered X-ray diffraction (PXRD) and thermogravimetric analysis. Compound **1** is a 2D coordination polymer, extended to a 3D porous supramolecular network having void space in between 2D layers. Compound **1** exhibits gas uptake capacity of N_2 , H_2 , CO_2 and CH_4 like small gas molecules in which moderately high uptake of H_2 and CO_2 takes place among the 2D MOFs. While the Zn variety, compound **2** features a one-dimensional chain like structure through strong intermolecular hydrogen-bonding.

Keywords: Co(II); 2D layered MOF; Zn(II); crystal structure; gas adsorption



Cu(II)/Cu(II)-Mg(II) Containing Pyridine-2,5-dicarboxylate

Frameworks: Synthesis, Structural Diversity, Inter-conversion and Heterogeneous Catalytic Epoxidation

Debraj Saha^{**†}, Saikat Gayen[†], Subratanath Koner^{**‡}

[†]Department of Chemistry, Darjeeling Government College, Darjeeling 734101, India

[‡]Department of Chemistry, Jadavpur University, Kolkata 700032, India

Abstract

Ligand concentration dependent structural diversity and inter-conversion of hydrothermally synthesized metal carboxylate compounds, $\{[\text{Mg}(\text{H}_2\text{O})_6][\text{Cu}(\text{pdc})_2] \cdot 2\text{H}_2\text{O}\}_n$ (1), $\{[\text{CuMg}(\text{pdc})_2(\text{H}_2\text{O})_4] \cdot 2\text{H}_2\text{O}\}_n$ (2), $\{2(\text{Him})[\text{Cu}(\text{pdc})_2]\}_n$ (3), and $\{[\text{Cu}(\text{pdc})(\text{im})_2] \cdot 2\text{H}_2\text{O}\}_n$ (4) (H_2Pdc = pyridine-2,5-dicarboxylic acid and im = imidazole), have been thoroughly investigated. Formation of compounds 1-4 depends on the concentration of imidazole. Structure of all four compounds has been verified by single crystal X-ray diffraction and other physicochemical studies. Compound 3 catalyzes olefin epoxidation reaction in heterogeneous condition.

1. Introduction

Metal organic framework (MOF) is nothing but a symmetric arrangement of metal ions which are connected through organic linkers and extended into 1, 2 and 3-dimensional networks via coordination bonding and other weak bonding interactions [1]. MOF has wide range of application potential in various fields, including gas adsorption,



Homo and hetero-bridged dinuclear copper(II) complex: Synthesis, X-ray structure and catalytic N-arylation

Tanmoy Maity¹, Debraj Saha², Soma Das³, Pameli Ghosh, Subratanath Koner*

Department of Chemistry, Jadavpur University, Kolkata 700 032, India

ARTICLE INFO

Article history:

Received 5 December 2018

Accepted 21 August 2019

Available online 24 August 2019

Keywords:

Schiff base
Copper(II)
Dinuclear chloro bridged
N-arylation
Homogeneous catalysis

ABSTRACT

Two new dinuclear Cu(II) Schiff base compounds were synthesized, structurally characterized and their catalytic efficacy in N-arylation reaction was studied. Reaction of CuCl₂ with two different polydentate Schiff base ligands viz. H₂L1 (H₂L1 = 1-(N-ortho-hydroxyacetophenimine)-ethane-2-ol) and H₂L2 (H₂L2 = 2-methoxy-6-[(2-hydroxyethylimino)methyl]phenol) has afforded two new very different in structure complexes [Cu₂(HL1)₂(μ-Cl)₂(H₂O)] (1) and [Cu₂L2(HL2)(μ-Cl)Cl₂(H₂O)] (2). Complexes 1 and 2 were characterized by single crystal X-ray diffraction, FT-IR, elemental analysis, UV/Vis spectroscopic and TG/DTA studies. Complex 1 featured a simple dichloro-bridged dinuclear moiety, whereas 2 a hetero-bridged (chloro and phenolic oxygen) dinuclear compound. Catalytic efficacy towards N-arylation reactions between aryl iodide with aryl amine catalyzed by complexes 1 and 2 under homogeneous condition had been studied. Both the catalysts exhibited excellent catalytic efficacy in DMSO medium.

© 2019 Elsevier Ltd. All rights reserved.

1. Introduction

Considering the dominant role of suitable metal salts and multidentate ligand in the adjustment and control of the architecture for the coordination compounds, selection of metal salt and ligand is of paramount importance and it needs to be very precise [1]. Coordination chemistry of Schiff base ligand is particularly interesting in this count as the selection of suitable amine and aldehyde substituents containing steric and electronic functional groups at selective positions may create structural and functional variations [2–6]. Simple but efficient [Cu(II)₂(μ-Cl)₂] moiety containing dimeric copper(II) units have attracted much interest of chemists during the past few decades for several reasons. Dinuclear type copper compounds have already attracted significant interest in biochemistry because Type III copper centers are found in multi-copper based proteins (e.g. tyrosinase, hemocyanins, copper oxidases) [7–10]. In last few decades chloro bridged dinuclear copper(II) compounds attracted chemists' attention to study magnetic interaction between two metal centers [11–24]. Such type of studies involving copper(II) ions is particularly focused on gathering

knowledge of different magneto-structural properties [11–24]. A great deal of investigations including quantum chemical calculations has been undertaken in respect of magneto-structural correlations in dimers [25–31]. This involves a wide variety of compounds with a huge variation of structural features of dimeric copper(II) ion units and its periphery, exhibiting diversified pathways of magnetic interaction [11,16,18–20,28–31].

Standing out from magnetic studies, catalytic application of copper(II) Schiff base compounds received only little attention and there is a scope of exploration. Ramadan et al. studied oxidase catalytic activity of mononuclear and dinuclear copper(II) compounds towards the aerobic oxidation of vitamin C [32]. Parra-Hake et al. studied catalytic activity in the enantioselective cyclopropanation of styrene using monomer and dimer copper(II) chiral Schiff base compounds, where ligands are synthesized from chiral amines [33]. Previously we have examined catalytic activity of a group of structurally diverse copper(II) Schiff base compounds towards O-arylation of nitroarenes [34]. Regarding importance of reactions, cross coupling reactions to form C–N bonds have great influence in recent time because of their wide applications in preparation of numerous useful compounds which are important in biological, pharmaceutical, and material science [35–37]. Copper-assisted classic Ullmann type reaction is one of the common synthetic routes for the preparation of such type of compounds, and copper is a preferred catalyst for environmental and economic reasons.

* Corresponding author.

E-mail address: snkoner@chemistry.jdvu.ac.in (S. Koner).

¹ Present address: Solid State and Structural Chemistry Unit, Indian Institute of Science, Bangalore 560 012, India.

² Present address: Darjeeling Government College, Darjeeling 734 101, India.

³ Present address: School of Material Science, Indian Association of Cultivation of Science, Kolkata 700 032, India.

<https://doi.org/10.1016/j.poly.2019.114127>

0277-5387/© 2019 Elsevier Ltd. All rights reserved.

Officer-in-Charge
D₁ Darjeeling Govt. College





7. Collaborative Research Activities of by **Sonam Lama, Department of Geography, Darjeeling Govt. College** with Dept. of Geography and Environment Management, Vidyasagar University, Medinipur, W. B. 721102, India.



Open access e-Journal
Earth Science India eISSN: 0974 – 8350
V. 12 (I), January, 2019, pp. 1-23
<http://www.earthscienceindia.info/>



Morphometric Analysis of Chel River Basin, West Bengal, India, using Geographic Information System

Sonam Lama¹ and Ramkrishna Maiti²

¹Department of Geography, Darjeeling Govt. College, Darjeeling, West Bengal, 734101, India

²Department of Geography and Environment Management, Vidyasagar University, Medinipur, West Bengal, 721102, India

Email: sonamgeo@yahoo.co.in; ramkrishnamaiti@yahoo.co.in

ABSTRACT

Morphometric analysis of Chel basin was carried out with the help of geographic information system (GIS). Mosaic of two Shuttle Radar Thematic Mapper (SRTM) 1Arc V3 (30m) tiles was used to prepare Digital Elevation Model (DEM). The watershed boundary was delineated and drainage lines were identified using Arc Hydro tools in ArcGIS 10.1 by collaborating Survey of India (SOI) toposheets. Morphometric parameters like stream order, stream length, bifurcation ratio, drainage density, stream frequency, form factor, circulatory ratio, and other parameters are computed under three broad categories namely linear, areal and relief aspects. River Chel was found to be a 5th order stream with overall length of 58.23 kms. Chel basin encompasses an area of 321 km² with basin perimeter of 115.21 kms. Relief ranges from 92m to 2449 m with total relief of 2357 m. An elongation ratio value of 0.47 suggests Chel is a highly elongated drainage basin. Further the circulatory ratio of Chel basin is 0.304. Mean bifurcation ratio for whole Chel basin is 3.43 whereas weighted mean bifurcation ratio for the same is 4.05. The mean drainage density of Chel basin is 1.07 and drainage frequency value is 0.49. The elliptic hypsometric curve with greater initial downward deviation from the equilibrium line followed by long gentle gradient and finally becoming almost parallel to the abscissa and very low hypsometric integral (H.I.=0.15) is suggestive of basin being in 'senile stage'. These finding would help in better understanding of various morphometric parameters at play and thereby enhance our spatial understanding for logical decision making in order to formulate proper management plans for the whole basin.

Keywords: Morphometric analysis, SRTM DEM, Hypsometric Curve and Integral, Senile stage, Chel River

Please cite this article as: *Lama, Sonam and Maiti, Ramkrishna (2019) Morphometric analysis of Chel river basin, West Bengal, India, using Geographic Information System, e-Journal Earth Science India, v. 12, pp. 1-23. <https://doi.org/10.31870/ESI.12.1.2019.01>*


Officer-in-Charge
D₁ Darjeeling Govt. College





8. Collaborative Research Activities of by **Prabir K. Sen**, Department of Chemistry, Darjeeling Govt. College with Department of Botany, Govt. General Degree College, Keshiary, Tilaboni-Mahisamura, Paschim Midnapur-721135.



Total Synthesis of Elvirol: An Unique Bisabolene Sesquiterpene

www.rmlkwc.ac.in Nilay Kumar Maitra^a and Prabir K. Sen^{b*}

^aDepartment of Botany, Govt. General Degree College, Keshiary, Tilaboni-Mahisamura, Paschim Midnapur-721135

^bDepartment of Chemistry, Darjeeling Govt. College, Lebong Cart Road, Richmond Hill, Darjeeling-734101

ARTICLE INFO

Received: 03.03.2019

Revised: 27.03.2019

Accepted: 30.03.2019

Key words:

Terpene, enantiomeric, biogenicity, α -curcumene, elvirol.

ABSTRACT

Elvirol is a potent antimicrobial compound which show antibacterial activity against *Staphylococcus aureus* and *Vibrio anguillarum*. It is a structurally exceptional natural product isolated from *Deliliabiflora* (L.) Kuntze (syn. *Ehvirabiflora* (L.) DC). The compound is a bisabolene sesquiterpene. Synthesis of elvirol does not obey specialisoprene rule. This review describes the total synthesis of the elvirol employing different methodologies.

Introduction

Curcuphenol 2 and Elvirol 1 (Figure 1) have molecular structures which possess powerful antibacterial, antifungal, antitumor and antimalarial activities[1]. This prompted chemists to undertake the synthetic analogical approach to synthesise these natural products. Elvirol 1 is a bisabolene sesquiterpene metabolite, isolated from *Elvira biflora* [2]. Although elvirol has been assigned a terpenoid basis, it is somewhat unique in that it does not conform to the isoprene rule that goes to make up all the terpene constituents. Different synthetic strategies have been employed to mediate total synthesis of Elvirol 1

Results and Discussions

It has been assumed that the biogenetic origin of elvirol 1 could be traced to α -curcumene 3 which undergoes an aromatic-epoxidation and

a subsequent 1,2- alkyl shift (Scheme1).

Enantiomeric nature of elvirol has not been referred to in its isolation and as such no information is available on its possible biological activity. Interestingly, its more well-known structural sibling curcuphenol 2 displays interesting biological activities of both its enantiomers [3,4]. Several reports of synthesis of elvirol have appeared in literature[3,4,5,6,7]and recently a synthesis of both its enantiomers has also been disclosed.

Bohlmann et.al, who reported the isolation of elvirol, also disclosed its first synthesis [5]. The synthesis started with the crotenylcresyl ether 4 , which on Claisen rearrangement furnished the propenyl phenol 5 . Protection of the phenolic group 6 followed by hydroboration resulted in the alcohol 7 which was converted to the bromide 8 . Oxidation to the aldehyde 9



9. Collaborative Research Activities of by **Kishor Biswas, P.G. Department of Botany, Darjeeling Govt. College** with **Department of Tea Science, North Bengal University, Darjeeling- 734013, West Bengal, India**

Pleione 13(2): 422 - 424. 2019.
© East Himalayan Society for Spermatophyte Taxonomy
doi:10.26679/Pleione.13.2.2019.422-424

ISSN: 0973-9467

NEW RECORD

***Astraea lobata* (L.) Klotzsch [Euphorbiaceae]: a new record for Eastern India from Darjeeling Terai**

Kishor Biswas¹ and Chandra Ghosh²

¹P.G. Department of Botany, Darjeeling Government College, Darjeeling- 734101, West Bengal, India

E-mail: kbiswas83@gmail.com

²Communicating author: Department of Tea Science, North Bengal University, Darjeeling- 734013, West Bengal, India. E-mail: amichandra07@gmail.com

[Received 11.10.2019; Revised 27.11.2019; Accepted 29.11.2019; Published 31.12.2019]

Abstract

Astraea lobata (L.) Klotzsch [Euphorbiaceae] is recorded for the first time from West Bengal in Eastern India. It occurred in the roadside area of Siliguri subdivision of Darjeeling district. A detailed description with illustration of the species is provided here.

Key words: *Astraea lobata*, New Record, West Bengal

INTRODUCTION

The genus *Astraea*, having eight accepted species, is a native of South America and West Indies (www.thelantlist.org, Version 1.1 2013). *Astraea lobata* (L.) Klotzsch is the only species to be found throughout the Neotropical region and introduced in Africa and Yemen. Though it is native to South America and West Indies, Khan & Khan (2002) reported this species from Bangladesh. Gaikwad *et al.* (2012) reported it from Sholapur district of Maharashtra, India for the first time and Das *et al.* (2016) from Tripura.

During a survey of the road side flora of Darjeeling district, a population of about 12 individuals of *Astraea lobata* was found near North Bengal University (26°42'9.83" N & 88°21'05.0" E) in flowering and fruiting condition. After critical examination and scrutiny of relevant literatures (Chakrabarty & Balakrishnan 1997; Webster 1993; Govaerts *et al.* 2000; Khan & Khan 2002; Balakrishnan & Chakrabarty 2007; Schmelzer 2007; Gaikwad *et al.* 2012; Das *et al.* 2016) the plant was identified as *Astraea lobata* (L.) Klotzsch. Its occurrence in this locality reports a new distributional record for West Bengal and also for the first time from Eastern India. A detailed description with suitable photographs is provided to facilitate its identification.

TAXONOMIC TREATMENT

Astraea lobata (L.) Klotzsch, Arch. Naturgesch. (Berlin) 7: 194. 1841; Das *et al.* *Pleione* 10(2): 392 – 395. 2016. *Croton lobatus* L., Sp. Pl. 2: 1005. 1753 “*lobatum*”; Vell., Fl. Flumin. 10: t. 70. 1831.

Monoecious annual herb, upto 80 cm high; stem terete, ribbed, branched, stellate-hairy with 1 or 2 branches longer and erect. Leaves simple, alternate; lamina 2.5 – 11 cm long, deeply 3 – 5 lobed; lobes oblanceolate to obovate, crenate-serrate with glandular tips, acuminate, 3 – 5 nerved at base, sparsely stellate-hairy; basal glands present; petioles 2.5 – 15 cm long; stipules free lateral, filiform to subulate, c.1 mm, glandular hairy. Racemes mainly terminal


Officer-in-Charge
D₁ Darjeeling Govt. College





STATUS OF MEDICINAL PLANTS IN MPCAS AND ADJOINING AREAS IN TERAI-DUARS REGION OF WEST BENGAL, INDIA

Kishor Biswas¹, Chandra Ghosh^{2*} and A.P. Das³

¹P.G. Department of Botany, Darjeeling Govt. College, Darjeeling, West Bengal, India.

²Department of Tea Science, University of North Bengal, Darjeeling, West Bengal, India.

³Department of Botany, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh, India (Formerly of University of North Bengal).

Abstract

Terai-Duars belt is covered by the IUCN recognised Himalaya Hotspot for biodiversity conservation and is rich in medicinally important herbs, shrubs and trees. The area is home to numerous rare and threatened species also. The present investigation recorded occurrence of 397 species of medicinally important plants belonging to 283 genera and 96 families, including 9 spp. of pteridophytes. Most of the recorded plants were herbs and found to be used medicinally and few for their aromatic property. Of these, 38 species were recognized as threatened ones. Comparison with previous report nicely showed fruitfulness of establishing the MPCAs to conserve threatened medicinal and accompanying non-medicinal plants those required conservational attention. It also suggests proper conservation strategies to protect this important green wealth of the country.

Key words: Medicinal Plants, Terai, Duars, Conservation, MPCAs.

Introduction

Terai-Duars region of West Bengal is lying at the feet of Eastern Himalaya and extended from Nepal to Assam. Entire Siliguri sub-division, southern and lower part of Kurseong sub-division of Darjeeling district and a small part of Jalpaiguri district lying west to the river Tista is known as Terai whereas the eastern part of Tista composed of remaining portion of Jalpaiguri and entire Alipurduar District is known as Duars [= Dooars]. The entire belt is covered with dense forests and being contiguous with the Eastern Himalaya, it is quite rich and diverse in floral components and is also diverse in habitat structure and forms of vegetation. Not only that, Terai-Duars belt is also covered by the IUCN recognised Himalaya Hotspot for biodiversity conservation (Conservation International 2005) and is home to numerous rare and threatened species of plants (Das 1996; Kadir 2001; Das *et al.*, 2003; Rai & Das 2008; Kadir & Das 2007; Shukla *et al.*, 2014; Sarkar & Das 2015, 2017). Mixed-deciduous forests comprise the major forest type of this area and other prominent types of forests are riverine scrubs and forests, herblands,

shrubby-scrubs, savannah type tall grasslands etc. (Mukerjee 1965; Sikdar 1984; Mohanta 2004; Das *et al.*, 2010; Sarkar & Das 2017). But, in recent decades, plantations (monoculture and mixed plantation of both native and exotic species) occupied wide area of Terai-Duars belt.

This Sub-Himalayan belt support excellent Savannah type of tall and very dense grasslands, which provide shelter to extremely high population of big animals like elephant, rhino, bison, different type of deer, leopard, royal bengal tiger, etc. To protect the rich diversity of plants and animals a number of Protected Areas, like three National Parks [Gorumara NP, Buxa NP and Jaldapara NP]; three Wildlife Sanctuaries [Mahananda WLS, Chapramari WLS and Buxa WLS]; one Reserve Forest [Buxa Tiger Reserve] have been developed in this zone (Anonymous 1997; http://wiienviis.nic.in/Database/WestBengal_7842.aspx). Forest and vegetations of this areas harbour a wide variety of useful and medicinal plants also (Biswas & Chopra 1940, 1956; Yonzon *et al.*, 1984; Ghosh *et al.*, 2020).

Previously, up to the end of 19th century, the entire Terai-Duars region was covered mostly with thick and

Officer-in-Charge
D1 Darjeeling Govt. College





Allelopathic Effects of Some Dominant Weeds on Seed Germination and Seedling Growth of Tea

Chandra Ghosh¹, Kishor Biswas^{*2} and A. P. Das³

Received: 31 May 2021 | Revised accepted: 04 Sep 2021 | Published online: 02 Oct 2021
© CARAS (Centre for Advanced Research in Agricultural Sciences) 2021

ABSTRACT

The allelopathic effect of different concentration of leachates and extracts of six dominant weed species was studied on seed germination and early seedling growth of tea plants [*Camellia sinensis* (L.) Kuntze]. Almost in all the cases of leachates and extracts, the highest concentration (1:2.5) showed inhibitory effect on germination of seeds and subsequent seedling growth of tea. However, interestingly, it was noted that in case of *Persicaria runcinata* the highest concentration (1:2.5) of leachate showed slightly stimulatory effects on seed germination. The leachates or/and extracts of those test species having no major effect on seed germination, affect seedling elongation especially the root elongation. The inhibitory or stimulatory effect of a test plant leachate or/and extract depends on the concentrations. The study also suggests further allelopathic investigation, isolation and identification of active allelochemicals as well as their potential uses as growth and yield promoting agents.

Key words: Leachate, Extract, *Camellia sinensis*, Root length, Shoot length

Allelopathy is a form of competition that works through interfering chemicals to prevent other plants from using the available resources and ultimately to keep other plants out of its space and thus influence the evolution and distribution of other species including microorganisms. Generally, the toxic chemical substances from allelopathic plants which are known as allelochemicals, escaped into the environment in four different ways – weathering, leaching, exudation and volatilization and subsequently influence the growth and development of other neighbouring plants [1-3]. Target species are affected by these toxins in different ways. They may affect germination of seeds, inhibit shoot and/or root growth, nutrient uptake, or may attack a naturally occurring symbiotic relationship thereby destroying the usable source of nutrient of the Plants. Modern research suggests that allelopathy may exert both positive and negative effects depending upon the concentration of allelochemicals and organisms involved [4-9].

One of the most worked out aspects of allelopathy in manipulated ecosystems is its role in agriculture, and the

effects of weeds on crops, impacts of crops on weeds and effect of crops on some other crops have been invariably emphasized. Scientific investigation also revealed the prospect and possibility of using allelochemicals as growth regulators and natural pesticides [10-11] and thus sustainable agriculture may be promoted by replacing or at least reducing the uses of synthetic and harmful pesticides (including weedicides, insecticides, nematicides, fungicides etc.) which are the continuous sources of innumerable hazards viz., development of resistance in organisms, environmental pollution, toxicity related health hazards in humans and livestock etc. So, for the sustainability of agriculture as well as pollution free environment it is urgent need to minimize their uses and to take advantages of allelopathic strategies for pest management. Tea [*Camellia sinensis* (L.) Kuntze] is one of the important crops which plays major role in the economy and development of North Bengal as well as the country. Major parts of Northern Bengal is occupied by tea gardens and diverse group of weeds in and around the gardens create different forms of hazards including outbreak of pests and pathogens, increasing cultivation cost, hampering the quality and quantity of tea etc [12]. On the other hand, no such information is there regarding the allelopathic effects of common weeds on tea and no such study has been undertaken by any other worker. Therefore, the present investigation was carried out to evaluate the impacts of dominant weeds on seed germination and early growth of tea seedling.

* Kishor Biswas

✉ kbiswas83@gmail.com

¹ Department of Tea Science, University of North Bengal, Darjeeling - 734 013, West Bengal, India

² Department of Botany, Darjeeling Government College, Darjeeling - 734 101, West Bengal, India

³ Department of Botany, Rajiv Gandhi University, Rono Hills, Doimukh - 791 112, Arunachal Pradesh, India

MATERIALS AND METHODS



Officer-in-Charge
D₁ Darjeeling Govt. College





10. Collaborative Research Activities of by Ekramul Kabir, Department of Physics, Darjeeling Govt. College with Department of Physics, Aliah University, Newtown Campus, Kolkata - 700156, India.

Complex impedance studies of organic ferroelectric- Diisopropylammonium Iodide (DIPAI)

Ekramul Kabir^{1,2,(a)}, M Khatun¹, Mustafa J Raihan³ and M Rahman¹

¹Department of Physics, Aliah University, Newtown Campus, Kolkata - 700156, India

²Department of Physics, Darjeeling Govt. College, Darjeeling-734101, India

³Department of Chemistry, Aliah University, Newtown Campus, Kolkata - 700156, India

^{a)}Corresponding author: ekramulphysics@gmail.com

Abstract. Frequency dependent dielectric modulus, impedance and AC conductivity of diisopropylammonium Iodide (DIPAI) have been studied. The conductivity shows a semiconducting type and the compound exhibit non-debye type of relaxation. At higher frequencies the dielectric loss decrease, as a result the electrical conductivity of the sample increases. Here barrier hopping model explains the conductive mechanism.

Keywords: Organic Ferroelectrics, Impedance Spectroscopy, Relaxation Mechanism, AC Conductivity

INTRODUCTION

Organic ferroelectric materials paved the way for non-toxic data storage, sensing and others application [1]. However, it has been challenging as well as interesting to develop organic counterpart of mostly used inorganic/perovskite materials with adequate technological properties such as high spontaneous polarization at room temperatures, low switching time etc. Ferroelectricity exists only in polar crystal structures with perfect symmetry and therefore it can be very challenging to researchers to develop new kind of ferroelectric materials with such properties. The ferroelectric state of these new kind of molecular ferroelectrics is highly stable at room temperature because the ferroelectric to paraelectric transition temperature is higher than inorganic one. Among them, Diisopropylammonium Chloride and Bromide (DIPAC and DIPAB) was found to be one of the most remarkable molecular ferroelectric material with low coercive field, large spontaneous polarization of and high curie temperature of [1,2]. Therefore, DIPAC-based molecular ferroelectrics are promising alternatives to oxide ferroelectrics for use in organic electronics technologies. Following the discovery of DIPAC and DIPAB researchers tried to invent another new material substituting the anion with Iodine, expecting to get larger spontaneous polarization as the chronological order of chlorine and bromine in periodic table. But some controversy was started for diisopropylammonium Iodide. Before scientists could reach their expecting results research group of Poland reported that there is no ferroelectric nature found in DIPAI and there is only one phase transition from paraelectric to piezoelectric form i.e. ferroelectric phase is absent in DIPAI according to this group[3]. Strong increase in dielectric permittivity is found in $P2_12_12_1$ to $P2_1/m$ transition which is analogous to ferroelectric nature. However with some modification in synthesis process research group of IISc Bangalore reported DIPAI is a strong ferroelectric material with largest spontaneous polarization $P_s=33\mu\text{C}/\text{cm}^2$, ever reported in organic ferroelectrics as well as inorganic one [4].

Herein, we have investigated on DIPAI molecular ferroelectrics. The main purpose of the present paper is to characterize the ferroelectric properties of DIPAI as well as the conductivity, impedance and modulus spectroscopy by capacitance-conductance (C_p -G) measurements. Here frequency and temperature dependence of these quantity were measured in the frequency ranges 20Hz-10MHz.


Officer-in-Charge
D₁ Darjeeling Govt. College





A Review on Polymer and Organic Ferroelectrics for Flexible High Energy Storage Material

Mamataj Khatun^{1,(a)}, E. Kabir^{1,2} and M. Rahman¹

¹Department of Physics, Aliah University, Newtown Campus, Kolkata - 700156, India

²Department of Physics, Darjeeling Govt. College, Darjeeling-734101, India

^{a)}Corresponding author: mamatajkhatun281@gmail.com

Abstract. At present semi-crystalline ferroelectric polymers and several organic molecular ferroelectrics are suitable for a large variety of flexible devices as an electrical energy storage application. Considerable progress has been made over the past several years in the enhancement of energy density of ferroelectric polymers, carbon nanotube (CNT) and also organic ferroelectrics. Realizing the application potential, this review article summarizes a range of several applications of PVDF composites, CNT and organic ferroelectrics in the field of memory elements. This article also highlights on dielectric capacitor and other energy storage devices with advantages and disadvantages.

Keywords: Capacitors, PVDF, CNT, Organic Ferroelectrics, Energy density applications

INTRODUCTION

Energy storage, an immediate step to the versatile, clean and efficient use of energy, is one of the great challenge in twenty-first century. Ever increasing energy requirements and the rapid depletion of fossil fuels, significant demand raised to make efficient use of energy, as well as to seek sustainable and renewable energy sources. In response to the needs of modern society and emerging ecological concern, it become essential to find new, low-cost and environmentally friendly energy conversion and storage systems; such as batteries, fuel cells, electrochemical capacitors and dielectric-based capacitors; hence the rapid development of research interest in this field. Among these energy storage systems, all-solid dielectric-based capacitors show superior advantages due to their intrinsic high power density, fast charge-discharge speed, long cycle life and environmentally friendly characteristics and thus hold great promise for the generation of high performance power electronics used in hybrid electric vehicles, medical devices, and electrical weapon systems [1]. Dielectric capacitors with high energy density can significantly reduce the weight, volume, and cost of various energy storage systems. Conventional dielectric materials usually composed of polymer as matrix materials and inorganic/organic fillers as the reinforcement. Utilizing both properties polymer dielectric materials have a relatively high breakdown field, while the fillers, have high dielectric constant and the combination of both provides enhanced dielectric properties depending on the nature and type of the polymer chain as well as fillers [2]. Apart from inorganic and polymer matrix, recently reported organic ferroelectric croconic acid and diisopropylammonium based halides also posses high dielectric constant with low dielectric loss and high spontaneous polarization which can be a very flexible material for energy storage [3]. Thus a key issue to raise the dielectric permittivity of material, organic ferroelectric material can be a promising for high energy storage applications. The aim of this review is to provide comprehensive information on dielectric capacitor for high energy storage devices and a discussion of possible high dielectric constant materials ; polymers , conducting fillers and organic ferroelectrics.



11. Collaborative Research Activities of by **Salim Mandal, Department of Geography, Darjeeling Govt. College** with Dept. of Geography, **University of Gour Banga, Malda, West Bengal, India.**

Children and Youth Services Review 114 (2020) 105046



Impact of domestic smokes on the prevalence of acute respiratory infection (ARI) among under-five children: Evidence from India



Salim Mandal^{a,*}, Ankita Zaveri^b, Rahul Mallick^b, Pradip Chouhan^b

^a Department of Geography, Darjeeling Government College, Darjeeling, West Bengal, India

^b Department of Geography, University of Gour Banga, Malda, West Bengal, India

ARTICLE INFO

Keywords:
ARI
Cooking fuel
Biomass
Smoking
Under-5 children
NFHS-4

ABSTRACT

Background: Acute respiratory infection (ARI) is one of the major causes of childhood morbidity which leads to mortality as well.
Aim: The study aimed to estimate the effect of household cooking fuels and smoking habits on the prevalence of ARI among under-five children over India.
Methods: This study employs nationally representative data National Family Health Survey (NFHS-4: 2015–2016) which was gathered and arranged by International Institute for Population Science, Mumbai as the Nodal Agency under the patronage of the Ministry of Health and Family welfare, Government of India. The χ^2 test implemented to assess the difference by the prevalence of ARI against the use of household cooking fuels, smoking habits and socio-demographic characteristics. Then binary logistic regression models were incorporated to look at the crude and net impact of cooking fuels used in households on childhood ARI.
Result & Findings: ARI was mostly affective for those children who were from those households where biomass were the main source of cooking fuels and significantly the prevalence of ARI was related to the combustion of biomass fuels for cooking ($p < 0.0005$). The smoking habits ($OR = 1.42$, $CI: 1.18-1.70$) and use of biomass cooking fuels ($OR = 1.03$, $CI: 0.86-1.08$) significantly predicted the higher probability of ARI prevalence among children. Therefore children should be kept away from the kitchen during cooking and the kitchen room should have sufficient open space to evacuate the pollutants easily.

1. Introduction

One of the most frequent and adverse diseases occur in the early childhood period is acute respiratory infection (ARI). Severe illness and death occurs due to ARI and pneumonia among under-5 children accounted for 4.5% worldwide in 2002 (Pandey, Smith, Boleij, & Wafula, 1989; Holberg, Wright, Martinez, Morgan, & Taussig, 1993; Emmelin & Wall, 2007; Maio, Simoni, Baldacci, Sherrill, & Viegi, 2009; WHO, 2003). And this problem is mostly prominent in the developing countries (Gashat-Cruz, Morales-Aguirre, & Mendoza-Azpiri, 2005; Ramesh Bhat, Manjunath, Sanjay, & Dhanya, 2012). ARI among children leads to acute lower respiratory infection (ALRI) which was found as major factor of child mortality (Mishra, Smith, & Retherford, 2005). The shocking situation was about 4.9 lakh children were victims annually to death due to ALRI which had 1.5 percent contribution to the whole world disease burden (Smith, 2003; Mishra et al., 2005). Living beings take breath from surrounding environment. And purity of surrounding environment depends on human activities and cultures and their living condition. Cooking is one of all the daily necessary activities in every

house in rural as well as urban areas. Air quality directly related to respiratory system of living beings. Many times indoor air condition depends on cooking fuel used in the household. People from different standard of living used to exercise different types of cooking fuel in their household. Previous studies estimates that air quality and cleanliness affected by cooking fuels like biomass, coal, lignite and charcoal, woods etc (Smith & Liu, 1994). A number of health damaging air pollutants and smokes are produced due to combust of biomass fuels (woods, straw/shrubs/grass and agricultural crop, animal dung etc). The air pollutants emit from the biomass combustion includes particulate matter, carbon monoxide (CO), nitrogen oxides (NO_x), methanol (CH₂O), benzene (C₆H₆), 1,3-butadiene (C₄H₆), polycyclic aromatic hydrocarbons (PAHs) (such as benzo[a]pyrene-C₂₀H₁₂), and various toxic organic compounds. Biomass cooking fuels are used by majority portion of households in developing countries. In the developing country India most of the people are reside in rural areas [68.84%] compare to urban areas [31.16%] (Census of India, 2011). Cooking fuels mostly used in the rural areas are associated with dry organic substances like straw/shrubs/grass, crop waste, dung fuel, dry leaves,

* Corresponding author.

<https://doi.org/10.1016/j.chi.2020.105046>

Received 13 December 2019; Received in revised form 24 April 2020; Accepted 26 April 2020

Available online 29 April 2020

0190-7409/ © 2020 Elsevier Ltd. All rights reserved.

Officer-in-Charge
D1 Darjeeling Govt. College





Influence of socio-demographic factors on coverage of full vaccination among children aged 12–23 months: a study in Indian context (2015–2016)

Tarikul Islam ^a, Salim Mandal^b, and Pradip Chouhan ^a

^aDepartment of Geography, University of Gour Banga, Malda, India; ^bDarjeeling Government College & Department of Geography, University of Gour Banga, Malda, India

ABSTRACT

Background: Vaccine-preventable diseases (VPDs) are one of the key public health concerns in low and middle-income countries due to incomplete vaccination coverage. Nearly three million children up to 5 years of age die due to VPDs each year. Vaccination plays a significant role in reducing child mortality and morbidity from VPDs. Globally, full vaccination coverage efficiently saves two to three million children's lives from life-threatening VPDs.

Objective: This study intends to inspect the influence of socio-demographic factors on full vaccination coverage of children aged 12–23 months in India.

Methods: A cross-sectional observational study was carried out using the NFHS-4, 2015–2016 data of India. A total of 44,771 children aged 12–23 months born to the mothers aged 15–49 years in the last 5 years preceding the survey were used for this study. For the analyses of the data, Bivariate and Multivariate analyses were performed.

Results: The prevalence of full vaccination coverage of children aged 12–23 months in India was 62%. The result of the study indicated that maternal educational attainment, household wealth status, child size at birth, and maternal health-care services are the main significant predictors of full vaccination coverage. Other socio-demographic factors include maternal age, sex of the household head, exposure to mass media, child birth order, social category, religion, place of residence and region also play significant role in the coverage of full vaccination.

Conclusion: The study found that socio-demographic factors play a significant role in full vaccination coverage children in India. Therefore, policymaker and administrators should accentuate the inventive approach for the development of women education, improvement of family income, and easy accessibility of maternal and child healthcare services to surmount the impediment of children full vaccination coverage, which eventually reduce the risk of child morbidity and mortality.

ARTICLE HISTORY

Received 4 February 2021
Revised 25 August 2021
Accepted 31 August 2021

KEYWORDS

Immunization; vaccines; full vaccination coverage; children of aged 12–23 months; India

Introduction

Vaccination is an important life-saver aspect of a child at the early age and a cost-effective tool against vaccine-preventable diseases (VPDs).^{1–3} It plays a significant role in reducing child mortality and morbidity from VPDs.^{1–3} During 2011–2020, vaccination coverage helps to reduce under-five mortality by about 24%.^{4,5} Globally, full vaccination coverage efficiently saves nearly two to three million children's lives annually from 20 life-threatening VPDs; such as diphtheria, influenza, measles, tetanus and pertussis.⁶ As per Immunization Agenda (IA), 2030, vaccination will avert about 24 million people from falling into poverty.⁷

As lifesaving significance, the World Health Organization (WHO) has started Expanded Programme on Immunization (EPI) in 1974 to wipe out under-five mortality from VPDs. After the initiation of EPI, vaccination coverage was significantly increased over the decades.⁸ To ensure impartial access of present vaccines to the children despite their living places, all the members of the World Health Assembly (WHA) have approved Global Vaccine Action Plan (GVAP) in 2012.⁸ Globally, 116 million (85%) infants received three doses of DTP (diphtheria-tetanus-pertussis-containing vaccines) and

125 (64%) countries reached 90% or more DTP3 coverage rate in 2019.⁹ In 2011, globally, full vaccination coverage of 12–23 months children was increased to 83%.¹⁰

In spite of these, VPDs are one of the key community health concerns due to deficient full vaccination coverage.¹¹ Each year, globally about three million children die due to VPDs¹² and which is 20% of total under five child deaths.¹³ Nevertheless, in 2019, globally 20 million children were unable to access lifesaving vaccines like measles, tetanus, and diphtheria within 12 months of their life.¹²

The full vaccination coverage is the percentage of children who have received all compulsory doses of particular vaccines within 12 months of their age. It is the principal indicators of utilization of vaccination by a population, and higher rate of routine vaccination coverage is very effective to eradicate VPDs from the populations.^{14,15} As per WHO, children covered with full vaccination if they received single dose of BCG and measles, all three doses of DPT and polio vaccines within first year of their life.¹⁶

In 1978, after the implementation of EPI globally, India did not delay to take immediate actions in this regard.¹⁷ As in 1984, UNICEF identified six VPDs; meanwhile the Indian



How maternal age links to childhood mortality? A brief analysis from NFHS-4 (2015–2016), India

Salim Mandal ^a and Pradip Chouhan ^b

^aDepartment of Geography, Darjeeling Govt. College, West Bengal, India; ^bDepartment of Geography, University of Gour Banga, Malda, West Bengal, India

ABSTRACT

The study aimed to estimate the relationship between childhood mortality and maternal age using bivariate association and logistic regression using the nationally representative data from India through NFHS-4 (2015–2016). The study reveals that the odds ratio of childhood mortality was comparatively higher among lower aged women (<20 years old) and aged women (30 years and more). The result depicted that childhood mortality was comparatively less among those women of 20–29 age groups and suggests raising maternal education to avoid child marriage and early marriage, not to plan a child at the upper age (>40 years old).

ARTICLE HISTORY

Received 25 May 2021
Accepted 21 March 2022

KEYWORDS

Childhood mortality;
Maternal age; NFHS-4;
logistic regression; India

1. Introduction

Many previous studies confirmed the significant relationship between child mortality and maternal age as a vital biological factor (Knodel & Hermalin, 1984). Child marriage (marriage or union under 18 years old for girls) and childbirth at an early age is common in many under-developed and developing countries. Several studies proved that child marriage leads to a high child mortality rate (Geronimus, 1986; Knodel & Hermalin, 1984; Alam, 2000; Raj et al., 2010; Finlay et al., 2011; Kozuki et al., 2013). Child marriage always leads to the probability of maternal death along with stillbirth, miscarriage, child death during 0–5 years of age (Nour, 2009; Paul, 2018; Raj & Boehmer, 2013). Moreover, young mothers frequently have the risk of attention-deficit/hyperactivity disorder (ADHD; Chang et al., 2014). The complication can also occur with those women who were going to be a mother at their advanced age or above the average age of motherhood and very few studies were accomplished to estimate adverse pregnancy outcomes for comparatively aged mothers (Kenny et al., 2013; Laopaiboon et al., 2014). Women having first child earlier remain at higher risk of child mortality than women having their first child later (Jayaraman et al., 2009). But what may be the suitable ages or age group of a woman to be a mother for the first time and last time as well? We aimed to answer the question through the association between maternal age and childhood mortality in the Indian context.

CONTACT Salim Mandal ✉ salim.ugb2017@gmail.com Department of Geography, Darjeeling Govt. College, West Bengal, India

© 2022 Informa UK Limited, trading as Taylor & Francis Group

Officer-in-Charge
D₁ Darjeeling Govt. College





12. Collaborative Research Activities of by Md Hasanujjaman, Department of Physics, Darjeeling Govt. College with Variable Energy Cyclotron Centre, 1/AF Bidhan Nagar, Kolkata 700064, India.

PHYSICAL REVIEW C **102**, 034910 (2020)

Dispersion and suppression of sound near the QCD critical point

Md Hasanujjaman^{1,*}, Mahfuzur Rahaman^{2,3,†}, Abhijit Bhattacharyya^{4,‡} and Jan-e Alam^{2,3,§}

¹Department of Physics, Darjeeling Government College, Darjeeling 734101, India

²Variable Energy Cyclotron Centre, 1/AF Bidhan Nagar, Kolkata 700064, India

³Homi Bhabha National Institute, Training School Complex, Mumbai 400085, India

⁴Department of Physics, University of Calcutta, 92, A.P.C. Road, Kolkata 700009, India

(Received 22 March 2020; accepted 28 August 2020; published 28 September 2020)

We have used second-order relativistic hydrodynamics equipped with an equation of state which includes the critical point to study the propagation of a perturbation in a relativistic QCD fluid. The dispersion relation for the sound wave has been derived to ascertain the fate of the perturbation in the fluid near the QCD critical end point (CEP). We observe that the threshold value of the wavelength of the sound in the fluid diverges at the CEP, implying that all the modes of the perturbation are dissipated at this point. Some consequences of the suppression of sound near the critical point have been discussed.

DOI: 10.1103/PhysRevC.102.034910

I. INTRODUCTION

Relativistic heavy ion collision experiments (RHIC-E) are carried out to create a new state of strongly interacting matter, called quark-gluon Plasma (QGP) [1,2], where color degrees of freedom are deconfined from their parent hadrons; its properties are governed by the colored quarks and gluons. The study of the transition from QGP to the hadron phase is one of the main goals of RHIC-E. For the last several years, significant work has been done to explore the QCD phase diagram in the (μ, T) plane, where T and μ denote temperature and baryonic chemical potential respectively. Lattice QCD simulations show that, at vanishing baryonic chemical potential ($\mu = 0$), the transition from hadron to QGP is a crossover [3–7] whereas, at large μ , the transition from hadronic matter to QGP is found to be first order [6,8]. Therefore, it is expected that the first-order phase transition ends at some point in the (μ, T) plane, which is called the critical end point (CEP). The existence of the CEP was suggested theoretically in Refs. [5,9–11] and predicted later in lattice simulation [12–14]. The experimental search for the CEP has been taken up through the beam energy scan (BES) program at the BNL Relativistic Heavy Ion Collider (RHIC). The search will continue rigorously in future experiments at the Facility for Anti-proton and Ion Research (GSI-FAIR) and Nuclotron-based Ion Collider Facility (JINR-NICA) [15].

A major issue in the exploration of the phase diagram of QCD is to find out the location of the CEP. The exact location of the CEP is not known theoretically because of the difficulties associated with the sign problem of the Dirac fermion

[16–18] in lattice QCD calculations. Some of the QCD based effective models such as NJL and PNJL predict the location of the CEP [19] with uncertainties of 266–504 MeV in μ_c and 115–162 MeV in T_c . Therefore, locating the CEP in QCD phase diagram remains as a big, challenging task. It is one of the main aims of the RHIC-BES programme [20,21] to find the CEP by creating systems with different μ and T by tuning the colliding energy ($\sqrt{s_{NN}}$) of the nuclei. At the CEP the correlation length diverges [22–24], resulting in divergences in several thermodynamic quantities which may affect signals of QGP. The chances of detecting such effects become greater if the freeze-out curve in the μ - T plane is sufficiently close to the CEP.

In the present work, however, we are not searching for the location of the CEP. Rather, we want to examine the effects on the fate of a sound wave propagating through a fluid in presence of a CEP. Here the location of the CEP is taken to be at: $(T_c, \mu_c) = (154 \text{ MeV}, 367 \text{ MeV})$ [25]. It is expected that a system conducive to studying the effects of the CEP may be realized through nuclear collisions at GSI-FAIR, NICA, and BES-RHIC. The QGP produced in such collisions will expand rapidly along a trajectory with s/n constant (s and n stand for the entropy density and baryon number density respectively) and cools down consequently. It is assumed that the isentropic trajectory followed by the QGP in the (μ, T) plane will pass through trajectories which are very close to the CEP.

The space-time evolution of the QGP can be modeled by the relativistic viscous hydrodynamics. The first-order theory of relativistic viscous hydrodynamics governed by Navier-Stokes (NS) equations depends on the first order in dissipative fluxes, which is known to violate causality and gives unstable solutions [26], therefore making it unsuitable to study the space-time evolution of QGP. These problems were solved by Muller [27] and Grad [28] after including quantities in the second-order dissipative flux, therefore these theories are called the “second-order hydrodynamics.” The relativistic

*jaman.mdh@gmail.com

†mahfuzurahaman01@gmail.com

‡abhattacharyyacu@gmail.com

§jane@vecc.gov.in

Officer-in-Charge
D1 Darjeeling Govt. College





13. Collaborative Research Activities of by **Dr. Abdul Ashik Khan**, Department of Chemistry, Darjeeling Govt. College with Dept. of Chemistry, University of Kalyani, Kalyani 741235, India and Dept. of Chemistry, JIS College of Engineering, Kalyani 741235, India

Journal of Molecular Structure 1234 (2021) 130152



Inhibitory efficacy of RNA virus drugs against SARS-CoV-2 proteins: An extensive study

Manab Mandal^a, Swapan Kumar Chowdhury^b, Abdul Ashik Khan^c, Nabajyoti Baildya^d, Tanmoy Dutta^e, Debabrata Misra^b, Narendra Nath Ghosh^{f,*}

^a Department of Botany, Dukkhal Nibaran Chandra College, Suti 742201, India

^b Plant and Microbial Physiology and Biochemistry Laboratory, Department of Botany, University of Gour Banga, Malda 732103, India

^c Department of Chemistry, Darjeeling Govt. College, Darjeeling 734101, India

^d Department of Chemistry, University of Kalyani, Kalyani 741235, India

^e Departments of Chemistry, JIS College of Engineering, Kalyani 741235, India

^f Department of Chemistry, University of Gour Banga, Mokdumpur, Malda 732103, India

ARTICLE INFO

Article history:

Received 10 January 2021

Revised 6 February 2021

Accepted 9 February 2021

Available online 26 February 2021

Keywords:

SARS-CoV-2

RNA virus drugs

Molecular dynamics simulation

Baloxavir marboxil

ABSTRACT

Herein we have made a comprehensive analysis of inhibitory efficacy of 16 RNA virus drugs against RdRp, Mpro and PLpro proteins of SARS-CoV-2. Analysis of docked conformation revealed that Baloxavir marboxil (BMX) corresponds to the highest binding energy. Analysis of residue confirmed that BMX strongly interact with these three proteins involving H-bonding, ionic as well as hydrophobic interactions. Molecular dynamics simulation and analysis of parameters like RMSD, RMSF, binding energy confirmed noticeable conformational alternation with these proteins with makeable effect on RdRp. The potentially inhibitory action of BMX against these three proteins suggests the inhibition of overall transcription process of SARS-CoV-2. These observation along with the recently observed inhibitory action of BMX on influenza with clinically proven no side effects emphasizes to uncover the role of BMX by *in-vitro* and *in-vivo* analysis.

© 2021 Elsevier B.V. All rights reserved.

1. Introduction

The recent pandemic COVID-19 causes a Public Health Emergency of International Concern (PHEIC) and seriously damaged the global economy. On January 13th, 2020 complete genome analysis was performed and revealed a novel corona virus (Gen Bank No. MN908947), official name is SARS-CoV-2 previously known as SARS-CoV [1]. SARS-CoV-2 can spread with human-to-human transmission via respiratory droplets (e.g. through coughing or sneezing) or even by contact with contaminated surfaces [2].

It is a single-stranded positive-sense RNA (ssRNA) virus consisting of 29,903 nucleotides and two untranslated sequences of 254 and 229 nucleotides at the 5'- and 3'- ends, respectively and is included in β -corona virus genus, closely related to the genomic organization of SARS-CoV identified in 2003 [3]. The most important structural proteins of CoV are spike (S) protein (trimeric), membrane (M) protein, envelop (E) protein, and the nucleocapsid (N)

protein. Some of the viruses such as beta-CoVs also have hemagglutinin esterase (HE) glycoprotein [4]. The interaction of angiotensin converting enzyme 2 (ACE2) of Human cell with spike protein of SARS-CoV-2 helps the virus to enter into the human cell immediately viral replication and transcription are started with the functional proteins like main protease (Mpro), papain-like protease (PLpro), RNA-dependent RNA polymerase (RdRp) [5,6]. Different studies revealed that the viral proteins showed varying mutation rates [7]. NSP12 (RdRp) accompanied with D614G (S) mutation showed mutation rate (MR) 0.994 while other residues of RdRp showed slower mutation rate (MR) 0.04 with A185 and 0.04 with V776 [8].

But till now any potentially active drug is not available in the market to combat with SARS-CoV-2. According to World Health organisation there are 24 vaccines that are in advance stages and another 142 vaccines are also in various early stages of development of the SARS-CoV2 pathogen [9]. Drug repurposing is an excellent way to choose a drug, developed for the treatment of other diseases to treat a new type of disease. But a number of antiviral drugs such as arbidol [10], chloroquine [11], darunavir [12], favipiravir [13], hydroxychloroquine [14], interferons [15], lopinavir [16],

* Corresponding author at: Department of Chemistry, University of Gour Banga, Malda 732103, India.

E-mail address: ghosh.naren13@gmail.com (N.N. Ghosh).



Inhibitory effect of anti-HIV compounds extracted from Indian medicinal plants to retard the replication and transcription process of SARS-CoV-2: an insight from molecular docking and MD-simulation studies

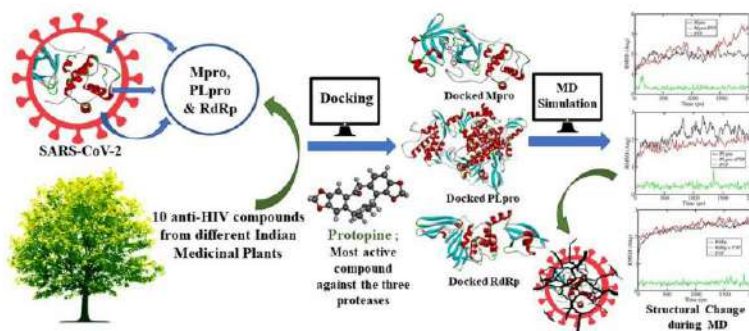
Tanmoy Dutta¹ · Nabajyoti Baildya² · Abdul Ashik Khan³ · Narendra Nath Ghosh⁴

Received: 20 August 2020 / Revised: 19 April 2021 / Accepted: 21 April 2021
© The Author(s), under exclusive licence to Springer-Verlag GmbH Austria, part of Springer Nature 2021

Abstract

Outbreak of Coronavirus (SARS-CoV-2) has thrown a big challenge to the globe by snatching millions of human lives from the world. In this study, inhibitory efficiency of ten anti-HIV compounds from different Indian medicinal plant parts have been virtually screened against Mpro, PLpro and RdRp proteins of SARS-CoV-2. The molecular docking study reflected that among these compounds, Proptine (PTP) has the highest binding affinity for the three cases. Introduction of PTP molecules within the binding pocket of these proteins showed a large structural and conformational changes on the structure of proteins which is revealed from molecular dynamics (MD) simulation studies. RMSD, RMSF and analysis of thermodynamic parameters also revealed that PTP makes a huge impact on the structures of the respective proteins which will pave an opportunity for doing advanced experimental research to evaluate the potential drug to combat COVID-19.

Graphic abstract



Keywords SARS-CoV-2 · COVID-19 · Proptine · Anti-HIV · Molecular dynamics simulation · Mpro · PLpro · RdRp

✉ Narendra Nath Ghosh
ghosh.naren13@gmail.com
Tanmoy Dutta
dutta.tanmoy88@gmail.com
Nabajyoti Baildya
nabajyotibaildya@gmail.com
Abdul Ashik Khan
abdulashik0@gmail.com

¹ Department of Chemistry, JIS College of Engineering, Kalyani 741235, India

² Department of Chemistry, University of Kalyani, Kalyani 741235, India

³ Department of Chemistry, Darjeeling Government College, Darjeeling 734101, India

⁴ Department of Chemistry, University of Gour Banga, Mordumpur, Malda 732103, India



14. Collaborative Research Activities of by **Dr. Kishor Biswas**, Department of Botany, Darjeeling Govt. College with Department of Botany, **Rajiv Gandhi University**, Rono Hills, Doimukh, Arunachal Pradesh 791112, India.

Indian J. Applied & Pure Bio. Special Volume 40-45 (2021).
Environment & Sustainable Development : Problems, Prospects &
Mitigation Date : 25th-27th November, 2021

ISSN: 0970-2091
A web of Science Journal

Rare, Endemic and Threatened Plants of Terai – Duars Belt of West Bengal, India

Kishor Biswas^{1*} and **A. P. Das²**

¹P.G. Department of Botany, Darjeeling Govt. College, Lebong Cart Road,
Darjeeling – 734101 (India).

²Department of Botany, Rajiv Gandhi University, Rono Hills,
Doimukh 791112 (India)

*Correspondence: kbiswas83@gmail.com

Abstract

Being located at the foot of the *Darjeeling* part of the *Eastern Himalayas*, Terai-Duars region is very rich in phytodiversity and unique habitats of a number of rare, endemic and threatened elements. Present study documented a total of 41 species (22 Endemic, 9 Endangered, 2 Near Threatened, 6 Vulnerable and 1 Critically Endangered) belonging to 27 families. Uncontrolled increase in anthropogenic activities leading to destruction and fragmentation of vegetations, invasion of exotic aggressive species were detected as the major threats. Presently replacement of natural forest by economically potent exotic species and their huge plantation has also been added to the list of threats. Thus the present work suggest further extensive study on this RET elements, their population structure and status, major threats to them and to frame the proper conservational strategies.

Terai - Duars belt of West Bengal is the Sub-Himalayan region of the Indian state that extends from Nepal to Assam. Geographically this area is located from 26°16'00" N to 27°00'00" N latitudes and from 87°59'30" E to 89°53'00" E Longitudes and bordered by Hilly region of Darjeeling district and Bhutan to the North; by Cooch Behar, North Dinajpur and Bangladesh to the South. Botanically, Terai is defined as the region of forest trees. Duars is divided into two distinct types of land forms - plains and undulated areas. The topography of Terai region is uneven and the altitude ranges from 62 to 350

m, whereas that of Duars ranges from 90 to 1750 m. Soil of this marshy Sub-Himalayan belt consists of almost horizontal layers of unconsolidated sand, silt, pebbles and gravels¹. The entire belt is criss-crossed by a number of the monsoon-swollen Himalayan Rivers, rivulets and streams and encounters mostly of humid subtropical type of climates more or less similar to that of the remaining districts of North Bengal. Due to its proximity to the hills, it faces longer winter and receives heavier rainfall. Average Monthly maximum temperature varies between 23°C – 32°C in January and September respectively whereas the average



Status of tree diversity of the Jaldapara National Park in West Bengal, India



Chandra Ghosh^{a,*}, Sumita Ghatak^b, Kishor Biswas^c, A.P. Das^d

^a Department of Tea Science, University of North Bengal, Siliguri, Darjeeling, West Bengal 734013, India

^b Office of the Chief Conservator of Forest, MIS & e-Governance, West Bengal, India

^c P.G. Department of Botany, Darjeeling Gov. College, Darjeeling, West Bengal 734101, India

^d Department of Botany, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh 791112, India

ARTICLE INFO

Keywords:

North Bengal
Threatened flora
Vegetation
Duars
Angiosperms
Phytodiversity

ABSTRACT

A floristic investigation was made during 2016 – 2018 to observe the tree diversity and their present status in the Jaldapara National Park (JNP) which is situated in the Duars region of West Bengal, India. A total of 294 species of trees belonging to 189 genera and 63 families, including 4 species of gymnosperms were recorded. Fabaceae (s.l.) with its 36 species has been appeared to be the dominant family. The tree community of JNP was found to be an excellent blend of wild as well as cultivated species of trees. All the four species of gymnosperms recorded are introduced to the park area. The present study highlights on different categories of threatened taxa which contributed about 43.53% of the recorded tree species. Different types of anthropogenic interferences, including NTFP (Non Timber Forest Product) collection and artificial forest-fire causing dangerous threats for the maintenance of its original vegetation and survival of numerous species in all the strata of the vegetation. Strict implementation of forest conservation related rules and the establishment of ex-situ Protected Area near the park may improve the situation.

Introduction

West Bengal is bounded by the Eastern Himalayas in the North, Bay of Bengal in the South, surrounded by five Indian states (Sikkim, Assam, Bihar, Jharkhand and Orissa) and three countries (Bhutan, Nepal and Bangladesh). The Northern part of West Bengal, often referred as North Bengal, is the gateway to northeast India and partly falling within and otherwise contiguous with the central part of the IUCN recognized 'Himalaya Biodiversity Hotspot', in which around 30% of higher plant species are endemic to the region (Grierson and Long 1983; Das 1995; A.P. 2004; Bhujel and Das 2002; Ghosh and Das 2009).

North Bengal covers two Phyto-ecological zones: 1. Himalayan Region: a. *Darjeeling Himalayas* and b. *Sub-Himalayan region* and 2. Gangetic Plains: the *Barind Tract* (Rodgers and Panwar 1988). Champion & Seth (1968) recognized 10 major forest types in West Bengal of which 08 are found in North Bengal region. Northernmost part of North Bengal is hilly and the remaining parts are the southwardly rolling plains. Natural beauty as well as the biological wealth of this area is quite diverse

and plentiful (Das and Chanda 1987; Bhujel and Das 2002; Das 2005; Das et al., 2003, 2008; Ghosh and Das 2007; Sarkar and Das, 2017).

Northern part of West Bengal harbours 05 National Parks, 06 Sanctuaries, 01 Tiger Reserve and 01 Elephant Reserve, whereas the entire state of West Bengal has 06 National Parks, 15 Sanctuaries, 02 Tiger Reserves and 02 Elephant reserves. The varied habitat conditions in the protected and reserved forests lying at the Himalayan foothills harbours an extremely rich flora, diverse wildlife and various cultural races and communities (Biswas 2017; Ghosh et al., 2020).

Among the 13 recognised Protected Areas of North Bengal, Jaldapara National Park (JNP) is the most prestigious one and is the second largest natural home for the great Indian one-horned Rhinoceros (*Rhinoceros unicornis* L.) in India after Kaziranga National Park in Assam. The park is also a rich reservoir of biodiversity and supports the occurrence of quite a good number of threatened, an endemic taxa (Banerjee 1993; Pandit 1996; Anonymous 1997; M. 2007, 2016; Das et al., 2003; Ghosh and Das 2005; C. 2007; Ghosh et al., 2013). Angiospermic trees represent a large part of floral diversity in forested

* Websites consulted: <http://www.bsienvs.nic.in> <https://www.googleearth.com> <https://www.inditales.com> <https://www.ipni.org> <http://www.iucn.org> <http://www.iucnredlist.org> <https://www.mapsofindia.com> <https://www.plantsoftheworldonline.org> <https://www.theplantlist.org> <https://www.wikimapia.org> <https://www.wildfact.com>

* Corresponding author.

E-mail address: chandraghosh19@nbu.ac.in (C. Ghosh).

<https://doi.org/10.1016/j.tfp.2020.100061>

Received 23 September 2020; Received in revised form 28 December 2020; Accepted 29 December 2020

Available online 4 January 2021

2666-7193/© 2021 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Officer-in-Charge
D1 Darjeeling Govt. College





15. Collaborative Research Activities of by **Dr. Rujas Yonle**, Post Graduate Department of Zoology, Darjeeling Govt. College with Regional office, Eastern Himalaya-Northeast India, Ashoka Trust for Research in Ecology and the Environment, Gangtok, Sikkim, India.

HUMAN DIMENSIONS OF WILDLIFE
<https://doi.org/10.1080/10871209.2021.1905114>



ARTICLE



Socio-ecological assessment of squamate reptiles in a human-modified ecosystem of Darjeeling, Eastern Himalaya

Aditya Pradhan ^a and Rujas Yonle ^b

^aRegional office, Eastern Himalaya-Northeast India, Ashoka Trust for Research in Ecology and the Environment, Gangtok, Sikkim, India; ^bPost Graduate Department of Zoology, Environmental Biology Laboratory, Darjeeling Government College, Darjeeling, West Bengal, India

ABSTRACT

Squamate reptiles are among the most underappreciated taxa due to their unappealing esthetics and numerous myths and misconceptions associated with them, depriving them of much needed conservation-related attention. This study was undertaken in a human-modified ecosystem of Darjeeling, Eastern Himalaya, by integrating ecological and social methods to assess the conservation potential of reptiles and understand community perceptions about reptiles. Ecological diversity was investigated by time-constrained visual encounter surveys, whereas key informant interviews ($n = 42$) using a semi-structured questionnaire examined the perceived diversity, attitudes, and behavior toward reptiles. Results indicated that respondents underestimated the local reptilian-diversity, but recognized their habitats and phenology. Eighty-three percent of key informants believed that squamates are poisonous, whereas 52% suggested that they would kill squamates. Knowledge-building programs that promote citizen science and help in identifying venomous squamates may be key to squamate reptile conservation in the region.

KEYWORDS

Human-dominated landscape; reptiles; conservation; ecosystem services; community attitudes; biodiversity

Introduction

Understanding the needs of humans is a crucial component in biodiversity conservation, as human-biodiversity interactions can range from reverence to extreme conflict (Deutsch et al., 2020). The conceptual framework of the Millennium Ecosystem Assessment (MEA, 2005) recognizes the dynamic interaction between humans and ecosystems. This framework focuses on benefits that humans derive from ecosystems, referred to as ecosystem services, whereas the perceived or actual negative impacts of ecosystems on humans are considered to be disservices (Shackleton et al., 2016). Many components of biodiversity have socio-cultural importance and are subject to socio-cultural valuation, including appreciation of wildlife, esthetic, spiritual, educational, religious, and recreational values (MEA, 2005). This “conservation perspective of ecosystem services” (Mace et al., 2012, p. 20) treats biodiversity as an ecosystem service. This perspective has been utilized by numerous studies to frame the sociological and psychological underpinnings of human-biodiversity interactions on multiple taxa, with birds receiving the most attention (Belaire

CONTACT Aditya Pradhan adityazoo@live.com Environment Regional Office Eastern Himalaya-Northeast India, Ashoka Trust for Research in Ecology, NH 10 Tadong, Gangtok, Sikkim 737102, India.

This article has been republished with minor changes. These changes do not impact the academic content of the article.

© 2021 Taylor & Francis Group, LLC

Officer-in-Charge
D₁ Darjeeling Govt. College





16. Collaborative Research Activities of by **Dawa Bhutia**, Post Graduate Department of Zoology, Darjeeling Govt. College with Ecology and Toxicology Laboratory, Department of Zoology, University of North Bengal, Darjeeling- 734013, West Bengal, India.

South Asian J Exp Biol; 12 (6): 834-840; 2022 [DOI: 10.38150/sajeb.12(6).p834-840]



South Asian Journal
of Experimental Biology



ISSN: 2230-9799

Vol. 12, Issue 6 Page 834-840

<http://www.sajeb.org>

REGULAR ARTICLE

Metabolism of β -naphthoflavone by cytochrome P450 isoforms in three air breathing fish, *Channa punctatus*, *Heteropneustes fossilis* and *Clarias batrachus*

Dawa Bhutia^{1*} and Joydeb Pal²

¹P.G. Department of Zoology, Darjeeling Government College, Darjeeling-734101, West Bengal, India

²Ecology and Toxicology Laboratory, Department of Zoology, University of North Bengal, Darjeeling- 734013, West Bengal, India

ARTICLE INFO

Article History:

Received: 1 Aug 2022

Revised: 28 Sep 2022

Accepted: 21 Oct 2022

*Corresponding Author:

Email: dbhutia16@gmail.com

Telephone: 9609827290

Keywords: *Channa punctatus*, *Heteropneustes fossilis*, *Clarias batrachus*, Cytochrome P450, β -naphthoflavone

ABSTRACT

The crucial phase I xenobiotic metabolising enzyme cytochrome P450 (CYP 450) has a variety of isoforms and a wide range of substrate specificities. While the roles of mammalian CYP 450 are well established, those of non-mammalian species are much less defined. These roles are frequently extrapolated from mammalian data and assumed to be similar across vertebrate species. In the present study, three air breathing fish species, *Channa punctatus*, *Heteropneustes fossilis* and *Clarias batrachus* were injected intraperitoneally (IP) with 50 mg/kg β -naphthoflavone (β -NF) and its effects on hepatic CYP 450 system were evaluated. β -NF treatment resulted in significant increase ($p < 0.01$) in CYP 450 content and CYP1A mediated EROD (Ethoxyresorufin O-deethylase) activity in all three treated fish groups compared to control. CYP2B mediated N,N-dimethylaniline demethylase activity and CYP2E1 mediated aniline hydroxylase activity showed no response suggesting insensitivity to β -NF treatment. All three fish species showed an increase in CYP3A4 mediated erythromycin N-demethylase activity, but only *H. fossilis* displayed a significant difference ($p < 0.05$). Of all the activities investigated, EROD activity mediated by CYP1A responded towards β -NF treatment the best and could serve as a sensitive biomarker to gauge the effects of chemical pollutants in the aquatic environment.

1. Introduction

Many of the chemicals that have been introduced into the environment over the past 50 years are highly persistent substances, such as pesticides, heavy metals, polychlorinated biphenyls (PCBs), polychlorinated dibenzodioxins (PCDDs), and polyaromatic hydrocarbons (PAHs). Aquatic organisms are exposed to highly harmful compounds as a result of their chemical stability and persistency, which tends to accumulate in

various aquatic environments (Havelkova et al., 2007).

All spheres of life contain members of the vast, universal superfamily of hemoprotein monooxygenases known as cytochrome P450 (CYP 450). They participate in several physiological processes, such as the oxidative metabolism of xenobiotic and the production of endogenous substances. Conversion of foreign compounds into polar metabolites to facilitate their elimination is

Officer-in-Charge
D1 Darjeeling Govt. College

