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# RESEARCH PAPERS

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RESEARCH ARTICLE

**KARYOMORPHOLOGICAL ANALYSIS OF SOME EDIBLE AROIDS OF UPPER BRAHMAPUTRA VALLEY OF ASSAM**

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**SUMMARY** Aroids (Araceae) locally known as '*Kachu*' are among the most favoured edible plants throughout Assam. Karyomorphology of 16 collections belonging to 10 species of edible aroids of Upper Brahmaputra Valley of Assam has been studied. The species included here are, *Alocasia macrorrhizos* (L.) G. Don (2n = 42), *A. odora* (Roxburgh) K. Koch (2n = 28), *Amorphophallus bulbifer* (Roxb.) Blume (2n = 26), *Colocasia antiquorum* Schott (2n = 56), *C. esculenta* (L.) Schott (2n = 28, 42, 56), *Cyrtosperma merkusii* (Hassk.) (2n = 26), *Lasia spinosa* (L.) Thwaites (2n = 26, 28), *Staudneria assamica* Hook. f. (2n = 28), *Typhonium trilobatum* (L.) Schott (2n = 26) and *Xanthosoma sagittifolium* (L.) Schott (2n = 26). The lowest and highest diploid chromosome numbers in the taxa studied here are, 2n = 26 and 56 respectively and the intervening numbers being 2n = 28 and 42. Intraspecific variations in chromosome number and evolutionary significance of karyotypes are discussed. Satellite markers were not observed in the accessions.

**Keywords:** Edible aroids, karyomorphology, aneuploidy, polyploidy, Assam.

**INTRODUCTION**

Aroids (Araceae) colloquially known as *Kachu*, are one of the most important and favoured edible plants of not only the people of Upper Brahmaputra Valley of Assam but the entire Northeast India. This family has 8 subfamilies, 119 genera and 6450 species distributed mostly in tropical and subtropical regions (Mabberley 2017).

Chromosome data are known to be of taxonomic value and found to be essential in studies focusing on diversification (Stebbins 1971). Karyomorphological features also play an

important role in determining the taxonomic status of the species as they help in the study of plant systematics and evolution (Clark & Wall 1996). When different taxa showed the same chromosome number and karyotypic features, then it is very problematic to distinguish between them by conventional cytological analysis (Sultana et al. 2011). Hence, there is a need to generate more cytological and morphological information which will be helpful in examining relationships within the species as well as in the genera (Sheffer & Croat 1983).



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# scientific reports



OPEN

## Computational modelling of nanotube delivery of anti-cancer drug into glutathione reductase enzyme

Saheen Shehnaz Begum, Dharitri Das, Nand Kishor Gour & Ramesh Chandra Deka<sup>✉</sup>

Density functional theory method combined with docking and molecular dynamics simulations are used to understand the interaction of carmustine with human glutathione reductase enzyme. The active site of the enzyme is evaluated by docking simulation is used for molecular dynamics simulation to deliver the carmustine molecule by (5,5) single walled carbon nanotube (SWCNT). Our model of carmustine in the active site of GR gives a negative binding energy that is further refined by QM/MM study in gas phase and solvent phase to confirm the stability of the drug molecule inside the active site. Once released from SWCNT, carmustine forms multiple polar and non-polar hydrogen bonding interactions with Tyr180, Phe209, Lys318, Ala319, Leu320, Leu321, Ile350, Thr352 and Val354 in the range of 2–4 Å. The SWCNT vehicle itself is held fix at its place due to multiple pi-pi stacking, pi-amide, pi-sigma interactions with the neighboring residues. These interactions in the range of 3–5 Å are crucial in holding the nanotube outside the drug binding region, hence, making an effective delivery. This study can be extended to envisage the potential applications of computational studies in the modification of known drugs to find newer targets and designing new and improved controlled drug delivery systems.

Combination of computational tools such as docking, molecular dynamics simulations as well as QM/MM are powerful and necessary to explain the biological environment that loses its essence outside the human cell. In human erythrocytes, glutathione reductase (GR) catalyzes the reduction of glutathione disulfide to glutathione which maintains the reducing environment of the cell with the primary function of maintaining a high intracellular ratio of [GSH]/[GR], where GSH is reduced glutathione. The oxidative stress of the cell increases in the absence of glutathione, with the generation of peroxides and free radicals that cause damage to all cellular components. The GR family consists of a central five-stranded parallel  $\beta$ -sheet surrounded by  $\alpha$ -helices and an additional crossover connection composed of a three-stranded antiparallel  $\beta$ -sheet<sup>1</sup>. It is an oxidoreductase homodimer with 52 kD monomers, of which each has three domains viz. residues 1–157 FAD-binding domain, residues 158–293 NADPH-binding domain, and residues 365–478 dimerization domain<sup>2,3</sup>.

Carmustine is  $\beta$ -chloro-nitrosourea (BCNU) is a nitrosourea whose primary function is the alkylation of DNA<sup>4–6</sup>. During craniotomy, a piece of bone is removed to expose the area of brain over the tumor. The outermost layer of the brain tissues (known as dura mater) is opened, thus, the tumor is located and then resected. After the tumor is removed, the bone is usually replaced and the scalp stitched shut. The removal of the tumour creates a cavity. Commercially, Gliadel wafer is a form of carmustine medication where carmustine is incorporated in the cavity after surgical removal of a brain tumor. Such carmustine wafer allows for delivery of the drug directly to the site of the brain tumor, the amount of carmustine received depends on the size of the cavity and how many wafers can be put into place<sup>7–11</sup>.

Alkylating agents such as carmustine, lomustine (Nitrosoureas), bendamustine and cyclophosphamide (Nitrogen mustards), busulfan (Alkyl sulfonates), temozolomide (Triazines) are some of the chemotherapeutic drug agents that are used in modern cancer chemotherapies<sup>12</sup>. The rationalization for using alkylating agents in chemotherapeutic cancer treatment is that such agents exert acute cytotoxic effects on actively growing cells.

However, acquired drug resistance is one of the greatest hindrances for the successful treatment of cancer. Resistance can emerge due to several reasons such as environmental factors, genetic or epigenetic alterations in the cancer cells. Hence, finding newer routes to cease actively growing cancer cells is implicit. Inhibition of specific proteins such as GR may be one of the possible routes that would lead to cancer cell death.

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## Nature of sorption of trivalent arsenic on novel iron oxyhydroxide stabilized starch/OMMT composite: A mechanistic approach

P. Gogoi, M. Das, P. Begum and T. K. Maji

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### ABSTRACT

Materials which are chemically, energetically and operationally acceptable for arsenic water treatment are highly required. In this study a hybrid material (SICC) of aminated starch, oxyhydroxide of iron and OMMT clay has been demonstrated for arsenic treatment. This new material was highly efficient in arsenic water treatment which could reduce arsenic concentration far below detection limits. All binding interactions during material preparation and arsenic sorption were exclusively characterized with FT-IR, XRD and other spectroscopic tools. A molecular modeling on the basis of density functional theory was carried out to verify the above findings. Influence of material dose, treatment time, initial ion concentration, varying temperatures, etc., on extent of sorption was studied in detail. The thermodynamic parameters viz.  $\Delta G$  ( $>-11$  kJ/mol),  $\Delta H$  (42.48 kJ/mol),  $\Delta S$  (177.6 J K<sup>-1</sup> mol<sup>-1</sup>) and  $E$  a (59.16 kJ/mol) determined the feasibility of the process, its endothermic behavior and most importantly the chemical nature of the sorption accompanied by ion-exchange to some extent. The sorption followed a monolayer chemisorption pattern as determined by the Langmuir model ( $R^2 = 0.973$ ,  $R_L = 0.081$ ) with a  $Q_{max} = 2.04$  at 303 K. The binding of As(III) on the material was governed by a pseudo second order kinetic model.

**Key words** | chemisorption, endothermic, feasibility, hybrid material, molecular modeling

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### HIGHLIGHTS

- Properties of the hybrid material were enhanced synergistically.
- Suspended materials were negligibly small in hybrid material.
- Material with 10% clay loading accompanied by Iron(III) oxyhydroxide stabilization was found best in all respects.
- Arsenic on SICC was predominantly chemisorbed accompanied by ion exchange to some extent.
- The sorption process was spontaneous and endothermic in nature.

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## Visible-Light-Induced Difunctionalization of Styrenes: Synthesis of N-Hydroxybenzimidoyl Cyanides

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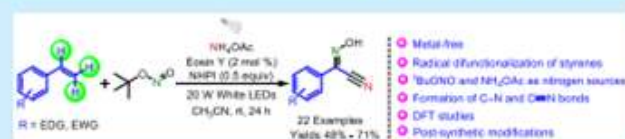
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**ABSTRACT:** A visible-light-induced synthesis of N-hydroxybenzimidoyl cyanides from aromatic terminal alkenes is achieved by using Eosin Y as an organic photoredox catalyst. The process goes via a radical pathway with successive incorporation of two nitrogen atoms, one each from *tert*-butyl nitrite and ammonium acetate. The final product is achieved by the concomitant installation of an oxime and a nitrile group. DFT calculation supports a biradical pathway and all the proposed steps. A few useful synthetic transformations of N-hydroxybenzimidoyl cyanide are also illustrated.

Visible-light-mediated photocatalytic functionalization have attracted considerable attention in modern organic synthesis, because of sustainable energy source to promote chemical reactions.<sup>1</sup> Usually, the photoredox process via a single-electron transfer (SET) under mild reaction conditions is utilized for the synthesis of numerous organic compounds.<sup>2</sup> In this context, Ru- and Ir-based complexes are well-explored photocatalysts for several organic transformations mediated by visible light.<sup>3</sup> However, despite their extraordinary photophysical properties, their use is discouraged, because of their scant availability, toxicity, and high cost.<sup>4</sup> Lately, organic dyes such as Rose Bengal, Eosin Y, Eosin B, etc. have been used in lieu of transition metals, since they are inexpensive, less toxic, and easy to handle. In particular, Eosin Y is used as an organophotoredox catalyst in many radical-based organic transformations.<sup>5</sup> Of late difunctionalization of alkenes has become a popular and competent chemical transformation by which two functional groups can be introduced simultaneously across the double bond.<sup>6</sup> Normally, difunctionalization of alkenes requires transition-metal catalysts and proceeds via radical-mediated processes. This increases the molecular complexity in a step-economical fashion.<sup>7</sup> Among various methods, the radical-mediated difunctionalization of alkenes has made great progress recently, particularly the visible-light-mediated photoredox SET process.<sup>8,9</sup>

On the other hand, oxime is a privileged scaffold for the preparation of amines, amides, and nitrogen-containing heterocyclic compounds.<sup>10</sup> Oxime functionality is found in compounds having anti-inflammatory, antibiotics, and pesticidal activities.<sup>11</sup> Similarly, the nitrile serves as a synthetic precursor of many functional groups such as amine, amide, aldehyde, tetrazole, and carboxylic acid, which are also found

in a variety of compounds having numerous biological activity.<sup>12</sup> The presence of these two important functional groups in a single molecule may further augment its activity against various targets (Figure 1).<sup>13</sup> Conventionally, nitrile

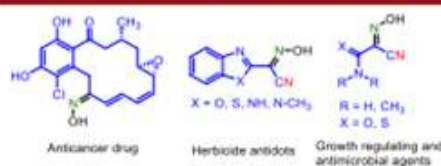


Figure 1. Representative biologically active oximes and N-hydroxybenzimidoyl cyanides.

group is introduced by Sand Meyer and Rosenmund-von Braun reactions, as well as by the use of traditional cyanating reagents such as NaCN, CuCN, KCN, TMSCN, Zn(CN)<sub>2</sub>, and K<sub>4</sub>[Fe(CN)<sub>6</sub>].<sup>14</sup> However, many of the cyanation processes suffer from certain drawbacks, because of the direct use of the toxic cyanide anion, which releases fatal and volatile HCN under the reaction conditions.<sup>15</sup>

An elegant synthesis of oxime has been reported by the Beller group in 2009 from styrene and *tert*-butyl nitrite in the

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## Nitroalkenes

# tert-Butyl Nitrite Mediated Nitro-Nitratosation of Internal Alkenes

Bilal Ahmad Mir,<sup>[a]</sup> Suresh Rajamanickam,<sup>[a]</sup> Pakiza Begum,<sup>[a]</sup> and Bhisma K. Patel<sup>\*[a]</sup>

**Abstract:** In an oxygen atmosphere *tert*-butyl nitrite (TBN) reacts with unsymmetrical internal benzylic alkenes giving nitro-nitratosation product exclusively. The  $\gamma$ -diaryl-substituted styrenes provided better yields compared to  $\gamma$ -alkyl-aryl-substituted styrenes. The higher yields for the former type of substrates is possibly dictated by the additional stability of benzylic radical due to the anchimeric assistance imparted by the  $\gamma$ -substituted phenyl ring. During oxidative nitration, the nitro ( $\text{NO}_2$ ) group adds at the non-benzylic site, whereas the nitrato group ( $\text{ONO}_2$ ) is attached at the relatively stable benzylic position. Under similar reaction conditions,  $\alpha,\beta$ -unsaturated carbonylic acids, afforded nitroalkenes as the sole product.

### Introduction

The metal-free reagent, *tert*-butyl nitrite (TBN) is emerging as a multi-tasking reagent in various synthetic applications because of its easy availability, easy handling, low cost, and stability.<sup>[1]</sup> Thermolysis of TBN provides NO and  $^t\text{BuO}$  radicals. The former can directly participate in a reaction, whereas both of these radicals can initiate several reactions. Due to the intrinsic ability of TBN to activate molecular oxygen it captures dioxygen generating a  $\text{NO}_2$  radical, which prompts nitration and many other oxidation processes. Interestingly, the NO radical is a good acceptor of transient radicals thus serving as an efficient radical trapper and source of N and N–O synthons.<sup>[1]</sup>

Terminal alkenes such as styrene react differently with TBN depending upon the other additives present in the reaction. Styrenes react with TBN in the presence of  $\text{Fe(II)}$  catalyst and  $\text{NaBH}_4$  to give corresponding oximes.<sup>[2]</sup> Treatment of styrene with TBN in an air atmosphere in toluene at room temperature provided  $\beta$ -nitroalcohol along with some nitrated products (Scheme 1c).<sup>[3]</sup> Styrenes undergo cross-coupling in the presence of metal-based carbene and NO radical (generated in situ from TBN) providing isoxazoles.<sup>[4]</sup> In this process, styrene serves as a dienophile and undergo [3+2] cycloaddition in situ generated nitrile oxide intermediate. Following the analogous [3+2] cycloaddition strategy our group obtained symmetrical isoxazoles from styrenes in the presence of TBN,  $\text{Sc(OTf)}_3$  and quinoline.<sup>[5]</sup> While quinoline did not participate and serve only as a base during the formation of isoxazoles. However, in a Cu-catalyzed process, it took part along with the styrene and TBN providing imidazo[1,2-*a*]quinolines via a three-component process. Here, TBN serves the dual role of an N1 synthon as well as an oxid-

ant.<sup>[6]</sup> In the absence of any other additives, styrene analogues react with TBN in DMSO providing 1,2,4-oxadiazole-5(4*H*)-ones.<sup>[7]</sup> Sulfonyl hydrazide as sulfonyl radical and TBN as the NO source adds across the styrene double bond to give a bi-

### Previous works:

$\text{Ar-CH=CH-Ar} \xrightarrow[\text{DCM}]{\text{NO}_2, \text{O}_2}$ 

$\text{Ar-CH(OH)-CH(NO}_2\text{)-Ar}$  +  $\text{Ar-CH(ONO}_2\text{)-CH(NO}_2\text{)-Ar}$  (a)

$\text{Ar-CH=CH-Ar} \xrightarrow[\text{aq. HClO}_4]{\text{O=N-OOH, O}_2}$ 

$\text{Ar-CH(OH)-CH(NO}_2\text{)-Ar}$  +  $\text{Ar-CH(ONO}_2\text{)-CH(NO}_2\text{)-Ar}$  (b)

$\text{Ar-CH=CH-Ar} \xrightarrow[\text{O}_2, \text{rt}]{^t\text{BuONO, H}_2\text{O}}$ 

$\text{Ar-CH(OH)-CH(NO}_2\text{)-Ar}$  +  $\text{Ar-CH(ONO}_2\text{)-CH(NO}_2\text{)-Ar}$  (c)

$\text{Ar-CH=CH-Ar} + ^t\text{BuONO} \xrightarrow[\text{CH}_3\text{CN, rt}]{\text{Mn(OAc)}_3, 2\text{H}_2\text{O}}$ 

$\text{Ar-CH(OO}^t\text{Bu)-CH(NO}_2\text{)-Ar}$  (d)

$\text{Ar-CH=CH-Ar} \xrightarrow[\text{K}_2\text{S}_2\text{O}_8, \text{base}]{^t\text{BuONO}}$ 

$\text{Ar-CH=N-CH(Ar)-Ar}$  (e)

$\text{Ar-CH=CH-Ar} \xrightarrow[\text{K}_2\text{S}_2\text{O}_8, \text{base}]{^t\text{BuONO}}$ 

$\text{Ar-CH=CH(NO}_2\text{)-Ar}$  (f)

### Present works:

$\text{Ar-CH=CH-Ar} \xrightarrow[\text{0}^\circ\text{C, CH}_3\text{CN}]{^t\text{BuONO, O}_2}$ 

$\text{Ar-CH(ONO}_2\text{)-CH(NO}_2\text{)-Ar}$  (g)

$\text{R} = \text{Me, Ar}$   
 $\text{R} = \text{Ar}$  (higher yield)  
 $\text{R} = \text{Me}$  (lower yield)

$\text{Ar-CH=CH-COOH} \xrightarrow[\text{100}^\circ\text{C, CH}_3\text{CN}]{^t\text{BuONO, O}_2}$ 

$\text{Ar-CH=CH(NO}_2\text{)-COOH}$  (h)

Scheme 1. Various methods for nitration of alkenes.

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## C-H Functionalization

# Copper(I) Catalyzed Differential Peroxidation of Terminal and Internal Alkenes Using TBHP

Bilal Ahmad Mir,<sup>[a]</sup> Suresh Rajamanickam,<sup>[a]</sup> Pakiza Begum,<sup>[a]</sup> and Bhisma K. Patel<sup>\*[a]</sup>

**Abstract:** Terminal and internal alkenes react contrarily with *tert*-butyl hydroperoxide (TBHP) giving various products. A Cu(I) catalyzed decarbonylative C–C bond formation followed by a carbonylation–peroxidation of vinyl arenes has been achieved using *tert*-butyl hydroperoxide (TBHP) as the oxidant in acetonitrile. Whereas,  $\alpha$ -methyl styrenes yielded aryl methyl ketones and the  $\alpha$ -substituted unsymmetrical internal alkenes afforded

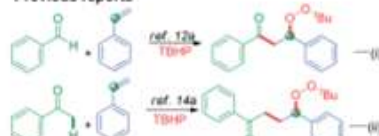
selective  $\alpha$ -peroxidation under the identical reaction conditions. Concurrent peroxidation–carbonylation–cycloalkylation/cycloetherification of internal cyclic alkene such as indene is achieved by switching the solvent system from acetonitrile to cycloalkanes/cyclic ether. All these reactions proceed via radical paths generating interesting peroxo-compounds.

## Introduction

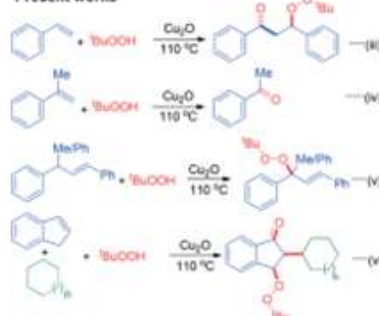
Difunctionalization of alkenes is significant in the synthetic transformation to build molecular complexity in a single operation. Both intra and intermolecular hetero-difunctionalizations of alkenes have received considerable attention. In contrast to intermolecular processes, intramolecular difunctionalizations are much more selective and thermodynamically favorable. The transition-metal-catalyzed intermolecular difunctionalizations such as carbonylation,<sup>[1]</sup> dihydroxylation,<sup>[2]</sup> oxyarylation,<sup>[3]</sup> oxyamination,<sup>[4]</sup> aminofluorination,<sup>[5]</sup> aminocyanation,<sup>[6]</sup> hydroalkylation,<sup>[7]</sup> carboboration<sup>[8]</sup> and other difunctionalizations<sup>[9]</sup> are well explored. However, intermolecular difunctionalization of olefins has rarely been explored following the C–H bond functionalization strategy. Carbonylation of alkenes has been developed as one of the powerful methods for the synthesis of carbonyl compounds.<sup>[10]</sup> But the simultaneous introduction of a carbonyl group and another functional group such as alcohol, amine and peroxide into alkenes is not well explored.<sup>[11]</sup> Lately, organic peroxides are used as oxidizing agents and initiators for free-radical reactions both in academia and industry. These peroxo compounds are produced and used in various natural and biological processes such as preparation of antimalarial agents,<sup>[11a–11f]</sup> anthelmintics,<sup>[11g]</sup> and antitumor drugs.<sup>[11h,11i]</sup> A Fe(II)-catalyzed carbonylation–peroxidation of olefins is reported via the  $sp^2$  C–H bond functionalization using aldehydes and *tert*-butyl hydroperoxide (TBHP) (Scheme 1).<sup>[12a]</sup> This carbonylation–peroxidation product has been utilized by Li group for the synthesis of ( $\pm$ ) clavilactones A, B<sup>[12b]</sup> and D.<sup>[12c]</sup> MacMillan group demonstrated a complementary asymmetric carbonylation of olefins using aldehydes following the

concept of singly occupied molecular orbital (SOMO).<sup>[12]</sup> Klusmann group have reported an acid-catalyzed oxidative keto-peroxidation of olefins using ketones and TBHP (Scheme 1(i)).<sup>[14a]</sup> Recently, Chen and co-workers reported a vanadium catalyzed carbonylation–peroxidation of styrenes using aldehydes and TBHP (Scheme 1(ii)).<sup>[14b]</sup> On the other hand, in 2018 Wang et al. reported a *tetra*-*n*-butylammonium bromide (TBAB)-catalyzed carbonylation–peroxidation of styrenes using aldehydes and TBHP.<sup>[14c]</sup> In addition to this, Li group reported an Fe-catalyzed alkoxycarbonylation–peroxidation of alkenes with carbazates and T-Hydro.<sup>[14d]</sup> The application of readily

### Previous reports



### Present works



Scheme 1. Strategies for difunctionalization via C–H functionalization.

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**Title of the paper:** An analysis of tourism status and prospects in Assam

**Name of the Journal:** Asian Journal of Multi Disciplinary Research and Review

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## AN ANALYSIS OF TOURISM STATUS AND PROSPECTS IN ASSAM

Written by **Anil Tanti**

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### ABSTRACT

Assam is the gateway to North-East India. It is comprised of eight states Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. Further, Assam shares international borders Bangladesh and Bhutan. Tourism is one of the world's largest and fastest growing industries. Considering its importance North East India is emerging as a beautiful tourism place. Assam is a land of wild forests, natural beauty, diverse history, rich culture, mighty rivers, historical monuments and over lakhs acres of tea plantations are making magnificent resources for tourism. Besides it, the majestic Brahmaputra River, Majuli the largest river island of Asia, royal hills, rich flora and fauna of the state are the paradise for tourists. It has breath-taking scenery which is known to be one of the pinnacle biodiversity hotspots in the whole world. Today tourism is considered as the biggest tool for generating revenue and employment. Ministry of Tourism is realizing that tourism is becoming an important sector of Indian economy and earning foreign exchange. Hence both central and state governments are adopting various policies to extend new field of tourism. Thus the new approaches are added to tourism which is called Tea Tourism, Golf Tourism, water tourism, agriculture tourism, cultural tourism etc. This paper makes an attempt to Analysis of Tourism Status and Prospects in Assam.

**Keywords:** Gateway, Biodiversity, Foreign exchange, Employment, Economy.

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## FINANCIAL AND INFRASTRUCTURAL SUPPORT SYSTEM TOWARDS SHG'S: EVIDENCES FROM ASSAM

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### ABSTRACT

*SHGs are set up with certain objectives and to achieve their objectives the SHGs need to follow a particular system. The objectives of SHGs are framed by National Institute of Rural Development, National Rural Livelihood Mission and different State Livelihood Missions and apart from these, many other agencies, are entrusted with the responsibility of development of rural India by providing essential help towards the women folk of our society. SHG is a distinctive programme for promotion and empowerment of rural folk mainly for upgrading the marginalized fraction. SHGs aims to include women as members with minimum or without any educational, entrepreneurial and industrial background to become self reliant through instilling self confidence so that they can develop their own decision making capacity and can solve problems on their own. In this particular study effort is being made to identify the support system developed by various agencies help the SHGs to achieve their target. Along with Financing pattern followed by agencies to the SHGs, infrastructural requirements of SHGs are also considered in this study.*

**Key words:** SHG, support system, financing pattern, infrastructural requirements

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### 1. INTRODUCTION

Primarily SHGs were set up in India as a micro credit group for economic empowerment of women and weaker sections through which the poor and needy sections of our society can have access to large quantum of resources. SHG provides an exposure to better technology

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Ocean Dynamics  
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## A numerical study on the role of atmospheric forcing on mixed layer depth variability in the Bay of Bengal using a regional ocean model

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### Abstract

This study investigates the role of driving atmospheric forces [winds, net heat flux, and evaporation–precipitation (E–P)] and the possible mechanisms on the mixed layer depth (MLD) spatiotemporal variability in the Bay of Bengal (BoB) using a finer-resolution (~9 km) Regional Ocean Modeling System (ROMS). The model simulation is configured for 2004–2012 with initial and boundary conditions from Mercator Ocean data, atmospheric forcing from ECMWF, and climatological river input. Comparison with in situ observations shows that the model well produces the mean seasonal characteristics of MLD variability. Spatial correlations have been carried out between the atmospheric forces and MLD to determine the relative influence of these forces on the MLD variability. During the southwest monsoon, strong southwesterly wind plays a crucial role in deepening the MLD up to 80 m in the southern BoB. In winter, the decrease in net heat flux and the increase in positive E–P in the upper ocean deepen the MLD in the northern bay to a depth of ~60 m. However, the high density stratification in the northern BoB due to the large inflow of freshwater from various rivers limits the seasonality of MLD, particularly in the northern BoB. The positive correlation between E–P and MLD suggests that the advection of the freshwater plume by the southward East India Coastal Current (EICC) forms a thin mixed layer in the western BoB. The model results well captured the contrasting Indian Ocean Dipole (IOD) years and reveal that the interannual variability of MLD seems to be connected to the IOD events in the BoB. The MLD is shallow during the positive phase of IOD (pIOD) in 2006, whereas the mean MLD is more profound (~50 m) during the negative period of IOD (nIOD) in 2010. In pIOD years, the anomalous upwelling coastal Kelvin waves (KWs) propagate, reflect Rossby waves, and trigger upwelling to form a shallow MLD throughout the BoB. The positive net heat flux at the air–sea interface also plays a dominant role in the MLD shoaling in pIOD year, as shortwave radiation increases and exceeds the cooling effect of latent heat flux during this period.

**Keywords** Mixed layer depth (MLD) · Bay of Bengal · ROMS · Wind stress · Heat flux · Evaporation–precipitation · Freshwater advection · IOD

### 1 Introduction

The mixed layer in the oceans is generally considered the quasi-homogeneous upper ocean layer, where the tracers such as temperature, salinity, and density are vertically uniform to a large extent. This homogeneous layer is the result of an intense vertical turbulent mixing at the air–sea

interface caused by atmospheric forces like wind stress, surface heat flux, buoyancy flux, evaporation, and precipitation. The depth of the mixed layer is vital to ocean variability, as it acts as an interface between the atmosphere and the ocean below. Besides, mixed layer depth (MLD) influences primary productivity, affects phytoplankton blooms by regulating the availability of nutrients and light (Fasham 1995; Narvekar and Prassana Kumar 2006), and is critical in understanding upper oceanic heat, buoyancy, and momentum exchange (Chen et al. 1994).

The Bay of Bengal (BoB) (Fig. 1), a semi-enclosed tropical ocean basin located in the northeastern part of the Indian Ocean, plays a critical role in determining the climate change in the Indian subcontinent. The basin circulation is unique in world oceans due to the effect of the seasonal

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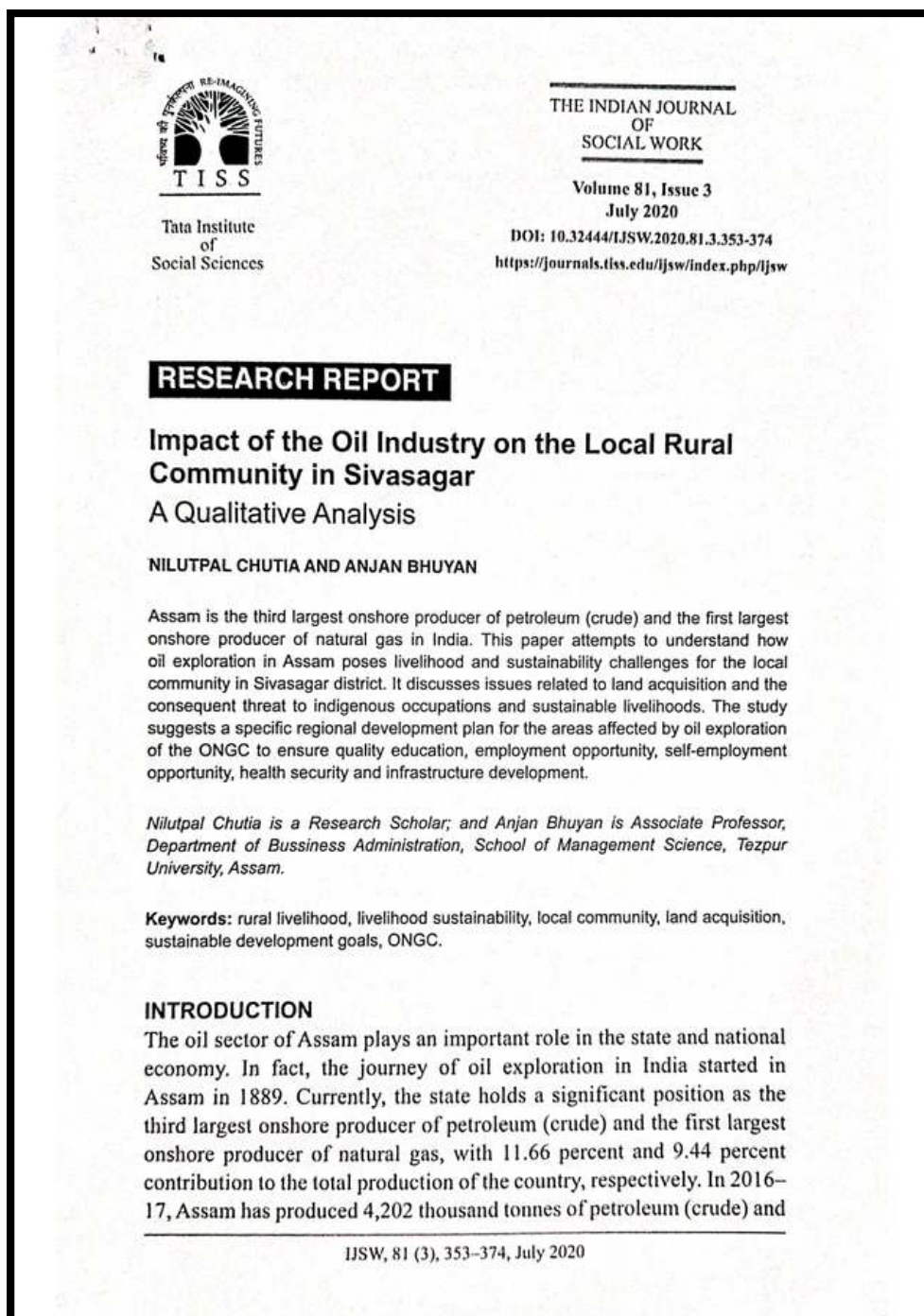
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## A Social Background of Kaibarta Community in Assam

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### Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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### ABSTRACT

Assam is well-known as the land of heterogeneous population with ethnic diversity. The society in the ancient days was predominantly a non-Aryan society in Assam. The people of Assam can be divided broadly into tribal and non-tribal categories from another angle. It is to be noted that the non-tribal category are included into three major groups such as the General Caste (GC), the Scheduled Castes (SC) and the Other Backward Classes (OBC). There are sixteen SC, twenty seven Scheduled Tribes (ST) and twenty nine communities are listed as OBC in Assam. The people of all communities are basically honest, truthful, straightforward and trustworthy in Assam. They are more interested to maintain social peace and harmony in Assam. They have moved away more or less from their traditional social life style after independence in Assam. The members of the Kaibarta community are playing a very important role in social development of Assam. The culture of the Kaibarta community is very rich in Assam. In this context, the present study is an attempt to discuss about the social background of Kaibarta community in Assam.

**Keywords:** Culture; kaibarta community; scheduled caste; Assam; population; agriculture; fishing.

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## Use of Modified Entropy Index and Logit Transformation Model to Access Non-Crop Enterprise Diversification in the Flood Affected Areas of Assam, India

B. Gogoi, S. Saikia

**Abstract:** Changing climatic condition like increasing density of rainfall, more siltation in the river beds etc., stimulates devastating flood in Assam. Year after year the changing nature of flood in Assam extemporize more risk in agriculture. In such circumstances, risk mitigation and livelihood security in the flood prone agricultural sector of Assam becomes one of the key agendas for development of the small and marginal farmers. Different studies have brought this issue of climate change and risk in agriculture and opined that crop diversification is one of the prolific strategies to mitigate risk and ensure livelihood in agriculture. However, very few studies have mentioned about non-crop enterprise diversification and risk mitigation in the agricultural sector of Assam. Therefore, an attempt has been made to examine the impact of non-crop enterprise diversification in risk mitigation in the flood prone areas of Assam by using Modified Entropy Index and Logit Transformation Model. The findings of the study show that the farmers in the flood prone areas under study diversified more non-crop enterprises than in the flood free areas. Therefore, small and marginal farmers of the flood prone areas of the study can takenon-crop sector to be an effective measure to combat flood like situations.

**Key words:** Non-Crop Enterprise Diversification, Risk Mitigation, flood, prolific strategy.

The ex-ante coping mechanisms that may be available to farmers to tackle the production risk include contract farming, crop insurance and diversification. While the scope of contract farming and crop insurance are very limited in a developing country many a time farmers take recourse to crop diversification. There is a proliferation of studies in India on the issue of crop diversification as a risk mitigating strategy in agriculture [1, 2, 3, 4, 5]. However, very few studies have taken the issue of non-crop enterprise diversification as a sound strategy to mitigate risk in the flood affected agriculture of Assam. Thus, this study is a modest attempt to cover the issue of non-crop enterprise diversification<sup>1</sup> in context of flood prone agriculture. Every year large areas come under the grip of floods that cause extensive damages to crops, animal lives and properties. Figure 1.1 shows the crop area affected (percentage of Gross Cropped Area) by flood in the state in some recent years. Limited studies in the literature have identified the association between agriculture and flood in context to Assam. In the study of Mandal[6] and Goyari [3] have found that farmers in the region is practicing crop diversification to deal with the flood. Few researchers addressed their studies on crop diversification responding to flood in Assam. But there have been limited studies exploring the scope of non-crop Diversification including livestock, poultry and fishery subject to flood proneness. The present study is a modest attempt to fill up this void of research which includes the nature and extent of non-crop enterprise diversification in terms of value-wise contribution of each non-crop enterprise to total agricultural value of production. So, this makes the present study novel from the other available studies in the existing literature.

### I. INTRODUCTION

Frequent and destructive nature of flood causes huge loses to the farm families of Assam and extemporize more risk in agriculture. Therefore, risk mitigation and livelihood security in the flood prone agricultural sector of Assam becomes one of the key agendas for the small and marginal farmers. Different research studies found thatimproper policy measures and institutional failures in agriculture make the sector more challenging for development.

### II. OBJECTIVES OF THE STUDY

A. To examine the extent of non-crop enterprise diversification through Modified Entropy Index.  
B. To identify the determinants of non-crop enterprise diversification through Logit Transformation Model.

### III. METHODOLOGY

This paper is completely based on primary data. The locations for field investigation were limited only to the

<sup>1</sup>Non-crop enterprise diversification is a kind of process through which a farmer shifted his resources from one non-crop enterprises to different non-crop enterprises to generate more profit or to provide insurance. In this study non-crop refers livestock, poultry and fishery.

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## Hardy's Tess – a Window to Victorian Society: a Study

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### INTRODUCTION

#### Realism in Hardy's Novels:

Thomas Hardy has made a successful attempt in representing the life of the country folk of Victorian England. The novelist seems, like George Meredith, to belong to the present rather than to a past age. But unlike Meredith who makes man the most important phenomenon in the universe and who always sees the rays of hope in life and victory in man's struggle against the odds, Hardy makes man an insignificant part of the universe, struggling against powers greater than himself. His man sometimes struggles against systems which he cannot reach or influence. Under such ground Hardy is called a 'pessimist' the term which is not so justified if one judges some of his novels in the light of the social conventions prevalent at his time. In fact, the dark aspects of life which were quite often observed among the people of Hardy's Victorian England drew his attention more than anything else relating to life.

#### Statement of the Problem:

In every novel, realism is an important aspect where characters play an important part. Hardy as a novelist cannot be expected to be exceptional in this concern. But there is every necessity of examining how far the characters in his novels are true to the Victorian Socio-economic reality. In this paper the character of Tess has been taken for the study.

Tess of the d'Urbervilles has universally been regarded as Hardy's masterpiece which describes the life of a very beautiful country girl named Tess who undergoes inexplicable suffering resulted from her seduction committed by a libertine named Alec. In the course of time Tess tries to forget her bitter past and makes a humble attempt to start a new life with Angel Clare who too after learning her past ultimately deserts her when she desperately needs his company and support. All these makes the poor woman utterly frustrated and out of her frustration kills Alec at the time when Angel comes back to her life after realization of his fault. She is sentenced to death for Alec's murder. The novel is a true document of Hardy's Victorian society, specially the country life and its social codes, and the agricultural world and its people along with their tensions and agonies. Tess, being Hardy's finest creation, claims more and more study and exploration.

### REVIEW OF LITERATURE

Being a true painter of life Hardy easily attracts the attention of the readers and critics. Excessive interest in him has throughout the years invited study and research work on his novels. John Bayley in his An Essay on Hardy (1981) suggests an insightful approach to Hardy as a poet and novelist and also discusses the vital ingredients of eroticism and humour and the unusual ways in which passiveness, 'pessimism', and anthropomorphism function in the poems and novels. David Cecil in his book Hardy the Novelist (1963) remarks that in all his fiction, chance is the incarnation of the blind forces controlling human destiny. In Thomas Hardy (1961) Douglas Brown studies 'Tess' as the tragedy of the exodus of the agricultural workers from the villages and the countryside. E. A. Baker in The History of English (1987) stresses on the conflict between man and nature.

#### Aims and Objectives of this study is to

- know how far successfully the novelist depicts Tess as a typical country girl
- know how far the delineation of Tess reflects the sex related issues and social bindings of the Society of Hardy's time

### METHODOLOGY

Any research investigation demands scientific method to be followed to reach the destined goal. The present investigation is a literary one and for making such exploration effective and fruitful, different approaches look convenient. There may be the approaches like descriptive, analytical, and comparative and so forth. The present study necessitates all these approaches to be taken into account so as to achieve the predicted goal. In brief, each of these approaches has to be bothered with to make the study complete and result-gaining.



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## Spatiotemporal analysis of road surface temperature (RST) and building wall temperature (BWT) and its relation to the traffic volume at Jorhat urban environment, India

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### Abstract

The study analyzed the pattern of building wall temperature (BWT) and road surface temperature (RST) in both urban and suburban area and its relation to traffic volume at Jorhat municipal area. The surface temperature pattern is assessed using the FLIR TG-165 spot thermal imaging camera and HTC MT-4 IR thermometer, while traffic volume is investigated through schedule survey and video recording over the selected urban roads. The study revealed a positive correlation between traffic volumes with BWT and RST, though the correlation is quite stronger with RST. The higher positive relationship between traffic volume and RST has been noticed mostly in the shadowing part of the surface, whereas on the other hand, the relationship pattern of BWT with traffic volume is also found noticeably higher at the shadowed part of the surface. In both analyses, the relationship between traffic with RST and BWT is identified as remarkably stronger at midday and afternoon period. The urban areas with maximum traffic congestion are identified as accountable for the higher BWT and RST.

**Keywords** Road surface temperature (RST) · Building wall temperature (BWT) · Traffic · Sunlight and shadow

### 1 Introduction

Urban heat island is an environmental phenomena characterized by significantly higher temperatures in urban areas contrary to rural surroundings (Zhu et al. 2017). It has become a major environmental issue due to urbanization and which ultimately leads to an intense

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## Evaluation of temporal dynamics of land use and land surface temperature (LST) in Agartala city of India

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### Abstract

The study has been conducted at Agartala Municipal area (AMA) of Tripura, which exhibits rapid population growth and faster land use land cover changes. The major purpose of the study is to understand the dynamics of land use and Land surface temperature (LST) in the city of Agartala. The study incorporated satellite data such as Landsat TM (Thematic Mapper) and OLI (Operational Land Imager)/TIRS (Thermal Infra-Red Sensors) data along with LandScan datasets of the years from 2008 to 2018. The results revealed a drastic change of land use land cover specifically built up land with net change of 15.63 sq km. While during the same epoch, population portrayed a net growth of 250,017 in the city. The population induced change of land use land cover have accelerated the mean LST of the city from 25.71 °C to 26.29 °C in summer and 21.48 °C to 26.05 °C in winter season, respectively. The increasing strength of correlation between NDBI (Normalized Difference Built-up Index) & NDVI (Normalized Difference Vegetation Index), NDBI&LST, NDVI&LST and finally Population density and LST with changing 'r' value from -0.46 to -0.89, 0.75 to 0.90, -0.76 to -0.81 and 0.34 and 0.67 in summer (2008–2018) whereas -0.34 to -0.83, 0.66 to 0.85, -0.56 to -0.78 and 0.35 to 0.50 in winter, respectively, signify the active role of population growth and built up land development on the intensification of the process of LST in the study area.

**Keywords** Land use · Population Density · NDVI · LST · AMA

### 1 Introduction

In the recent decades there is an increasing trend of climate research aimed to investigate climate change in the local and regional level by anthropogenic factors for better understanding of climate's driving forces (Adegoke et al., 2003). One of the significant alteration of natural landscape by anthropogenic processes is land use land cover dynamics (Weng, 2001; Xiao & Weng, 2007; Guo et al., 2012). A frequent land use and land cover change becomes the primary consequences of urbanization and urban growth in the local, regional and global scale. However in the recent period, the alteration of land use and land cover

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RESEARCH ARTICLE - ANTHROPOGENIC HAZARD



## Analyzing dynamic behavior of land use and land surface temperature in the city of Imphal, India

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### Abstract

The study has been conducted over the Imphal city using multi-temporal satellite imageries. The study investigated the pattern land surface temperature (LST) development over the hill city of Imphal and its relation to land use pattern and population density. The result revealed an ascending growth of LST as a consequence of population growth and rapid land use dynamics. The Imphal city exhibited a remarkable change in the land use structure, especially in the built-up land, vegetation and crop land. Addition of built-up land of 667.44 hectares in the city territory has consequently upsurged the mean LST of the city from 23.23 °C to 30.30 °C in summer and 14.74–18.10 °C in winter during the period of 26 years (1994–2020). Summer season witnessed a consistently increasing intensity of LST in the city whereas winter depicted a completely opposite scenario during 1994–2020. Among all the land use classes, built-up land expressed maximum LST dynamics in both seasons during the period 1994 to 2020. The high positive correlation coefficient between built-up land with LST and strong negative correlation between vegetation cover and LST paved the way for maximum LST development in the city province.

**Keywords** LST · NDVI · Built up · Vegetation cover and correlation

### Introduction

Over the last two decades the global urban population proportionally increased from 12% in 1990 to 50% in 2011 (Grimm et al. 2008; Trotter et al. 2017). Growing population in urban areas modifies the land use and land cover structure with increasing built environment with reducing water body and vegetation cover. Land covers dynamics are chiefly based on population growth alongside human intervention (Achmad et al. 2015). Agricultural needs (Camermer et al. 2013; Li et al. 2013; Dale et al. 1997), natural calamities (Dubovyk et al. 2011), economic along with urbanization (Rimal et al. 2019; Khan et al. 2014), and other factors (Mustafa et al. 2018). However, among all population growth is the major factor for expansion of urban area with changing land use and land cover pattern of cities. Rapid land use and land cover change modifies ecology,

reduces environmental quality specifically by altering thermal environment of an area. Land cover change alters the albedo of the surface, which sequentially increases energy interactions between atmosphere and surface thus introducing an influence on local climate (Sagan et al. 1979). Thus land use change brings simultaneous change in LST. Land surface temperature (LST) is the temperature felt when there is an uninterrupted swap over longwave radiation and turbulent heat fluxes between surface and atmosphere interface (Myneni et al. 2011; Li et al. 2013; Sobrino and Jovanovska, 2016). In other words LST can be defined as a skin surface temperature of the earth (Kumar et al. 2018). LST is the key indicator to understand the thermal dynamics of an urban area. The differences of land surface temperature (LST) between urban and non-urban area is helpful to understand the nature intensity of surface urban heat island phenomena (Neog et al. 2020). LST is now considered as one of the significant tool for scrutinizing temporal change of the heat of the earth surface (Kumar et al. 2018). It is normally known that the transformation of vegetative area to built-up environment (Mallick et al. 2008) and conversion of wetland, marshy areas to cropland and bare soil region (Pal and Akoma, 2009) plays a vital role in uprise of LST. The LST can be retrieve form the satellite products such as

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**EFFECTS OF VARIABLE VISCOSITY AND THERMAL  
CONDUCTIVITY ON UNSTEADY FREE CONVECTION FLOW  
PAST AN IMPULSIVELY STARTED INFINITE VERTICAL PLATE  
WITH NEWTONIAN HEATING IN THE PRESENCE OF THERMAL  
RADIATION AND MASS DIFFUSION**

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**Abstract**

*The influence of variable viscosity and thermal conductivity on unsteady free convection flow past an impulsively started infinite vertical plate with Newtonian heating in the presence of thermal radiation and mass diffusion is examined. Both the fluid viscosity and thermal conductivity are considered as an inverse linear function of temperature. The governing boundary layer equations with associated boundary conditions are converted to non-dimensional form. The magnetic Reynold number is assumed to be so small that the induced magnetic field can be neglected. The resulting non-linear partial differential equations are then solved using an iterative method for an implicit finite difference scheme. Effects of various flow governing parameters on the fluid velocity, temperature and concentration fields are presented graphically. Further, the numerical values of skin-friction co-efficient, Nusselt number and Sherwood number are computed and presented in tabular form.*

**Keywords:** Variable viscosity, thermal conductivity, Mass transfer, unsteady free convection flow, thermal radiation, MHD.

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**Name of the faculty with designation:** Dr. Yuvraj Gogoi, Assistant Professor.

**Department:** Political Science

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## YOUTH UNREST UNLOCKING THROUGH DEMOCRATIC SOCIALIZATION IN NORTHEAST INDIA

Dr. Paban Kr. Gogoi\*

### ABSTRACT

The disgruntlement among young people is a global problem that is evident in all nations. Young people, who are an essential component of the state and society, express their annoyance by expressing their dissatisfaction with the socio-economic and political developments exist in the nation. They mainly express their dissatisfaction through radical and democratic methods. The democratic approach involves non-violent protests and agitations, whereas the radical approach mostly involves insurgency and extremism. The youth of Northeast India are not an exception to the global and Indian context, as they are engaged in both democratic protest and insurgency. Evidence of democratic movements and insurgencies has largely been visible since the 1960s. As a result, this is a serious topic of discussion, and scholars and academics are working to identify and provide various solutions for the youth unrest in Northeast India. Therefore, the goal of this academic exercise is to determine the best approaches for comprehending the issue. This paper aimed to investigate the content through the process of socialization.

**Keywords :** Northeast India, Youth unrest, Democratic Socialisation, Insurgency, State

**Introduction :**

arises among young people due to their discontent with



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**Department:** Zoology

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ORIGINAL ARTICLE



# Smokeless tobacco 'sadagura' and areca nut extract exposure induces extensive embryotoxicity in chick embryo, *Gallus gallus domesticus*

Doli Talukdar<sup>1</sup> · Pimili Langthasa<sup>1</sup> · Dharmeswar Barhoi<sup>1</sup> · Sarbani Giri<sup>1</sup>

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## Abstract

**Objective** Areca nut (AN) and *sadagura* (SG, homemade smokeless tobacco) are often consumed alone or in combination irrespective of gender including pregnant women in the southern region of Assam, India. However, very few studies have been carried out so far to evaluate its ill effect during embryogenesis. The present study aims to determine the effects of AN, SG, and combination of both (AN + SG) in developing chick embryos as it serves as an excellent model for teratogenic and developmental toxicity study owing to its similarity with the human embryo.

**Methods** Fertile White Leghorn chicken eggs (*Gallus gallus domesticus*) were exposed to different concentrations of 0.125, 0.25, 0.5, and 1 mg/egg of AN, SG, and AN + SG extract, respectively. The eggs were divided into four groups: control, AN extract-, SG extract-, and AN + SG-treated group. Three different parameters, viz. mortality rate, morphometric measurements, and qualitative anomalies, were studied to observe teratogenic effects.

**Results** Results indicated a dose-dependent increase in mortality rate in all the treatment groups. Also, quantitative measures suggested significant decrease ( $p < 0.001$ ) in wet body weight, crown-rump length, anterior-posterior head length, and eyeball diameter in all the concentration of AN, SG and AN + SG of treatment groups when compared to control group. Compared to control, anomalies like microcephaly, microphthalmia, deformed beak, hemorrhage, omphalocele, flexed limbs, and ectopia cordis were prominent in treated groups. Our findings depict organ-specific as well as systemic defects in the developing embryos.

**Conclusion** Our results suggest that exposure to AN, SG, and AN + SG causes adverse developmental abnormalities and embryo mortality in the chick embryo.

**Keywords** Areca nut · *Sadagura* · Smokeless tobacco · Chick embryo · Embryotoxicity

## Introduction

Areca nut (AN), most common ingredient of betel quid (BQ), and *Sadagura* (SG), a smokeless tobacco (SLT), are widely consumed and highly popular in southern Assam, India [1]. AN also known as *Areca catechu* is consumed as a masticatory agent in various parts of the globe including India, Taiwan, Southeast Asian countries, and Latin

America [2]. It is generally taken in combination with lime, and sometimes, tobacco is wrapped up with Piper betel leaf and known as BQ. Chewing of BQ ranks fourth among the most widely consumed addictive substances after smoking, alcohol, and caffeine [3]. Association between smoking and adverse effects on embryological development has been reported by several workers; however, studies on smokeless tobacco exposure and embryo toxicity are inadequate. SG is consumed alone or with BQ and is made up of sun-dried and roasted tobacco leaves with small amounts of black cumin and aniseed as flavoring agents [1]. In the present study, we are reporting the effects of *Sadagura* which consisted of three ingredients, i.e., tobacco leaves, aniseeds, and black cumin seeds. Although the possibility cannot be ruled out, aniseed and black cumin seed are common Indian spice and used in day-to-day cooking. Moreover, our study did not aim to assess the effect of individual ingredients, but the

**Electronic supplementary material** The online version of this article (<https://doi.org/10.1007/s13530-020-00038-6>) contains supplementary material, which is available to authorized users.

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**Consumption pattern and genotoxic potential of various smokeless tobacco products in Assam, India: A public health concern**

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**ABSTRACT**

Smokeless tobacco (SLT) consumption is presumed to be one of the major causes of high incidence of oral cancer in India. The present study aimed to document various types of SLT products consumed and their potential impact on the genome instability on the population from Assam state in Northeast India. A cross-sectional study (n = 5000) showed that 60.56 % of the study population consumed at least one of the three forms (*sadagura*, *zarda* and *khaini*) of SLT of which 52.0 % were only *sadagura* users. Genotoxicity assessment using buccal cytome assay in 240 age and sex matched volunteers revealed that except for *zarda*, other forms of SLT induced significantly higher incidence of micronuclei in the buccal epithelial cells compared to the control individuals. Similar effects were also observed in other cytome parameters related to cell proliferation, cytokinesis defects and cell death. Significantly higher incidence of micronucleus was observed among *sadagura* and *khaini* users in lymphocyte cytokinesis-blocked micronucleus assay. The addition of lime in *sadagura* increased the pH and anion levels which possibly result in higher absorption and may lead to the development of cellular anomalies.

**1. Introduction**

Tobacco consumption, either in the form of smoking and/or smokeless tobacco (SLT) has the potential to cause various adverse health effects including cancer. In addition to different lifestyle factors, usage of tobacco has been accounted for as one of the major causes for the development of cancer of lungs, esophagus, and the lip and oral cavity [1]. According to the report of the Population-Based Cancer Registry of India (2012–2014), the proportion of tobacco-related cancers in India is quite high in case of males [2]. The magnitude of the situation in the northeastern part of the country is more critical as 57 % of all cancers in males and 28.3 % of all cancers in females are caused due to indiscriminate consumption of tobacco [3].

In India, usage of both commercial SLT products like *khaini*, *zarda*, *gutka* and other local forms with or without additives like lime are prevalent [4,5]. The population used for survey and data collection in

this study belongs to the northeastern part of India, where in addition to commercially available SLT products like *zarda* and *khaini*, a unique homemade product commonly known as *sadagura* is consumed arbitrarily [6].

Recently, we have reported that long-term co-exposure of SLT and arsenic with poor nutritional status has immense potential to cause genotoxicity and oxidative stress in murine test system [7,8]. Previously Kausar and co-workers (2014) have found that consumption of SLT and pesticide exposure can cause changes in the buccal cell population and hematological parameters [9]. The alkaloids present in tobacco and related products have been found to cause genotoxicity and play a crucial role in tobacco-related carcinogenesis [10]. Nicotine is one of such major alkaloids detected in tobacco and related products. Chronic exposure to nicotine may lead to activation of growth-promoting pathways and provide a suitable environment for the development of cancer and also hamper the activity of anticancer agents by activating survival

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