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Dr.Vivek Kumar Kedia, Deptt. Of Botany

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Mn^{2+}-Dependent Thermophilic Protease of *Thermoactinomyces Vulgaris* Tsiklinsky

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Abstract Protease of *Thermoactinomyces vulgaris* was highly thermophilic, as it exhibited its optimal catalytic activity at 65°C, which was much higher than the growth temperature (50°C) of this obligate thermophile. Among the metal ions tested, Mn^{2+} was most stimulatory, enhancing the specific activity of protease by about 4.4-fold over the control, and broadened the range of its temperature optimum (i.e. 60–65°C). A heavy metal (Hg^{2+}) inhibited the enzyme activity by about 15%. The increase in slope of Arrhenius plot as well as the energy of activation (E_a) of *T. vulgaris* protease due to Mn^{2+} indicated that this divalent cation enhanced the rate of high-temperature enzyme catalysis at the expense of E_a. The increasing concentration of the substrate (casein) increased the specific activity of protease gradually in a dose-dependent manner, both in the absence as well as in the presence (10 mM) of Mn^{2+}. This divalent cation increased the V_{max} of this enzyme without affecting K_m for the substrate. The thermophilic protease of *T. vulgaris* appeared to be a metalloenzyme, in which Mn^{2+} is firmly bound to it, as even 10 mM of EDTA was not able to chelate/remove Mn^{2+} completely to inhibit its activity.

Keywords: Arrhenius energy of activation · Arrhenius plots · Energy of Activation · Extracellular protease · High-temperature catalysis · Protease · *Thermoactinomyces vulgaris* · Thermophilic protease

Introduction

Thermoactinomyces vulgaris has been characterized extensively in our research laboratory with respect to its growth [36], genetics [4, 11, 34] and thermophilic hydrolases, including acid and alkaline phosphatases [35, 37, 38, 39] and membrane ATPase [5, 33].

A group of hydrolases, such as proteases are an important class of enzymes which constitute more than 59% of the total industrial enzyme market [25]. Proteases, secreted extracellularly by thermophilic bacteria, can be used in a range of commercial applications such as leather preparation, protein recovery or solubilization, meat tenderization and organic synthesis [6, 20]. Proteases are also used extensively in bread industry, as higher processing temperatures can be employed with faster reaction rates [7, 10, 40]. Thermolysin-like proteases (TLPs) are the best characterized species of proteolytic enzymes secreted by both Gram-positive and Gram-negative bacteria [43]. They hydrolyze proteins to short peptides or free amino acids and catalyze peptide synthesis in organic solvents or in solvents with low water content. Alkaline proteases, produced by thermophilic and alkaliphilic bacilli, can withstand high temperature, pH, chemical denaturing agents and non-aqueous environments. Alkaline proteases have major application in the detergent industry, as pH of laundry

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Pseudomonas sp.: A promising biocontrol agent against selected phytopathogens

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Abstract: The biological control of plant pathogenic microorganisms by *Pseudomonas* sp. is attracting increasing attention in the agricultural world, since the indiscriminate use of toxic chemicals constitutes a potential threat to both human and animal health, as well as the environment. A total of 27 bacterial strains were isolated from the rhizospheric soil of the tomato (*Solanum lycopersicum*) plant, and their antagonistic activities against a few of the selected pathogenic bacteria and fungi were evaluated using dual-culture assays, biochemical tests for the production of Hydrogen Cyanide (HCN), Indole Acetic Acid (IAA), Iron Chelating Agent (siderophore), and phosphate solubilisation. Furthermore, the separated antagonists were examined for the generation of hydrolytic enzymes such as protease, amylase, β-1, 3 glucanase, cellulase, chitinase, and pectinase. In all 27 strains isolated, the highest antagonistic activity was shown by only two bacterial strains *Pseudomonas* (VK1and VK2), against *Klebsiella pneumoniae*, *Salmonella typhi*, *Xanthomonas campestris*, *Bacillus sp.*, *Alternaria alternata*, *Aspergillus niger*, *A. flavus* and *Fusarium sp.* Both the strains were identified as *Pseudomonas sp.* on the basis of morphological, physiological and biochemical characterization. Comparatively, strain VK1 was more effective against above pathogens than VK2 strain which was confirmed by dual culture assay. Both the strains of *Pseudomonas sp.* further were characterized further antagonistic traits like production of HCN, IAA, siderophore, insoluble phosphate solubilising ability and hydrolytic enzymes properties.Similarly, VK1 strain showed positive test for all above biochemical tests, while VK2 strain was not able to produce IAA and showed negative test for phosphate solubilizing activities. So, VK1 strain of *Pseudomonas* was able to produce all above hydrolytic enzymes and found to be efficient antagonistic PGPRs. These findings indicated that isolated *Pseudomonas sp.* has a prominent natural, eco-friendly, bio-safe and cost-effective approach to cope against both phytopathogenic bacteria and fungi.

Key words: *Pseudomonas* • Biocontrol • Phytopathogen • Siderophore • IAA • HCN • Phosphate solubilisation • Dual culture

Introduction

Extensive use of hazardous chemicals as fungicide, pesticide and fertilizers causes irreparable loss of our environment. To overcome such type of irreparable harm to our environment, it is necessary to adopt alternatives of chemical agents like, pesticides, herbicides, fungicides etc. for eliminating the phytopathogenic microbes. In the present scenario, it is also mandatory to use eco-friendly methods in the management of agricultural practices. Indiscriminate use of chemicals has deteriorated the environment and destroyed the ecological balance.The biological solution forcontrolling different phytopathogens is the use of biocontrol plant growth promoting rhizobacteria (PGPR) which is capable of suppressing or preventing the plant disease causing organismlike *Aeromonas*, *Azotobacter*, *Pseudomonads*, *Bacillus*, *Streptomyces*, *Enterobacter*, *Clostridium*, *Burkholderia* (Devi 2022; Tapia 2020).

Biological control is the practice or process by which plant pathogens are controlled by means of another beneficial macroorganisms which are termed as antagonists. It involves the use of an organism or organisms to inhibit the pathogen and reduce disease (Cook and Baker, 1983). The increased interest in bio-control is due to its eco-friendly effect, however some of the antagonists also been found to show direct growth promoting effect on infected plants (Glick et.al 1995). *Pseudomonas* bacteria are

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Chemical composition and antioxidant activity of *Acorus calamus* L. accessions from different ecological niches

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The essential oil composition of *Acorus calamus* (Acoraceae) rhizomes, collected from twenty different ecological niches in Uttarakhand, India, with an oil yield ranging between 0.7–5.4% (v/w), was examined by GC/MS. Among the identified components, *β*-asarone (62.3–75.9%), *α*-asarone (2.2–6.1%), *Z*-isoelemicin (2.4–6.2%), *Z*-methyl isoeugenol (2.3–6.6%) and phenylbenzene (1.5–3.3%) were found to be the major ones. The antioxidant activity of different essential oils was compared to that of standard antioxidants to assess their free radical scavenging potential, metal chelating ability, and reducing power. The essential oils exhibited significant to good antioxidant activity. The IC_{50} values for DPPH radical scavenging, metal chelating, and reducing ability exhibited by the rhizomes essential oils were observed between 22.28–61.96 µg/mL, 29.95–159.26 µg/mL, and 21.41–61.19 µg/mL, respectively. Based on the above observations, the chemical diversity of *A. calamus* essential oil can be a good source of herbal nutraceuticals and phytopreservatives. The possible mode of action and structure-activity relationship between major compounds of essential oils and potential of antioxidant activity were studied using *in-silico* molecular docking and were found to support the *in-vitro* results.

Keywords: *Acorus calamus*, Antioxidant, Essential oil, Molecular docking, *β*-asarone

IPC code: Int. cl. (2023.01)– A61K 36/00, A61K 125/00, A61P 39/00

Introduction

Essential oils, often referred to as essences, volatile oils, or etheric oils, are complex natural concoctions of volatile, lipophilic, and odoriferous chemicals that are commonly found in aromatic plants. Essential oils have been reported as food-preserving agents mainly due to the presence of phenolic compounds as major constituents, which might be due to antioxidant properties[1]. *Acorus* is a genus monocot flowering plants found in wetlands, especially marshes, which are native to Northern Asia, Eastern and Southern Asia, North America, as well as Europe. The traditional indigenous plant *Acorus calamus* (sweet flag) is typically used to cure haemorrhoids, cough, gout, bronchitis, tumours, numbness, skin problems, and general weakness[2]. The primary plant antioxidants are polyphenols, which have a variety of biological properties as well as structural and functional qualities. Plant-based antioxidants are mainly phenolic compounds, carotenoids, and vitamins[3]. In case of essential oils, the antioxidant activity has been associated with compounds like terpenoids and phenolic, which diffuse and damage cell membrane structures[4]. *β*-asarone has been reported to be the major bioactive phytoconstituent of the volatile oil. *α*- and *β*-asarone are mainly responsible for the biological activity of *A. calamus*. The herb has also been reported to be an integral part of Ayurveda and Unani medicines. The concentration of asarone in *A. calamus* essential oils depends on the parts of the plant used to extract the oil and the ploidy[5,6].

The phenolic content of rhizomes has been reported in treating dyspepsia, dysentery, intestinal worms, cough and fever[7]. The sesquiterpenes, monoterpenes, lignans, phenyl propanoids, flavones, steroids, and xanthone glycosides from *A. calamus* have been reported to show insecticidal, antimicrobial, mutagenic, cytotoxic, anticonvulsant, neuroleptic, hepatoprotective, smooth muscle stimulant and relaxant activity[10]. *A. calamus* has also been reported to exhibit significant antioxidant activity. *A. calamus* essential oils from Pakistan, has been reported to exhibit potential pesticidal activity and also found to be effective in wound healing[11].

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aerial parts and roots of *Laportea bulbifera* (Siebold & Zucc.) Wedd. growing in the Central Himalayan region

Manisha Palni, Leelawati Nitwal, Anand B. Melkani, Deepshikha Joshi & Rajendra Prasad

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Abstract

The GC and GC/MS analysis of the essential oil samples obtained separately from whole aerial parts and the roots of *Laportea bulbifera* resulted in the identification of a total of 40 compounds from the whole aerial parts and 45 compounds from the roots representing 89.7% and 82.9%, respectively, of the total essential oil composition. The essential oil from aerial parts is dominated by oxygenated sesquiterpenes (66.4%) with α-elemol (55.1%), germacrene D-4-ol (4.2%), linalool (3.5%) and phytol (3.4%) as the major constituents while the root essential oil is dominated by oxygenated monoterpenes (30.4%) with *trans*-myrtanol (16.3%), *cis*-myrtanol (11.6%), nopinone (7.8%), cadin-4-en-10-ol (4.7%), and α-elemol (3.4%) as major constituents. The essential oil from whole aerial parts showed bactericidal [illegible]250 µL/mL concentration (MBC) against *Pasteurella multocida* and *Dickeya dadantii* while the root essential oil exhibited bactericidal effect at 125 µL/mL against *Escherichia coli*, *Enterococcus faecalis*, *Xanthomonas prunicola*, and *Dickeya dadantii*.

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The essential oil composition, antimicrobial activity and antioxidant assay of the extracts from aerial parts of *Dicliptera roxburghiana* Nees.

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Dicliptera roxburghiana Nees is a shrub belonging to the family *Acanthaceae*. The present study was undertaken because of the medicinal importance of this genus and the need for a report on its essential oil composition and antibacterial activity. Essential oil from the whole aerial part, including flowers, of the plant was extracted by steam distillation method and analysed by GC-FID and GC-MS. In all, sixty-nine compounds constituting 88.8% of the total oil composition have been identified. The essential oil contained high concentrations of non-terpenic compounds (33.5%), while the terpenoid compounds had a higher concentration still (52.0%). The unidentified portion contained several minor constituents with ambiguous Mass Spectra. The major constituents of the essential oil were identified as β-gurjunenone (11.2%), phytol (10.0%), pentadecanal (8.6%), cis, cis, cis-7,10,13-hexadecatrienal (7.6%), linalool (4.2%) and cembrenan -7-α-ol (4.2%). The antioxidant activity of four different extracts (whole aerial parts)was performed by two methods, namely, DPPH assay and metal chelating assay. Significant results were obtained in each case at 100 μg/mL concentration. For antibacterial screening, the essential oil exhibited the highest activity against Gram-negative *Pantoea wallisiae* (12.66±0.57 mm) and Gram-positive *Bacillus subtilis* (13.00±1.00 mm). The highest activity of ethyl acetate extract was recorded against Gram-negative *Pantoea wallisiae* (12.00±0.00 mm). The hexane extract of the plant was found to be most active against Gram-positive *Enterococcus faecalis* (13.33±0.57 mm). The chloroform extract showed the highest activity against Gram-negative *Klebsiella pneumoniae* (15.33±1.15 mm) and Gram-positive *Enterococcus faecalis* (12.00±1.00 mm). For methanol extract, the highest activity was observed against Gram-negative *Agrobacterium tumefaciens* (10.66±0.57 mm) and Gram-positive *Enterococcus faecalis* (10.33±0.57 mm). The essential oil exhibited the highest antifungal activity against the fungal strains, namely, *Aspergillus niger* (17.66±0.57 mm), followed by *Aspergillus flavus* (16.66±0.57 mm) and *Candida albicans* (16.33±0.57 mm). The essential oil and extracts from this plant species may be utilized to control various microbial infectious diseases and serve as an antioxidant supplements.

Keywords: Antibacterial, Antifungal, Antioxidant assay, *Dicliptera roxburghiana* Nees., Essential oil composition

IPC code; Int. cl. (2021.01)– A61K 36/00, A61P 31/00, A61P 39/00

Introduction

Dicliptera roxburghiana is a common shrub found to grow wild in the Uttarakhand Himalayan region and is locally known as *Patara*. There are 150 species of genus *Dicliptera* distributed in warm and tropical areas of the world[1]. In India, 21 species and nine varieties of genus *Dicliptera* have been reported[2], of which one species and one of its varieties are growing wild in Kumaun and Garhwal regions of Uttarakhand, i.e. *D. roxburghiana* Nees. and *D. roxburghiana* var. *Bupleuroides*[3].

The genus *Dicliptera* is known for its various medicinal uses, e.g., the leaf infusion of *D. laxata* has application as a poison antidote and is locally used in Southern Uganda[4]. Similarly, *D. verticillata* is reported to have traditional use to cure diarrhoea and malaria in Burkina Faso. The leaves of the species are used in making various soups in India[5]. The plant species also find applications in flavouring and spicing[6]. It is further reported that the ethanol extract of *D. verticillata* was analysed for its antioxidant assay and antimicrobial assay (broth macro-dilution method). The results showed moderate antioxidant activity (63.9%, IC_{50} 40.16 μg/mL) and bactericidal effects against *S. aureus, K. pneumoniae and E. coli*[7]. *Dicliptera ghatica* Sanapan is another important species of this genus that is reported to possess significant antioxidant activity[8]. β-Sitosterol and vanillic acid isolated from *D. bupleuroides* exhibit

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Journal of Essential Oil Bearing Plants ▶ List of Issues ▶ Volume 24, Issue 3 ▶ Chemical Composition and Antimicrobial A...

Chemical Composition and Antimicrobial Assay of Essential Oil from Whole Aerial Parts of *Ainsliaea aptera* DC. Collected from two Different Regions of Central Himalaya

Lalit S. Bisht, Anand B. Melkani ✉ Rajendra Prasad, Lalit Mohan, Manisha Palni & Leelawati Nitwal

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Abstract

Ainsliaea aptera DC, a medicinally important aromatic plant of the family Asteraceae grows wild in high altitude regions of Uttarakhand state (India). The essential oil samples obtained by steam distillation of its whole aerial parts collected from two different geographical regions were analyzed by GC and GC-MS. Total forty-five compounds from Tungnath sample and thirty-four compounds from Lohajung sample were identified constituting 95 % and 85.6 %, respectively of total oil composition. The terpenoid profile showed both qualitative as well as quantitative variation with respect to major constituents; E-β-farnesene (9.5 % and nil), germacrene D (14.6 % and 3.2 %), bicyclogermacrene (10.2 % and 3.3 %), δ-cadinene (4.2 % and 6.9 %), germacrene D-4-ol (nil and 4.9 %), spathulenol (11.6 % and 3.0 %), epi-α-muurolol (7.6 % and 10.8 %), α-cadinol (13.8 % and 19.5 %) and hexadecanoic acid (nil and 4.8 %). Antimicrobial activity of oil samples assayed against seven animal pathogens, three plant pathogenic bacteria, and three pathogenic fungi using the agar disc diffusion method. Both the oil samples showed moderate to very good antibacterial and antifungal potential. The oil sample from Tungnath was found to have the best activity against *E. coli*, *Enterococcus faecalis*, *Staphylococcus aureus*, and *Salmonella enterica* which was comparable to the activity shown by standard

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Haemoglobin/polyindole composites: the novel material for electrochemical supercapacitors

Published: 21 January 2019

Volume 42, article number 20, (2019) Cite this article

K Khati ✉, I Joshi, A Bisht & M G H Zaidi

Abstract

Conducting polymers have recently been employed with metal derivative macromolecules that have led to great improvement in the field of supercapacitor materials. The current work reports on the synthesis of a novel class of haemoglobin/polyindole composites (HPCs) through doping of haemoglobin (Hb) into a polyindole (PIN) matrix. HPCs with enhanced electrocapacitive performance were prepared through a cationic surfactant-assisted dilute solution polymerization of indole (IN) in the presence of Hb at various concentrations ranging from 10 to 30% (w/w) and ferric chloride ($FeCl_3$) as an oxidant. The HPCs were characterized through Fourier transform infrared spectra, scanning electron microscopy and simultaneous thermogravimetric analysis. Electrochemical capacitance (C_s, F g^{-1}) of graphite-based electrodes fabricated from HPCs over stainless steel in the presence of sulphonated polysulphone as a binder has been investigated in KOH solution (1.0 M) with reference to Ag/AgCl at a scan rate (V s^{-1}) ranging from 0.001 to 0.2. HPCs with 30% (w/w) of Hb have shown the highest C_s of 294.00 as compared with 112.00 for pure PIN at a scan rate of 0.001 V s^{-1}. Successive scans of HPC electrodes show a capacitive decline of ~2% during the first 1000 cycles at a scan rate of 0.1 V s^{-1} in KOH (1.0 M), which indicates the appreciable electrochemical cyclic stability of the HPCs over PIN. Thus, the fabricated HPCs may serve as potential electrode material for development of electrochemical supercapacitors.

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Haemoglobin graphite electrodes for electrochemical energy storage

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Abstract

Haemoglobin (Hb) has been employed as naturally copious metal plagiaristic that attains the material with sustainable supercapacitance. Herein, a fabrication method in the course of interaction between macromolecule compound Hb with graphite has been reported over stainless steel electrode in the presence of sulphonated polysulphone (SPS) as a binder. The microstructure of fabricated Hb graphite stainless steel (SS) electrode has been ascertained through scanning electron microscopy (SEM). Electrochemical capacitance of electrodes has been examined in KOH solution (1.0 M) with reference to Ag/AgCl at a scan rate 0.001 to 0.2 Vs^{-1}. Developed electrode has shown highest capacitance of 158.43 at scan rate of 0.001 Vs^{-1} along with energy and power densities of 3.86 $Whkg^{-1}$ and 237.92 $Whkg^{-1}$ respectively. In multiple cycles electrode rendered quite slow decrease in electrocapacitive during the first 1000 cycles (at scan rate of 0.1 Vs^{-1}) indicating good charge–discharge with improved electrochemical cyclic stability.

Introduction

Developing realms are currently ruthless for conservation and storage of energy into electricity through implicating the existing renewable resources such as biomass, animal waste, wind power and solar energy. In this perspective, the

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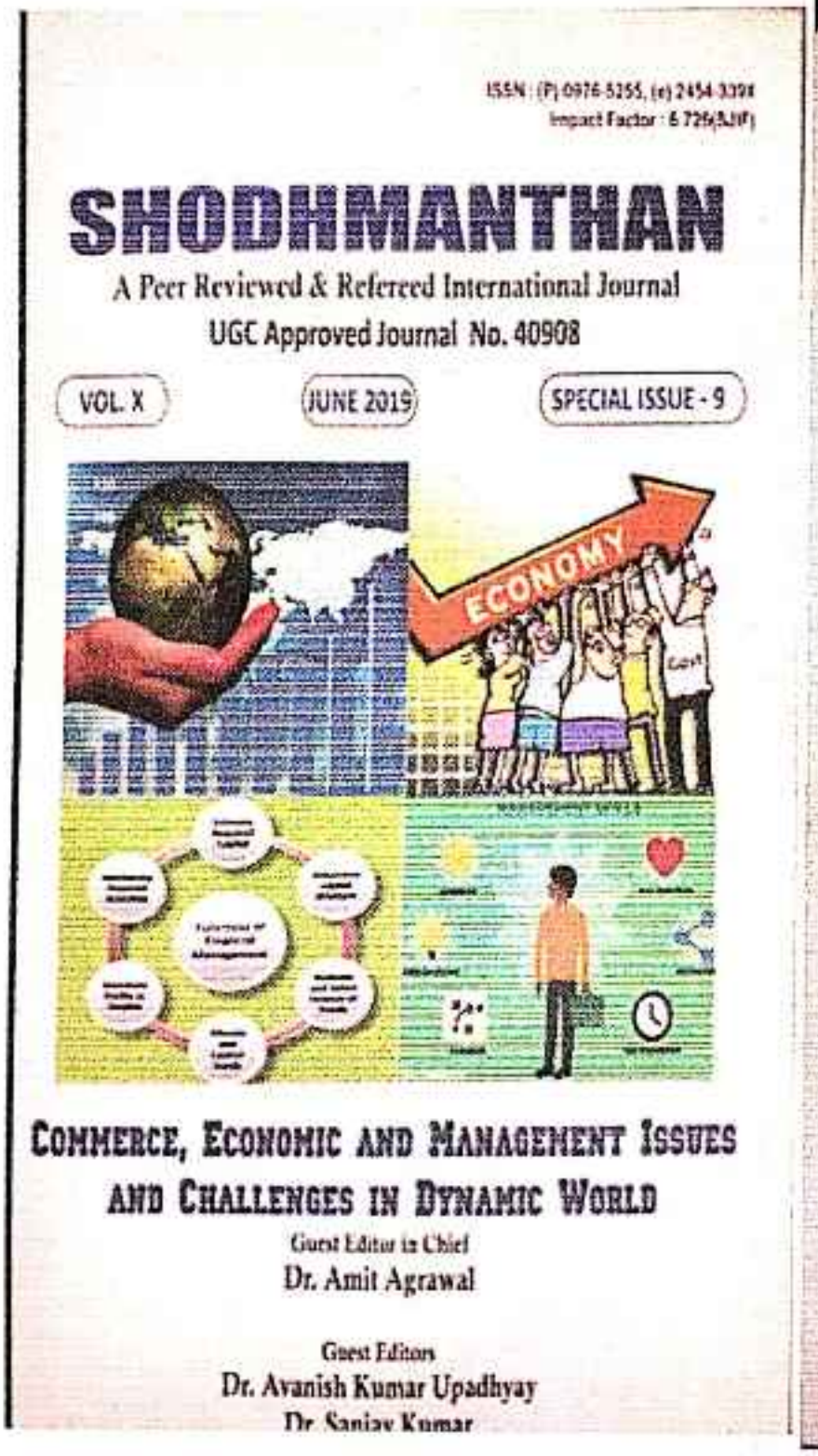

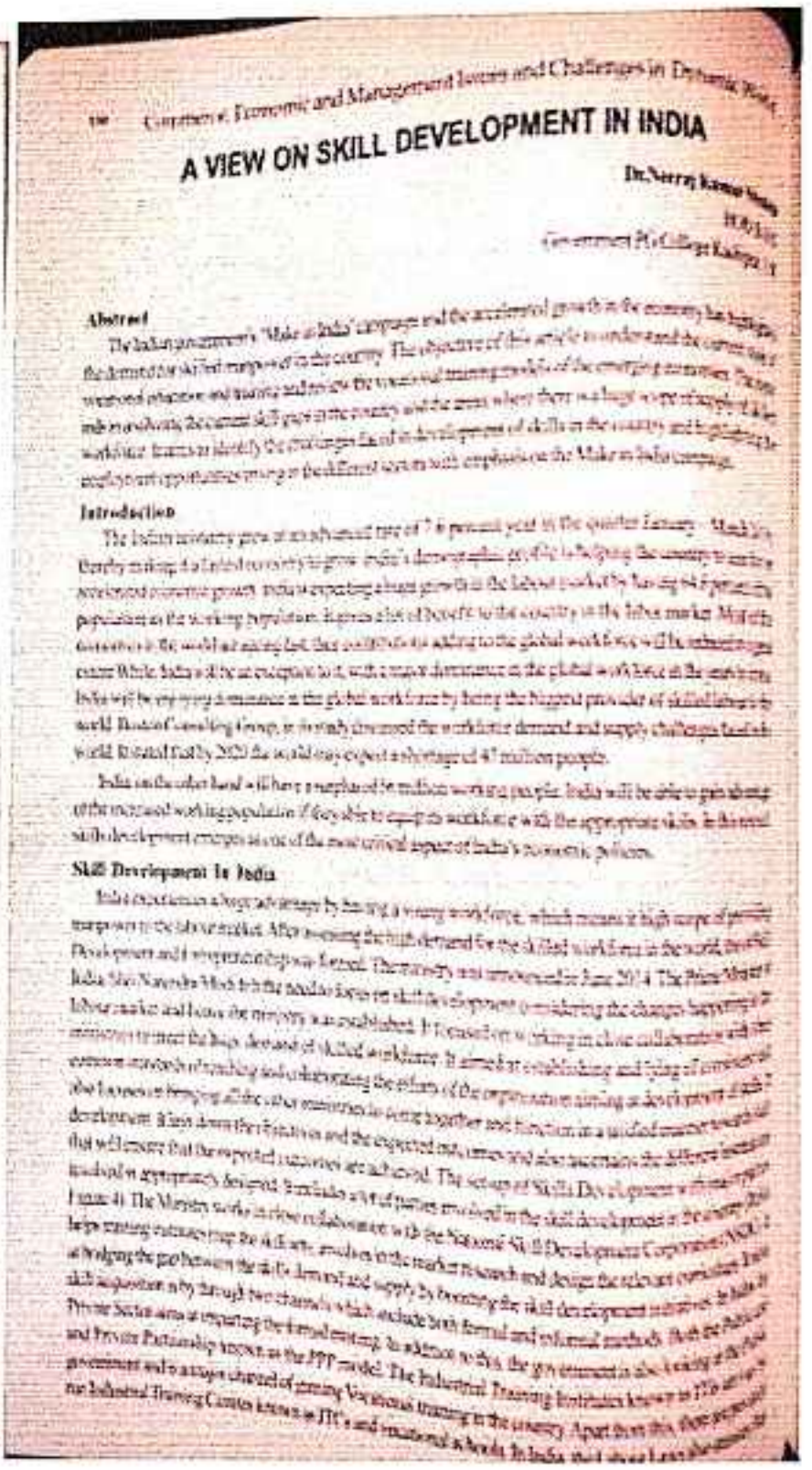

A VIEW ON SKILL DEVELOPMENT IN INDIA

Abstract

Introduction

Skill Development In India

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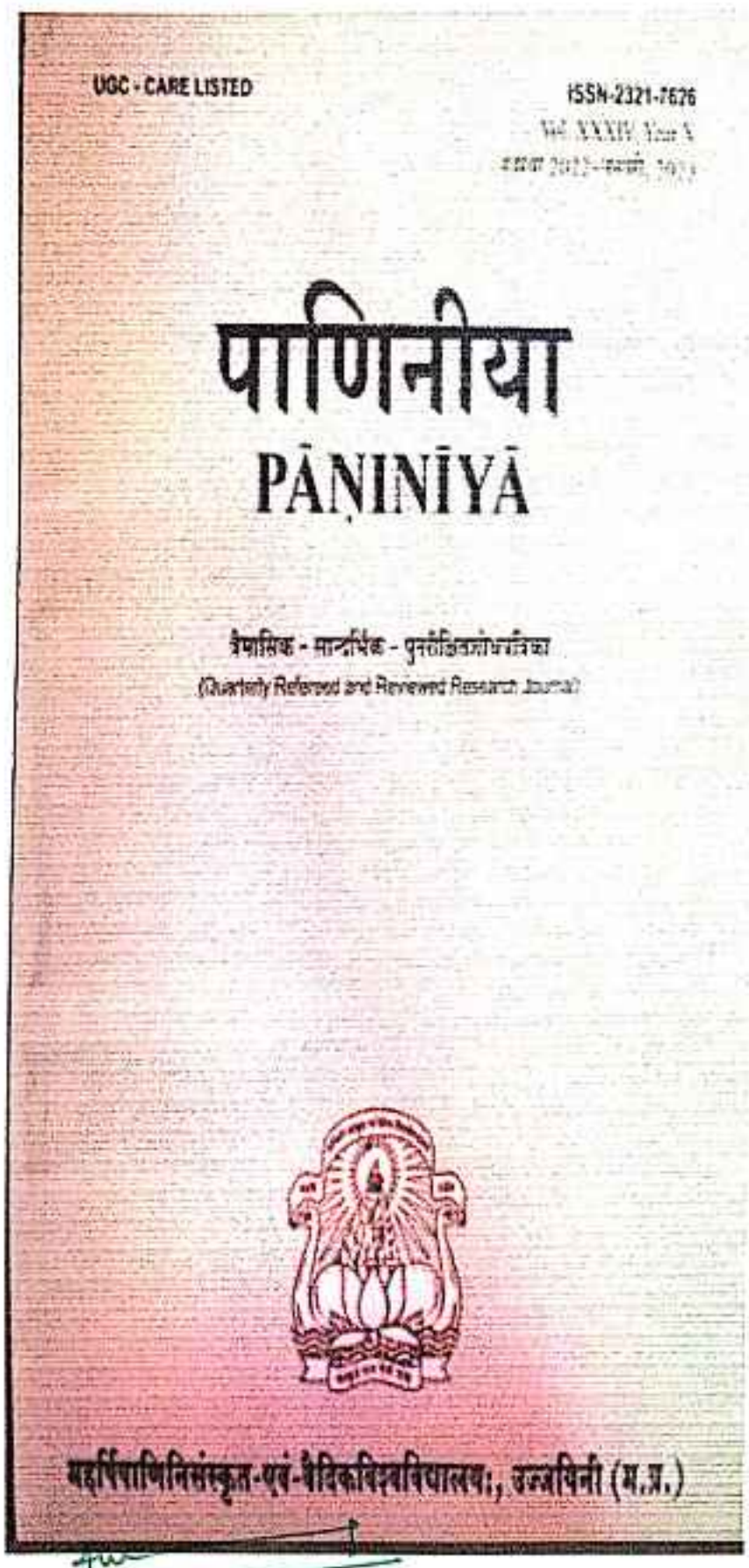

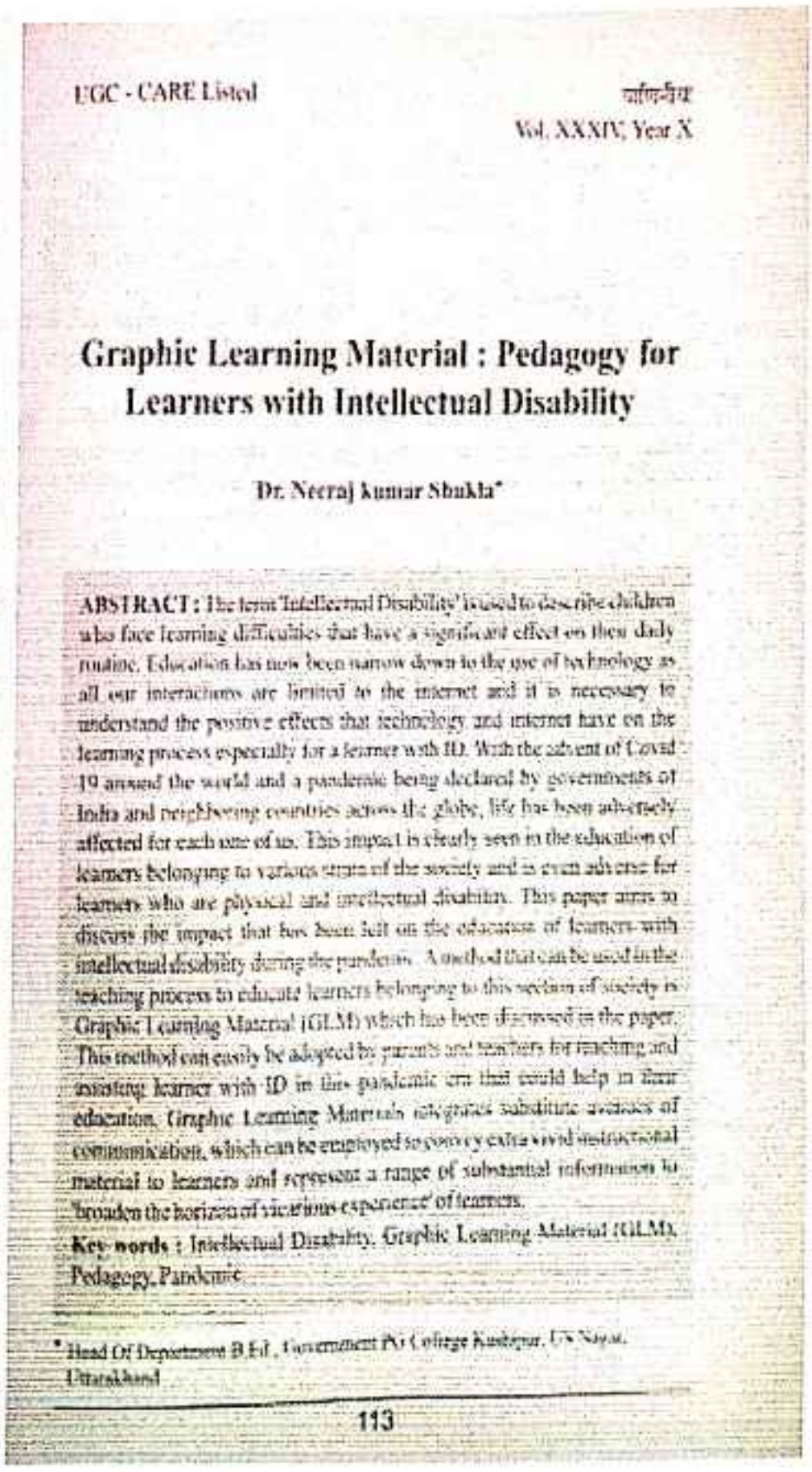

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The essential oil composition, antimicrobial activity and antioxidant assay of the extracts from aerial parts of *Dichpetes roxburghiana* Nees.

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Dichpetes roxburghiana Nees is a shrub belonging to the family [illegible]. The present study was undertaken because of the medicinal importance of this genus and the meagre report on its essential oil composition and antibacterial activity. Essential oil from the aerial aerial part including flowers of the plant was extracted by steam distillation method and analysed by GC-FID and GC-MS. In all, seventy-one compounds constituting 95.8% of the total oil composition have been identified. The essential oil contained high concentration of non-terpenic compounds (73.8%), while the terpenoid compounds had a higher concentration with [illegible]. The unidentified portion contained several minor constituents with ambiguous Mass Spectra. The major constituents of the essential oil were identified as heptacosane (11.2%) phytol (10.1%), pentadecanal (8.6%), [illegible] (7.8%), tetracosane (7.7%) and [illegible] (6.2%). The antioxidant activity of four different extracts (whole aerial portion) was performed by two methods namely, DPPH assay and metal chelating assay. Significant results were obtained in each case at 1.0 mg/ml concentration. For antibacterial activity, the essential oil exhibited the highest activity against *Staphylococcus aureus* (zone of inhibition 25±0.0 mm), followed by *Escherichia coli* (24±0.0 mm). The highest activity of ethyl acetate extract was recorded against *Staphylococcus aureus* (zone of inhibition 22±0.0 mm). The hexane extract of the plant was found to be most active against Gram-negative *Escherichia coli* (zone of inhibition 23±0.0 mm). The chloroform extract showed the highest activity against *Klebsiella pneumoniae* (zone of inhibition 19 mm) and *Streptococcus pneumoniae* (zone of inhibition 20±0.0 mm). The methanol extract the highest activity was recorded against *Staphylococcus aureus* (zone of inhibition 27 mm) and Gram-positive *Streptococcus pneumoniae* (zone of inhibition 26±0.0 mm). The essential oil exhibited the highest antifungal activity against the fungal strains namely, *Aspergillus niger* (zone of inhibition 27 mm), followed by *Aspergillus flavus* (zone of inhibition 25±0.0 mm) and *Candida albicans* (zone of inhibition 23±0.0 mm). The essential oil and extracts of the plant species can be utilized to control various microbial infectious diseases and serve as an antioxidant supplement.

Keywords: Antibacterial, Antifungal, Antioxidant assay, *Dichpetes roxburghiana* Nees, Essential oil composition

IPC Code: Int. Cl. (2021.01)—A61K [illegible], A61P [illegible]

Introduction

Dichpetes roxburghiana is a common shrub found to grow wild in the Uttarakhand Himalayan region and is locally known as *Paiara*. There are 150 species of genus *Dichpetes* distributed in warm and tropical areas of the world[1]. In India, 21 species and nine varieties of genus *Dichpetes* have been reported[2] of which one species and one of its varieties are growing wild in Kumaun and Garhwal regions of Uttarakhand, *i.e. D. roxburghiana* Nees and *D. roxburghiana* var. *Hapleuroides*[3].

The genus *Dichpetes* is known for its various medicinal uses, *e.g.*, the leaf infusion of *D. lanata* has application as a pectoral antidote and is locally used in Southern Uganda[4]. Similarly, *D. mombuttensis* is reported to have traditional use to cure diarrhoea and malaria in Burkina Faso. The leaves of the species are used in making various soups in India[5]. The plant species also find applications in flavouring and spicing[6]. It is further reported that the ethanol extract of *D. mombuttensis* was analysed for its antioxidant assay and antimicrobial assay (broth macro-dilution method). The results showed moderate antioxidant activity (63.8%, IC_{50} 40 to µg/mL) and bactericidal effects against *S. aureus*, *K. pneumoniae* and *E. coli*[7]. *Dichpetes ghanensis* Sansapeu is another important species of this genus that is reported to possess significant antioxidant activity[8]. β-Sitosterol and vanillic acid isolated from *D. hapleuroides* exhibit

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Size impact on Debye temperature of In and Ag spherical nanosolids

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Abstract: *The energy of the free surface atoms is completely different as compared to the energy related to the atoms in the bulk. The surplus energy associated with the surface atoms is known as the free surface energy. Though, for the Nano materials, the surface to volume ratio is significant, but in bulk materials, this free energy is neglected since it is associated with only top most layer of atoms on the surface and also the ratio of the residual volume of surface atoms and the total volume of the material is extremely small. We have developed a theoretical model, free of adjustable parameters, for the size dependent Debye temperature of Indium (In) and Silver (Ag) spherical Nanosolids. We adopt an approach using classical thermodynamics by considering Lindemann's criterion to study the size impact.*

Keywords: *Debye Temperature, Size Impact, Nanosolids*

I. Introduction

Nanoscience and Nano technology is the study of matter at atomic molecular scale and developing devices to study the shape and size of material having only few Nanometers (10^{-9} meter). Nanoscience and Nano technology began in the early 1980 with the advances in computing power and material modelling. The term Nano technology was coined by Norio Taniguchi in 1974 as follows: "Nanotechnology mainly consist of the processing of separation, consolidation, deformation of materials by one atom or by one molecule". The main link between Nano science and Nano technology is Nano materials. Over the past decade, nanomaterials have gain vast interest among researchers and Scientists. Various properties like Optic, Electronic, Magnetic, Catalytic, Biomedical and Thermodynamic of the nanomaterial vary noticeably when the particle size of materials becomes nanoscales compared to those of an isolated atom and bulk materials [1-4]. It is recognized and validated that the size dependence of thermal stability of nanomaterials is extremely become one of the major concerns in upcoming technologies [5,6].

Cohesive energy, defined as the difference between the average energy of the atoms in a solid and the isolated atom, is one of the most important physical parameters in quantifying the thermal stability of materials [7]. Many experimental and theoretical procedures have been implemented to investigate the size dependent cohesive energy of nanomaterials [8,9]. Tunes Chemical and Physical properties can shows by bulk materials have demonstrated by Ag and Au nanoscale [10,11]. The shape and size dependent melting thermodynamics of metallic nanoparticles have also been predicted by application of bond theory model, free of any adjustable parameter [12]. In this Paper, we present a theoretical model for studying the particle size on Debye temperature of Indium (In) and Silver (Ag) spherical nanosolids. The decreased Debye temperature of Nano solids are explained through the effect of surface to volume ratio over the bulk materials. The study based on surface effect as decreased particle size permits size depression and enlargement in the regime for which adequate experimental data do not exist.

II. Theoretical Formulation

According to Lindemann criterion, a crystal will melt when the root mean square displacement of its atoms exceeds a certain fraction of the interatomic distance in the crystal [13]. Relating the specific heat theory with the Lindemann criterion, formula for square of characteristic temperature is proportional to the melting point of the crystal. So the Debye temperature for the bulk material is written as [14]

$$\theta_D^2 \propto \left(\frac{T_m}{M r^2 T_m}\right) \qquad (1)$$

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Prediction of size-dependent melting temperature of metallic nanoparticles

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Abstract: A theoretical model for the study of size-dependent melting temperature of metallic nanoparticles has been developed by considering the surface-to-volume atomic ratio. The surface-to-volume atomic ratio plays a vital role in the study of various properties of nanoparticles. Using this model, size dependent melting temperatures of Al, Ag and Au metallic nanoparticles has been studied. The theoretical results have been compared with other theoretical models and available experimental data. It is observed that the melting temperature of Al, Ag and Au metallic nanoparticles reduces as the size of the particle reduces. The comparison of theoretical findings of the present work indicates that our theoretical predictions agree well with available experimental results, thereby supporting the validity of formulation developed.

Keywords: Melting temperature, Metallic nanoparticles, Particle size

1. Introduction

Nanoparticles are experiencing rapid development in recent years due to their known and potential applications in various areas. In the nanoscience and nanotechnology, the size of materials has reduced at the very low scale nanometer at least one dimension. In this size range, the surface-to-volume ratio is much increased and correspondingly the thermal, physical, chemical and mechanical properties are changed [1,2]. The properties of materials at nanoscale are different from the corresponding bulk material. The properties of nanomaterials change drastically as the particle size reduces below 30 nanometers. A sample of gold appears red at 10 nanometers. Its melting temperature decreases rapidly as their size is reduced up to the level of nanoscale [3]. A bulk material has specific value of melting temperature. This is due to well defined arrangement of atoms while for nanomaterials arrangement of atom, number of surface atom and bonding between atoms changes and edge effect comes into play and as a result, these properties vary with shape and size. Melting of a material is a very common and one of the important phase transformations. In recent decades, the researchers have paid more attention to the melting of nanosolids because the melting temperatures of nanosolids are different from that of the corresponding bulk materials [4]. The experimental and theoretical studies of melting temperature of nanoparticles have been conducted by many researchers. Eckert et al. [5] have performed an experiment for studying the melting temperature of Al nanoparticle and observed a reduction in melting temperature with decrease in particle size. Li et al. [6] carried out many experiments for the study of variation of melting temperature of Al metallic nanoparticle with particle size and observed a decrease in melting temperature with decrease in particle size. Buffat et al. [7] studied the melting temperature of Au nanoparticle experimentally and observed that the melting temperature of Au nanoparticle decreases with decrease in particle size. There are some theoretical studies on melting temperature of metallic nanoparticles. Mirjalili et al [8] developed a model based on the cluster mean coordination number calculations and predicted a depression in melting temperatures of Al, Ag and Au nanoparticles with decrease in particle size. Recently Reddy et al. [9] studied the size dependence of melting temperature of Cu, Pd, Pt, Al nano particles and reported the decrement in melting temperature of these nanoparticles with their size. Recently, Attota and Joshi [10] discussed a thermodynamic analytic model to study the size effect on melting temperature of nanometals and found that the melting temperature of nanomaterial shows decreasing trend with decrease in particle size. The melting is initiated from the surface which is a consequence of poor stability of the surface. In this work, we have modified a theoretical model to predict the size-dependent melting temperature of metallic nanoparticles by considering the surface-to-volume atoms ratio. For this purpose, we have considered Al, Ag and Au spherical nanoparticles. We have compared our theoretical results on melting temperature with available experimental and other theoretical data.

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Study of Melting Temperature Depression in Nanoparticles with their Size using Cluster Order Concept

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Abstract: A new model, based on cluster order calculations, has been developed for the study of melting temperature depression in nanoparticles with their size. Cluster order plays a crucial role in determining various properties of nanoparticles. Using this model, melting temperature of Al, Ag, Au and Sn nanoparticles has been calculated. Melting temperature depression of these nanomaterials has been observed as the particle size decreases. The theoretical predictions agree well with available experimental and other theoretical results which supports the validity of present model.

Keywords: Size effect, Melting temperature, Nanoparticles, Cluster order.

I. Introduction

Melting temperature depression is the phenomenon of reduction of the melting temperature of a material with reduction of its size. This phenomenon is very prominent in nanoscale materials which melt at temperatures hundreds of degrees lower than bulk materials. The melting temperature of a bulk material is not dependent on its size but as the dimensions of a material decreases towards the atomic scale, the melting temperature scales with the material dimensions. The decrease in melting temperature can be on the order of tens to hundreds of degrees for metals with nanometer dimensions [1-3]. Melting temperature depression is most evident in nanowires, nanotubes and nanoparticles which all melt at lower temperatures than bulk amounts of the same material. Nanoparticles are easiest to study due the ease of fabrication and simplified conditions for theoretical modeling. Nanoparticles are easiest to study due the ease of fabrication and simplified conditions for theoretical modeling.

It has been well established both experimentally and theoretically that the melting temperature of nanoparticles depends on the particle size [1, 4-6]. Wunder [9] studied the size dependence of the melting temperature of tin nanoparticles by means of transmission electron diffraction and microscopy. He found that the melting temperature of a spherical particle of an (Sn) decreases as the radius of the particle decreases. Jiang et al [10] and Chang-dong et al. [11] synthesized Sn nanoparticles of various sizes via chemical reduction method and they observed particle size dependent melting temperature. These results showed that different sized Sn nanoparticles had different melting point depression behavior. Sun et al. [12] and Liang et al [13] studied the size dependence of melting temperature of Al nanoparticles. Comte [14] performed the size dependence of melting temperature of nanocrystalline Au. Eckert et al [15] and Lee et al. [16] studied the effect of size on melting temperature of Al nanoparticles experimentally. Buffat and Borel [17] studied the melting temperature of Au nanoparticle. In all these experiments, the experimentalists observed a depression in melting temperature of these nanoparticles as the particle size decreases. The size- dependent melting properties of Sn [18], Ag [19], Al [20] and Au [21] nanoparticles have been studied both on experiment and theory.

There are some other theoretical work on melting temperature of nanoparticles. Kumar and Kumar [22] used a model to study the size dependence of melting temperature of Au, Al, Ag etc. nanoparticles. They found that the melting temperature of these nanoparticles decreases with decrease in particle size. Arora and Joshi [23] developed a thermodynamic analytic model to study the size effect on melting temperature of Al, Ag, Au and Sn nanometals and found the melting temperature shows decreasing trend with decrement in size of the nanomaterial.

It is very much evident from the above that various experimental and theoretical studies have been performed to study the melting temperature of nanoparticles with particle size but in all these studies the crystal order of the materials has not been considered as a physically very important role in this study. When the concentration of building blocks (atoms or ions) of a solid becomes sufficiently high, they aggregate into small clusters through homogeneous nucleation. With continuous supply of the building blocks, these clusters tend to coalesce and grow to form a large cluster eventually. Clusters are structures with a central site around which the cluster is grown. The cluster may be considered as an onion-like structure formed by several concentric shells around the central site. All the surface sites which may belong to various shells are referred as clusters. The number of atoms put defines the order of the cluster [24]. It is, therefore, interesting to study the melting temperature of nanoparticles with the inclusion of the effect of the cluster order. This encouraged the author to study the melting temperature depression

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Study of Size Dependent Thermal Conductivity of Gold FCC Nanomaterial

Anil Kumar and Mahipal Singh*

Department of Physics, R.H. Govt. P.G. College, Kashipur-244713, Uttarakhand, India

Abstract: A theoretical model for the study of size dependent thermal conductivity of Gold FCC nanomaterial has been developed by considering the cluster order with particle size of Gold (Au) FCC nanomaterial. Using this model, the thermal conductivity of Gold FCC nanomaterial has been calculated and compared with other theoretical models and existing experimental data. It is found that the thermal conductivity of Gold FCC nanomaterial decreases as the size of the nanoparticle decreases. The comparison of theoretical findings of this present work indicates that the developed theoretical model is in good agreement with available experimental data which shows the validity of the present work.

Keywords: size, thermal conductivity, gold, nanomaterial

I. Introduction

The physical properties of nanomaterials have been investigated extensively both theoretically and experimentally due to their scientific and industrial importance [1]. It has been reported that the nanomaterials exhibit interesting physical, chemical, electrical and thermal properties that are significantly different from the corresponding properties of bulk materials [2-4]. Because of the enormous surface area to volume ratio of nanomaterials, the energy associated with the atoms of these nanomaterials will be different in comparison of conventional bulk materials, leading to the size dependent properties of nanomaterials[5]. The energy of the free surface atoms is entirely different as compared to the energy related to the atom of the bulk. The surplus energy associated with the surface atom is known as the free surface energy. In bulk materials, this free surface energy is neglected because it has associated with only the most layers of the atoms on the surface. Also the ratio of the reduced volume of surface atoms and the total volume of the material is extremely small.

As the size of the low dimensional materials decreases to the nanometer size range, the electronic, magnetic, optical, catalytic, electrical and thermal properties of these materials are significantly altered from those of either the bulk or a single molecule [1]. Among these properties, the thermal conductivity of nanomaterials have received considerable attention because the thermal conductivity is a fundamental property of nanosolids that directly affects its applications. However, few efforts have been devoted on studying thermal conductivity of these materials.

Some experimental studies have been carried out to investigate the effect of nanoparticles on the thermal conductivity of various materials. Kotika and Prasad [6] have studied the effect of size of nanoparticles on the thermal conductivity of crystalline thin films at low temperatures and reported that the thermal conductivity decreases with decreasing particle radius. There are some theoretical studies on the size effect on the thermal conductivity of nanomaterials. Singh et al [7] have studied the grain size effect on the thermal conductivity of nanomaterials and found that the thermal conductivity of nanosolids decreases as the grain size decreases. Bhatt et al [8] have presented a theoretical model to study the size effects on thermal conductivity of nanomaterials and found a significant reduction in the thermal conductivity of nanomaterials as the particle size decreases. Jiang et al [9] have reported the decrease in thermal conductivity of nickel nanoparticles with decreasing particle size. It is found that very few experimental and theoretical works have been done in this field while much more work is required in this direction. In all these studies the crystal order of the materials has not been taken into account as it plays a vital role in the study of thermal conductivity of various nanomaterials. When the building blocks (atoms or ions) of a solid have energy high, they accumulate with each other and grow to form a larger cluster structure. The clusters may be considered as an intermediate between the isolated atoms and the crystal state. All surface sites, which may belong to various clusters, have a different number of nearest neighbors. The number of nearest neighbors defines the order of the cluster [9, 10]. It is, therefore, necessary to study and analyze the size effect on thermal conductivity of nanomaterial by considering the effect of cluster order. In the present work we have modified available theoretical model by including cluster order for the study of thermal conductivity of Gold (Au) FCC nanomaterials.

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Keywords: *size, thermal conductivity, gold, nanomaterial*

1. Introduction

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Some experimental studies have been carried out to investigate the effect of nanoparticles on the thermal conductivity of various materials. Kalska and Prieur [6] have studied the effect of size of nanoparticles on the thermal conductivity of crystalline thin films at low temperatures and reported that the thermal conductivity decreases with decreasing particle radius. There are some theoretical studies on the size effect on the thermal conductivity of nanomaterials. Singh et al. [7] have studied the grain size effect on the thermal conductivity of nanomaterial and found that the thermal conductivity of nanosolids decreases as the grain size decreases. Bhatt et al. [8]have proposed a theoretical model to study the size effects on thermal conductivity of nanomaterials and found a significant reduction in the thermal conductivity of nanomaterials by decreasing the particle size. Li et al. [9] have reported the decrease in thermal conductivity of nickel nanoparticles with decreasing particle size. Wang et al. [10] found that very few experimental and theoretical works have been done in this field which is a matter of concern. Efforts are required in this direction. In all these studies, the crystal order of the materials has not been taken into consideration. It plays a vital role in the study of thermal conductivity of various nanomaterials. When the nanoparticles are considered as the building blocks (atoms or molecules of a solid) they aggregate after reaching a critical size through homogeneous nucleation. With continuous supply of the building blocks, these clusters grow in size and come to form a large cluster assemblies. The cluster may be considered as an atom like structure in which the atoms are arranged in shells around the central one. All surface sites, which may belong to various shells of the cluster and contribute the size effect on thermal conductivity of nanomaterial by considering the effect of cluster order. In the present work, we have modified available theoretical model by including cluster order for the study of thermal conductivity of Gold (Au) FCC nanomaterials.

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Theoretical Study of Size Dependence Cohesive Energy of Nanoparticles

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Abstract

In the present work a simple method to calculate the cohesive energy of nanoparticles has been discussed. In this method the surface area of particle and atoms has been considered. For the purpose the size of nanoparticle has been taken into account. It has been observed that the cohesive energy of nanoparticle depends on their size and increases with the increase in the particle size. When the particle size is large the cohesive energy approaches the value of the corresponding bulk material.

Keywords: Size dependence, Cohesive energy, Nanoparticles

1. Introduction

The cohesive energy is an important physical quantity accounting for the bond strength of a solid which equals to the energy to divide the metallic crystal into individual atoms. It also refers to the heat of sublimation which can be determined by experiments [1] or computed theoretically using various methods such as cellular method [2], density function theory [3], KKR method [4] etc. All these methods are developed for calculating the cohesive energy of bulk material. The cohesive energy is constant for bulk materials but for nanomaterials, the cohesive energy depends upon the size of the nanomaterials which has been showed by experiments and also explained by different theories such as liquid drop model, surface area difference model and bond energy model[5]. The most important characteristic of a nanoparticle is its size effect i.e. the properties of a nanoparticle are different from the corresponding bulk material [6, 7, 8].

There are some experimental studies of size dependence of cohesive energy of nanoparticles. Kumar et al[9] carried out experimental study of cohesive energy of W. Asano et al [10] as well as Hou et al [11] studied the size dependence of cohesive energy of Ag and Co nanoparticles using computer simulations. A theoretical study of size dependence of cohesive energy of Ag, Cu, Al and Cu nanoparticles was carried out by Zhu et al [12]. Kumar and Kumar [13] studied the effect of size on cohesive energy of different nanoparticles theoretically. Recently, Singh and Pandey [14] used bond energy theoretical model, free from approximations to calculate cohesive energy of various nanoparticles. In all these studies, the cohesive energy has been found to be dependent on size of nanoparticle. The cohesive energy increases with the increase in the particle size. Moreover the theoretical efforts are lacking in the present work a simple method is discussed to calculate the cohesive energy of nanoparticles. This method shows that the cohesive energy of nanoparticles depends on their size. The cohesive energy increases with increasing the particle size. When particle size is large the cohesive energy approaches the value of the corresponding bulk material.

2. Theoretical Analysis

To calculate the theoretical cohesive energy of a metallic particle has a character as given by.

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The Debye Temperature of Metallic Nanoparticles

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Abstract
Expectations for the variety of actual properties of nanomaterials have incited incredible discussion in late years. Various specialists have announced uncommon changes in the actual properties of metals at their nanoscale. In the current work, we have concentrated on the Debye temperature of round nano strong, nanowire and nanofilms of Aluminum (Al), Copper (Cu), Palladium (Pd) and Platinum (Pt), having their sizes under 10 nm. For calculations, we have thought about the central connection of durable energy with a solitary pair. During our review, it is found that there is an uncommon change in the Debye temperature of round nano strong, nanowire and nanofilms of metals under 20 nm. In this variation, it is additionally seen that there is a greatest variety of Debye temperature is on account of nanofilms while least is on account of circular nano solids and moderate change on account of nanowires. Variety in Debye temperature has been deciphered based on the presence of various surface molecules because of the adjustment of surface to volume proportion of metals at the nano level. We have contrasted our processed outcomes and the accessible test information which shows their great understanding.

Keywords: *Debye, Nanoparticles*

I. Introduction:

In the nanoscience and nanotechnology, the size of materials has diminished at the exceptionally low scope nanometer no less than one aspect. In the size range, the surface to volume proportion is quite expanded and correspondingly the physical, synthetic, and mechanical properties are changed [1-3]. The properties of material at nanoscale are unique in relation to the comparing mass material. The property of nanomaterials change definitely as the size decreases less than 10 nanometers. A test of gold seems red at 10 nanometers in liquefying temperature diminishes quickly as their measure decreased up to the degree of nano scale [4-5]. Our motivation is to decide the Debye temperature of the nanomaterials which is firmly identified with the durable energy of the nanomaterials. The durable energy or holiness of sublimances is a significant actual amount to represent the strength of metallic bonds. The firm energy is the energy to partition the metallic gem into individual particles. For the above said reason we concentrated on the situation of state for the size subordinate Debye temperature of the nanoparticles of metals Aluminum (Al), Copper (Cu), Paladium (Pd) and Platinum (Pt). We have processed the Debye temperature of circular nanosolid, nanowire and nanofilm at the thought about examples. With the diverse method of variety, it is seen that the Debye temperature of metals at small [illegible] increases with increment of the measure.

II. Method Of Analysis:

The total cohesive energy of the nano crystalline solid, is given by

$$E_{coh} = E_b(n - N) + \frac{1}{2}E_b N \qquad (1)$$

Condition (1) is the amount of energy because of the confinement of the inside molecules [illegible] of nanocrystalline solids. Here E_b is the durable energy of the mass materials per molecule, n is the all out [illegible] of nano strong and N is the quantity of particles at the surface. [6]

For the cohesive energy per mole, the equation (1) may be written as

$$A_v E_{coh} = E_b A_v (n - N) + \frac{1}{2} A_v E_b N$$

$$\frac{A_v E_{coh}}{n} = E_b A_v \left(1 - \frac{N}{n}\right) + \frac{A_v E_b N}{2n} \qquad (2)$$

Where A_v is Avogadro number. The term $\frac{A_v E_{coh}}{n}$ [illegible] represents the cohesive energy per mole of the nanocrystalline solid and $E_b A_v = E_{bulk}$ is the cohesive energy per mole of the corresponding bulk material

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Effects of *Grain-Size* on Debye Temperature and Thermal Conductivity of Nanomaterials

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Abstract

A hypothetical model is accessories for to compute the warm conductivity of nanomaterials in various shapes, for example, round nanosolids, nano rises and nanofilms dependent on size subordinate nuclear strong energy on thinking about the surface impress. It is seen that the warm conductivity of various shapes nanosolids diminishes with decline in the grain size. The outcomes acquired are contrasted and the accessible test information. A nearby arrangement among hypothesis and investigation supports the legitimacy of the studied talked about.

Keywords: *grain-size, nanomaterials*

I. Introduction

Nanomaterials are establishments of nanoscience and nanotechnology. The possibility of nanotechnology felt without precedent for the renowned talk " There is a lot of room at the base" given by the Physicist Richard Feynman at the American Physical Society meeting on December 29, 1959 at Caltech. Nanostructure science and innovation is a wide and interdisciplinary dynamic space of innovative work interest that has been sustaining worldwide in the beyond couple of years. Nanomaterials are energizing since they show solid shape and size impacts which can't be clarified by standard hypotheses. Nanocrystals have huge surface-to-volume proportions, and surface impacts take on an importance that is regularly unrelated for mass materials. At nanoscale Au and Ag have exhibited many intriguing substance and actual properties that can't be seen from their mass partners [1-3]. Liu et al [4] fostered a model to accommodate the noticed size reliance of grid strain, center level shift and versatile modulus of Au and Ag nanostructures which depends on Goldschmidt Pauling's standard of bond compression and its expansion to the neighborhood bond energy and restricting energy thickness. Different models, for example, surface strain, surface unwinding, surface pressure, grid vibration, precariousness and surface phonon instructions have been created to comprehend the surprising practices of metallic nanostructures [5-9]. A round together insightful model with regards to the size subordinate versatile modulus and vibration recurrence of nanocrystalline metals, earthenware production and semiconductors is set up dependent on the intrinsic strain energy density of nanocrystals [10]. Additionally, the hypothetical clarifications for the size impact of the versatile modulus [11] and volume warm extension [12] are connected with the surface impact by presenting the surface energy commitments.

Free surface Atoms encounters a net as all like nearby climate that air particles in the majority of a materials. As an outcome, the energy related with these molecules will be not the same as that of the ones in the mass. The adds onal energy imparted to surface molecules is known as the surface energy. Surface free energy is typically ignored in regular continuum mechanics, since it is related with a couple of layers of molecules close to the surface and the proportion of the volume involved by the surface notes and the absolute volume of the material of interest is minuscule. The investigation of size and shape consequences for nanomaterials has drawn in gigantic consideration because of their logical and modern significance. Warm conductivity is the key properties of nanosolids, which is a standard centrality to its application. Nonetheless, not many endeavors have been executed for the warm conductivity. In this paper, on considering the surface impacts, we present another model to compute the warm conductivity of nanosized tin oxide, Si, Ag, and cut and it underlining round nanosolids, nanofilms and nanowires materials depends on size subordinate nuclear strong energy. The model expectations concur well with the accessible trial results.

II. Method Of Analysis

The amount of energy because of the commitments of the inside atoms and the surface molecules of the nanomaterials is referred to as bulk energy, which is communicated as [13]

$$E = E_{bulk} + E_{surface} = \frac{1}{2} N \quad (1)$$

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Droop reduction in ZnO/GaN Hybrid Light Emitting Diodes

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PN junction is the basic building block for the fabrication of optoelectronic devices. ZnO shows the n-type behaviour. Proper doping with suitable hole concentration and reduced defects is one of the major challenges in the fabrication of ZnO based devices. Nitrogen, Phosphorus, Arsenic and Bismuth are some of the potential p-type dopants, but some of them have several electrical properties to fabricate p-n junction from ZnO. In the present work, we proposed a hybrid n-ZnO/p-GaN heterostructure, in which n-type ZnO film is placed on Mg doped GaN film. Simulation results revealed that the electroluminescence intensity increases in hybrid LED structure and there is a strong sensitivity towards the layer properties in hybrid structure.

Keywords: ZnO, GaN, p-n, Light Emitting Diode, Droop

1 Introduction

Direct band gap materials like GaN, and GaAs are important compound semiconducting materials for the fabrication of optoelectronic devices. All optoelectronic devices require good material quality and ease to fabricate p-n junctions[1]. In recent decades, ZnO has attracted considerable attention due to its unique properties, like high electron mobility, wide and direct bandgap, and bandgap tailoring. This has been considered as some promising parameters for fabricating devices like light-emitting diodes, laser diodes, photo detectors, and solar cells. Moreover, hetero-structures are also possible on ZnO materials, which make ZnO ternary alloys-based materials as an alternate to III-Nitride semiconductors for fabricating optoelectronic devices[2-4]. ZnO films grown by pulsed laser deposition, vapor phase epitaxy, and sol-gel unintentionally show n-type behaviour due to bulk and deep level defects[5,6]. Thus, growing good quality p-type material with suitable hole mobility is one of the major challenges faced by researchers in ZnO. Although, N, P, As, Sb, and Bi show potential p-type dopants for ZnO, none of them show enough electrical and optical properties to fabricate a good p-n junction. Sarmanta et al[7] deposited p-type ZnO films on a sapphire substrate by Sb doping with hole concentration and mobility around 6.5×10^{18} cm^{-3} and 53 cm^2/V-s respectively[7]. The sample shows good structural properties but due to low hole mobility was not suitable for optoelectronic applications. Many authors suggest p-type substrates as an alternative to p-ZnO for fabricating p-n junctions. p-GaN and p-SiC with similar structural, electronic, and optical properties can be good alternatives. Moreover, their super-lattices and hetero-junctions structures show more electroluminescence due to large charge carrier accumulation at the interface.

In this work, we studied a hybrid GaN/ZnO quantum well structure with p-GaN as p-type material and n-ZnO as n-type material. Our previous study on III-Nitride reveals that GaN-based LEDs show a high reduction in internal quantum efficiency (efficiency droop) at high injection current levels[8]. This may be due to auger recombination, interface fields, and lattice defects. In another study, we also reveal that quantum well structures have more emission intensity, and the efficiency of LED increases with grading[9]. The same methodology has been used here to study the hybrid ZnO/GaN quantum well structure. In the numerical simulations, Poisson's equation, current continuity equations, and carrier drift-diffusion transport equations were solved for self-consistency.

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Magnetic Properties of Nanostructured Material with the Effect of Dimension

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ABSTRACT

In this Study, Q model, Jiang model and Lu model, are used to predict the variation of magnetic properties with size and shape in nanosolids. Magnetic properties of nanosolids such as Curie Temperature (Tcn), Magnetization (Msn) and Neel Temperature (T_{Nn}) of Cu, Ag are studied. It is predicted that as the size of nanosolids is decreased, all these three properties decrease with decreasing size. These magnetic properties are also studied with different shapes of nanosolids such as thin films, cylindrical nanowires, spherical, regular tetrahedral nanoparticles and regular triangular cross-section nanowires. The computational results are compared with the available experimental and simulated data to validate our theory.

Keywords: Curie temperature, magnetization, Neel temperature, nanomaterials, shape

1. INTRODUCTION

Unlike bulk material, properties of nanomaterial such as thermodynamic and magnetic properties are affected by the decrease in size and change of shapes in nanomaterials [1-4]. These nanomaterials can be presented in different shapes such as nanorods, thin films, cylindrical nanowires, spherical, rectangular tetrahedral nanoparticles and regular triangular cross-section nanowires. Magnetic and thermodynamic properties of nanomaterials go hand in hand as we study how they are affected by both decrease in size and the changed shapes of nanomaterials [5-9] these properties are the Curie temperature, magnetization and Neel temperature.

Curie temperature (T_{cn}) is the temperature above which, certain materials lose their permanent magnetic properties that can be replaced by induced magnetism. Whilst, Magnetization (M_{sn}) is a measure of density of induced magnetic dipole moments in a magnetic material. In addition, Neel temperature (T_{Nn}) is the temperature above which an antiferromagnetic substance loses its antiferromagnetism and becomes paramagnetic.

unpaired electrons, as size decreases, the electron spin is disturbed by small temperatures, due to the increase of the surface to volume ratio because of the decrease

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RESEARCH ARTICLE-PHYSICS

Boost in the Electromagnetic Shielding Effectiveness of Polystyrene–Polyaniline Composites by Addition of Carbon Nanofibers

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Abstract

In this work, substantial increase in electromagnetic (EM) shielding of polystyrene–polyaniline (PS-PANI) composite by way of addition of carbon nanofibers has been achieved. PANI was synthesized through chemical route using chemical oxidative polymerization method. Copolymer of PS with conducting polymer PANI and carbon nanofiber (CF) were prepared using solution mixing method. The synthesized PS-PANI-CF composites were characterized using X-ray diffraction, scanning electron microscopy, and D-shore hardness tester while thermal stability was determined by thermogravimetric analysis. Shielding effectiveness of the composites was investigated in the frequency range of 8.2–12.4 GHz (X-band region) using a vector network analyzer. Synthesized PS-PANI–CF composite exhibits an absorption dominated EM shielding value of 39 dB at 8.4 GHz frequency.

Keywords EMI shielding · Chemical oxidative polymerization · Solution mixing method · X-band · Polystyrene–polyaniline composite

1 Introduction

Electromagnetic wave interference (EMI) or EM pollution has become a major problem due to the fast growth of sensitive electronic equipment in commercial, civic, and military operations [1]. The search for lightweight, flexible, and cost-effective EMI screening materials has increased in recent years [2]. The immense rise of compact electronic equipment containing large number of integrated circuits at communication devices, battery-powered devices/micro-nanomotors, etc. emit unwanted electromagnetic waves, which may result in electromagnetic interference with the nearby sophisticated electronic paraphernalia besides EM pollution. The extensive uses of wireless and telecommunications systems in the radio and microwave areas are now progressively more. Undesirable EM waves are a serious concern since it influences the functional characteristics, reliability, and performance of equipment/appliances besides poses serious problems for human health [3]. The use of ordinary metals and metal hybrids as EMI shield material is restricted because of their high density, chemical reactivity, and complex fabrication process that involves high costs and time restraints. [4]. In this sense, intrinsically conducting polymer (ICP) and conductive polymer composites (CPC) and insulating polymers with conducting fillers have an essential role in the development of commercially viable EMI shielding materials. EMI shielding materials based on ICP and CPC are chemically stable, lightweight, and electrically conductive along with outstanding capabilities for electromagnetic radiation absorption, reflection or both over a wide spectrum of frequencies. The nanostructured polymer composites have further fortified their material characteristics with more efficacy of EMI shielding. Among ICPs, PANI possesses a diverse physicochemical properties in addition to high degree of stability and minimal cost [4, 5]. This allows its application in wide range of modern industries

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Electromagnetic shielding effectiveness and dielectric study of polystyrene/aluminum composite by addition of graphite and carbon nanofiber powder

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ABSTRACT

The adoption of 5G mobile technology has the potential of revolutionary enhancement in connectivity and communication that will revolutionize many sectors and improve user experience. A large demand for smart electronic devices and GHz range communication have led to the technical advancements in this field, however, this is affecting the environment by causing electromagnetic interference (EMI) or electromagnetic (EM) pollution. To prevent from electromagnetic pollution, in the present study, composites of polystyrene were synthesized using a solution mixing process with the inclusion of aluminum metal dust, graphite, and carbon nanofibers. The efficiency of composite shielding was evaluated in the X-band (8.2–12.4 GHz) frequency range using a vector network analyzer (VNA). At 12.3 GHz, the overall shielding efficiency of polystyrene–aluminum metal dust and carbon nanofibers was measured to be − 23.53 dB, whereas at 8.2 GHz, it was observed to be − 8.64 dB for polystyrene–aluminum composites and − 14.43 dB for polystyrene–aluminum–graphite composites. Thickness for all the samples was taken as 2 mm. Synthetic composites were characterized by XRD, SEM, and TGA. D-shore hardness tester was employed to gauge the hardness. The fabricated composites are supposed to be a good alternative for applications requiring EM pollution suppression or radar absorption.

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Alien Species of Family Asteraceae and their Indigenous Uses in Tarai and Bhabar Region of Uttarakhand

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Abstract: Uttarakhand with degraded lands, diverse topography and climatic variations is a treasure of non-native i.e., exotic or alien plants. Asteraceae represents a dominant family having a large number of alien plants. During the present study, frequent regular field visits were organized and a total of 51 alien plant species belonging to 37 genera and 10 tribes of Asteraceae family were collected from different sites. There were 88% (45 species) herbs, 4% (02 species) shrubs, 4% (02 species) undershrubs, 2% (01 species) climber and 2% (01 species) tree. A comparison of present data with previous literature revealed that Jaccard index ranges between 3.92% to 22.38%. Local people were interviewed and discussed to record their indigenous uses for medicine, food, oil, fodder, compost etc. Majority of plant species were useful as medicine (23 species) in different diseases e.g., cut and wounds (15 species), diabetes (2 species), earache (2 species), jaundice (1 species), toothache (2 species) etc. Two species were noted to be harmful and one species play both harmful and beneficial roles.

Keywords: alien • Asteraceae • Indigenous uses • Tarai and Bhabar • Uttarakhand.

Introduction

India is the most diversified country and known amongst one of the 17 mega diversity centers of the world. Due to its diverse climatic and environment conditions, it is highly susceptible to biotic invasion (Kohli et al., 2012). Out of the world's 36 biodiversity hotspots, four are found in India and the Himalaya region is one of them. The state Uttarakhand lies in the Northern part of the country between 28°43'-31°28' N latitude and 77°34'- 81°03' E longitude and it spawls over 53483 km² area. It is bounded by two international boundaries i.e., China in North and Nepal in the East and also shares the state boundaries i.e., Himachal Pradesh in West and Uttar Pradesh in South. On the basis of evolutionary history, Uttarakhand is divided into four geographical zones i.e. The Trans Himalaya, The Greater Himalaya, The Lesser Himalaya, The Siwalik ranges. Tarai and Bhabar is a part of the foothills which lies in the southern part of the state (Uniyal et al., 2007). The state with diverse topography and varied climate is a treasure of rich flora. Asteraceae, the most diversified family among dicot, is represented by 370 species under 134 genera in Uttarakhand (Pushalkar and Srivastava, 2018). It occurs in various life forms such as herb, shrub, undershrub, climber and tree. Family Asteraceae produces a special type of seed called cypsela, which is very adaptive in nature, so these plant species have high potential to reproduce and disperse minute seeds through air and water into the new area. Due to its advanced characteristics, it can adopt all types of environment and climatic changes.

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Alien Species of Family Asteraceae and their Indigenous Uses in Tarai and Bhabar Region of Uttarakhand

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Journal of Traditional and Folk Practices

Traditional uses of Asteraceous plants among *Buksa* tribe for skin disorders in Udham Singh Nagar, Uttarakhand, India

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Abstract

The present paper deals with traditional uses of asteraceous plants among *Buksa* tribe for skin disorders. The study was conducted during 2017-20 in Udham Singh Nagar district of Uttarakhand. *Buksa*, the second largest tribe in this district is mainly concentrated in Kashipur, Bazpur, Gadarpur and Rudrapur. During field work, it was observed that a total of 13 plant species belonging to 11 genera and 06 tribes of this family are being used by *Buksa* people for various skin ailments such as cuts and wounds, burns, fungal infections, boils and pustules, pus oozing, etc. It was concluded that *Eclipta prostrata* (L.) L. is the most prominently used plant species followed by *Ageratum houstonianum* Mill. and *Tagetes erecta* L. The paper also reveals some lesser known uses of these three plants.

Keywords Asteraceae, *Buksa* tribe, Skin disorders, Udham Singh Nagar

1. Introduction

Asteraceae Berchtold & Presl. (Compositae Giseke nom. alt.) commonly called daisy, sunflower or thistle family, is well known for its advanced and special taxonomic characteristics, i.e., flower head is composed of minute flowers called florets, surrounded by bracts. It is worldwide in distribution and exhibits various habit and habitats. It is well known for medicine, food, fodder and other purposes. It plays an important role in the treatment of dermatological problems. Various species of asteraceae, e.g., *Calendula*, *Helianthus*, *Taraxacum*, etc., are commercially used in skin ailments. The family has great ethnomedicinal value throughout the world. Several workers (Heinrich *et al*., 1998; Jan *et al*., 2009; Bisht and Purohit, 2010; Hurrell and Puentes, 2013; Rahman, 2013; Lakshman *et al*., 2014; Sunita, 2014; Das *et al*., 2015; Roy and Kanungo, 2016) have reported various medicinal uses of asteraceous plants. Achika *et al*. (2014) have reviewed on the phytoconstituents and related medicinal properties of plants in the asteraceae family.

Uttarakhand is a reservoir of rich plant diversity, tribal population and consequently ethnobotanical heritage. The state represents 4800 taxa of flowering plants belonging to 1400 genera of 215 families. Among dicots, asteraceae has the largest number of genera, i.e., 134 genera belonging to 370 species (Pusalkar and Srivastava, 2018). The state is inhabited by 291903 tribal people (Census, 2011) including five scheduled tribes *viz*. Tharu, Buksa, Bhotia, Jaunsari and Raji. The main concentration of tribal population is in the rural areas. As per records, 94.50% of tribal population resides in rural areas and the remaining ones live in urban centers of Uttarakhand (Farswan, 2017). The study area, Udham Singh Nagar is one of the 13 districts of the state lies in the Tarai belt where *Tharu* and *Buksa* are the main tribes inhabiting this area. The present study is based on *Buksa* tribe and their traditional phytotherapy. They have vast and unique indigenous knowledge about traditional phytotherapy and earn their livelihood mainly from animal husbandry

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ORIGINAL RESEARCH ARTICLE

Cumulative functional responses of larvae and adults of two aphidophagous ladybirds

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Abstract
The functional responses of two coccinellid-predators, *viz. Propylea dissecta* (Mulsant) and *Menochilus sexmaculatus* (Fabricius) sharing common aphid-prey, *Aphis gossypii* (Glover) were investigated in various heterospecific and conspecific combinations in laboratory conditions. The third and fourth instar larvae, along with adults (males and females) of the above coccinellids were fed on increasing densities (from 25 to 600) of *A. gossypii*, after releasing a couple of conspecifics or heterospecific coccinellids of the same stage in a microhabitat. Their cumulative prey consumption was examined at predator species, predatory stage and prey densities levels. Despite a Type II response by predators in each combination, high proportion of prey was consumed at low and middle densities. Heterospecific females consumed prey with a maximum attack rate (0.0024) with the least handling time (0.1831 hour) than conspecific ones. Adult female *P. dissecta* was smaller than *M. sexmaculatus* but together they consumed more aphids than the two females of *M. sexmaculatus* due to the least interference, which supports releases of dual-predators for aphid biocontrol. Amongst larvae, duo fourth instars *M. sexmaculatus* had an attack rate of 0.0015 and handling time of 0.1879 hour. We conclude that duo release of adult *M. sexmaculatus* and *P. dissecta* benefits more than their single releases for the biocontrol of *A. gossypii*. In addition, conspecific fourth instars *M. sexmaculatus* were better predators in various larval combinations.

Keywords Aphid · *Aphis gossypii* · Biocontrol · Coccinellidae · *Propylea dissecta* · *Menochilus sexmaculatus*

Introduction

Cotton or melon aphid, *Aphis gossypii* (Glover) (Hemiptera: Aphididae) is a major pest of several crops causing a decline in productivity (Rahman et al. 2010; Singh et al. 2014). It is a cosmopolitan, polyphagous species, a vector of numerous viruses (Carmo-Sousa et al. 2016), and widely distributed in various temperate, tropical, and subtropical regions (Dehkordi et al. 2012). Predaceous coccinellids, popularly known as ladybirds (Coleoptera: Coccinellidae) are known to be effective for aphid management (Hodek et al. 2012; Pervez et al. 2020). The release of single ladybird species for aphid biocontrol is often a failure due to mutual interference between conspecifics (Bayoumy et al. 2014) and their spatial-temporal limitations (Omkar and Pervez 2011). This interference between predators could be highly effective in the fields (Siddiqui et al. 1999) and semi-field conditions (Khalid et al. 2020). However, little is known how the ladybirds will mutually interact in the fields. Other factors, like dispersion, plant architecture, heterospecific predation, and climate are seemingly more operational. Omkar and Pervez (2011) released two ladybird species of contrasting characters in terms of their spatial-temporal availability and found synergistic influence on prey mortality.

Functional response analyses may help to understand the success of a predator and the outcome of aphid biocontrol could be better understood using functional response analyses (Holling 1959). Functional response, which evaluates the predator's response to the varying prey density and its

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Research Note

Kin recognition by the adults of a biological control agent, *Propylea dissecta* (Coleoptera: Coccinellidae)

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ABSTRACT: The ability to recognize kin is a well-established behavior across several animal phyla including insects. A laboratory experiment was designed to find out whether adults of an aphid-biocontrol agent, *Propylea dissecta* (Coleoptera: Coccinellidae) may avoid consuming their own eggs in prey scarcity in the presence of unrelated conspecific eggs. For the purpose, starved parent ladybirds were provided with their eggs and unrelated conspecific (alien) eggs in the absence of their natural prey (aphids). The predatory avoidance behavior of the parents towards alien-eggs and their eggs was recorded. The adult male of *P. dissecta* had lesser food demand than the female and consumed significantly lesser (6.7±0.26) kin eggs than the alien eggs (2.8±1.49). Similarly, the adult female cannibalized significantly lesser number of kin eggs (1.6±0.209) than the alien-eggs (3.5±0.15). Seemingly, both the parents had recognized their eggs and refrained from consuming them. This could be a strategy adopted by the parents to conserve their gene-pool and to further protect it by consuming the heterospecific eggs of potential enemies (alien eggs) in prey scarcity. This insurance of their gene pool could benefit these parents by conserving their genetic lines.

KEY WORDS: Egg cannibalism, kin recognition, *Propylea dissecta*

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Kin recognition is the process of assessing genetic relatedness using certain cues and preferentially providing benefits to the relatives (Schaushergen 2007; Hoe *et al.*, 2011). Several behavioral patterns like colonization plans, mating, cannibalism, defense, *etc.* are probably influenced by this ability. This behavior is seemingly triggered through the chemical label(s) on the body and a template in the brain of an individual. Chemical cues in the form of colony specific odours are known to exist among social insects, such as ants and bees (Hoe *et al.*, 2011). Kin-recognition is advantageous, as it provides numerous benefits, *viz.* resource exploitation, sex allocation, avoidance of kin cannibalism and avoidance of inbreeding depression (Fellowes, 1998; Saxena *et al.*, 2016, 2018). Thus, an individual may increase its inclusive fitness and aid to ensure the survival of a specific gene group increasing genetic representation of a species. For the augmentation of predatory insects, particularly biocontrol agents, this aspect of kin recognition may be exploited in augmentative rearing and to utilize them as biological control agents against numerous phytophagous insect pests (Omkar and Pervez, 2002).

Propylea dissecta (Mulsant) (Coleoptera: Coccinellidae) is an aphidophagous ladybird from the Oriental region, which preys upon numerous aphid species (Pervez and Omkar, 2004, 2005; Pervez and Kumar, 2017) and has immense aphid-biocontrol potential (Pervez and Omkar, 2011). Endogenous cues, like relatedness, seem to be the driving force for the avoidance of cannibalizing inferior and immature conspecifics (Joseph *et al.*, 1999; Pervez *et al.*, 2005). The success of this species in the Oriental region may depend on its ability to recognize its kin. The Kin recognition in this species was thus tested among the adults to find out whether males could also recognize the eggs and defer to cannibalize them. Keeping in view, we attempted to address the question, whether both the adult parents recognize their offspring and avoid consuming them in prey scarcity.

Maintenance of stock culture

Adults of *P. dissecta* were collected from cowpea (*Dolichos lablab* L.) fields near the suburbs of Kashipur, India (29.2104°N, 78.9619°E) preying on aphid, *Aphis craccivora* (Koch). These adults were brought to the laboratory and

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MATING BEHAVIOUR OF THE PREDACEOUS LADYBIRD, *HARMONIA DIMIDIATA*

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ABSTRACT

We studied the mating behaviour of the predaceous ladybird beetle, *Harmonia dimidiata* (Fabricius) (Coleoptera: Coccinellidae). The courtship behaviour of the male involves the secretion from the tibio-femoral joints of its hind legs of yellow coloured reflex blood containing the alkaloid harmonine, which is usually the first line of defense of the ladybird. In this case, this reflex blood also functions as a nuptial gift from the male, which is edible and facilitates mating. The amount of reflex blood offered as a nuptial gift decreases with each subsequent mating. Mating in *H. dimidiata* was prolonged and initially increased before subsequently decreasing with each subsequent mating. This information could be useful for the mass rearing of the species in the laboratory.

Keywords: *Harmonia dimidiata*, harmonine, mating, mating duration, tibio-femoral joint, reflex blood

Introduction

Harmonia (=Leis) dimidiata (Fabricius) is a thirteen-spot, multivoltine predaceous ladybird beetle (Coleoptera: Coccinellidae) that occurs in North America, India, Pakistan, Nepal, Bhutan, China, Taiwan and Japan (Yu et al. 2018). It was introduced into Far Eastern Russia from China. It is very effective in the biocontrol of aphids infesting melon, cucumber and peppers in greenhouses (Kuznetsov and Pang Hong 2002). It can be easily reared on the aphid species *Myzus persicae* (Sulzer) and *Schizaphis graminum* (Rondani) throughout the year, as the adults do not undergo diapause or migrate (Kuznetsov and Pang Hong 2002). It is an important predator of the apple aphid, *Aphis pomi* de Geer (Kumari 2018), mustard aphid, *Lipaphis erysimi* (Kalt.) (Singh and Singh 1986) and cotton aphid, *Aphis gossypii* (Glover) (Yu et al. 2018) and can consume more than 200 cotton aphids per day (Yu et al. 2013). The high net and daily consumption of *A. gossypii* of 133.050 and 200 aphids, respectively, reported for *H. dimidiata* (Yu et al. 2013) indicate its high foraging ability (Pervez and Yadav 2018). Female *H. dimidiata* mature earlier and tend to produce more eggs for longer when aphids are abundant (Agarwala et al. 2009). Thus, its high functional and numerical responses indicate its great aphid biocontrol potential (Pervez et al. 2018).

Despite its biocontrol potential, little is known about its reproduction, which is a prerequisite for mass rearing. Mating in ladybirds starts with a brief courtship by the male (Omkar and Pervez 2003). Behavioural studies on mating reveal that males spend most of their time searching for potential mates and on encountering a female they court her before copulating (Obata 1987; Omkar and Srivastava 2002, Omkar 2004; Pervez and Singh 2013).

Preliminary experiments revealed that males secrete reflex blood when courting (authors' personal observation). It is widely held that adult ladybirds release a yellowish orange liquid known as reflex blood as a defense when attacked (Zvereva and Kozlov 2016; Knapp et al. 2018). This reflex blood consists of haemolymph, which is exuded through joints in the exoskeleton in response to an attack by a predator (Majerus and Majerus 1997; Hodek et al. 2012; Knapp et al. 2018). In the present study, the possible role of this defensive exudate as a lure/nuptial gift in the mating behaviour of *H. dimidiata* is examined. Due to the paucity of literature on mating in *H. dimidiata*, laboratory experiments were designed to investigate the details of the courtship and mating behaviour in *H. dimidiata* and the effect of multiple mating on mating duration. The results increase our understanding of mating behaviour in *H. dimidiata* and help in mass rearing of this species.

Materials and Methods

Stock culture

Adults of *Harmonia dimidiata* occur in low numbers in local agricultural fields. These were collected and brought to the laboratory from an orchard at Kashipur, India, where they were feeding on the aphid, *Aphis gossypii* (Glover) infesting common wireweed, *Sida acuta* Burm. We cultured them in the laboratory by keeping pairs of adults in Petri dishes (9.0 cm diameter × 2.0 cm height) containing an *ad libitum* supply of the aphid, *A. gossypii* along with pieces of its host plant under constant conditions (27 ± 1 °C; 65 ± 5% RH; 14L:10D) in an Environmental Test Chamber (*Remi, Remi Instruments*). The adults were allowed to mate and the eggs they laid were reared from egg-hatch to adult emergence in 500 ml glass beakers (11.0 cm high and 9.0 cm in diameter, prey as above). Newly emerged adults were isolated in Petri dishes (size and host as above) and reared until they attained sexual maturity. The F_1 generation adults were used in the mating experiments.

Monalisa, Pervez, A., Jahan, M. Mating behaviour of the predaceous ladybird, *Harmonia dimidiata*. European Journal of Environmental Sciences, xx(x): xx-xx. https://doi.org/10.14711/xxxxxxx

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ORIGINAL RESEARCH ARTICLE

Effect of dietary history on intraguild predation and cannibalism of ladybirds' eggs

Ahmad Parvez[1] · Satish Chandra[1] · Rajesh Kumar[1]

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Abstract

Dietary history during immature development has a major influence on the evolution of food choices of aphidophagous ladybirds. We designed laboratory experiments to investigate the influence of consuming conspecific eggs or heterospecific eggs as the only food during larval development on the food choice of adult aphidophagous ladybirds, viz. *Propylea dissecta* (Mulsant) (*Pd*), *Coccinella septempunctata* L. (*C7*) and *Menochilus sexmaculatus* (Fabricius) (*Ms*). We provided conspecific eggs and heterospecific eggs in presence of fewer aphids, *Aphis craccivora* (Koch) for 24 h to the adult males of the three ladybird species that were previously reared on monotypic conspecific or heterospecific egg-diet to determine their food choice. All ladybirds preferably consume aphids. However, amongst different egg-diets, mostly ladybirds prefer to feed on the same egg-diet, which they had consumed during the larval stage. Contrarily, *C7* raised on conspecific eggs preferred different egg-diet (*Pd* eggs) than the same one. Furthermore, *C7* reared on heterospecific eggs consumed these eggs more readily during adulthood than the conspecific eggs. This explains why *C7* dominates coccinellid fauna, as an invader and an intraguild predator, in various geographical habitats. We concluded that prolonged exposure to unnatural diets, such as coccinellids' eggs during immature development, tend to develop a craving for such diets during adulthood of ladybirds.

Keywords Aphids · *Propylea dissecta* · *Menochilus sexmaculatus* · *Coccinella septempunctata* · *Aphis craccivora* · *Coccinellidae*

Introduction

Predatory ladybirds (*Coleoptera*: *Coccinellidae*) are potential biological control agents of several insect pests, including aphids (Aphididae), scale insects (Diaspididae and Coccidae), whiteflies (Aleyrodidae), and other small soft-bodied insects attacking crops (Hodek et al. 2012; Parvez et al. 2020). However, their biocontrol potential has been largely affected by the multitrophic intraguild interactions occurring in the prey-habitat (Polis et al. 1989; Polis and Holt 1992; Rosenheim et al. 1995). These interactions involve competition between the intraguild predators for the common food source affecting their biocontrol efficiency (Noia et al. 2008; Michaud et al. 2016; Castro-Guedes et al., 2020). Usually, in such interactions smaller sized and fewer mobile predators are victimized (Grechette et al. 2008; Ingels and DeClerck 2011; Rondoni et al. 2014). Adults and larvae of ladybirds attack weaker and immobile immature stages of conspecific or heterospecific ladybirds (Turnipseed et al. 2015). Aphidophagous ladybird larvae attack other ladybirds' eggs and pupae if prey is scarce to get nourishment and to eliminate potential competitors (Roccaet al. 2017; Deveci et al. 2018). Egg-cannibalism and intraguild predation by aphidophagous larvae are largely prevalent when aphid colonies are declining (Perez et al. 2006).

Seven-spot ladybird, *Coccinella septempunctata* L. (*C7*) is a cosmopolitan ladybird with a vast prey-range dominating the coccinellid fauna in the agricultural fields of India (Omkar and Pervez 2004). Little is known about its intraguild interactions despite it being successfully established in various global zoogeographical habitats (Omkar and Pervez 2002). Adults and larvae of *C7* resort to cannibalism and intraguild predation of eggs at low aphid densities and prefer conspecific eggs over *Hippodamia variegata* (Goeze) eggs (Khan and Yoldas 2018). *C7*

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ORIGINAL RESEARCH ARTICLE

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The functional responses of two coccinellid-predators, viz. *Propylea dissecta* (Mulsant) and *Menochilus sexmaculatus* (Fabricius) sharing common aphid-prey, *Aphis gossypii* (Glover) were investigated in various hetero-specific and conspecific combinations in laboratory conditions. The third and fourth instar larvae, along with adults (males and females) of the above coccinellids were fed on increasing densities (from 25 to 600) of *A. gossypii*, after releasing a couple of conspecifics or heterospecific coccinellids of the same stage in a microhabitat. Their cumulative prey consumption was quantified at predator species, predatory stage and prey densities levels. Despite a Type II response by predators in each combination, high proportion of prey was consumed at low and middle densities. Heterospecific females consumed prey with a maximum attack rate (0.0024) with the least handling time (0.1831 hour) than conspecific ones. Adult female *P. dissecta* was smaller than *M. sexmaculatus* but together they consumed more aphids than the two females of *M. sexmaculatus* due to the least interference, which supports releases of dual-predators for aphid biocontrol. Amongst larvae, duo fourth instars *M. sexmaculatus* had an attack rate of 0.0035 and handling time of 0.1879 hour. We conclude that duo release of adult *M. sexmaculatus* and *P. dissecta* benefits more than their single releases for the biocontrol of *A. gossypii*. In addition, conspecific fourth instars *M. sexmaculatus* were better predators in various larval combinations.

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INFLUENCE OF INTRASPECIFIC COMPETITION FOR FOOD ON THE BODYWEIGHT OF THE ADULT APHIDOPHAGOUS LADYBIRD, *COCCINELLA TRANSVERSALIS*

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ABSTRACT

Aggregation of conspecific predators sharing a common prey, influences their bodyweights. We investigated the influence of intraspecific competition of adult ladybirds of *Coccinella transversalis* Fabricius on their bodyweight feeding on rusty plum aphid, *Hysteroneura setariae* (Thomas). Adult males and females consumed a significantly greater number of aphids with increase in predator density. However, the aphid consumption per predator declined with this increase. The weight gain per predator also decreased linearly with increase in the density of both male and female predators. This indicates that the weight gain of the predator is a function of the prey consumed. The searching efficiency decreased with increase in predator density due to mutual interference. The mutual interference constants for adult male and female ladybirds were –0.419 and –0.546, respectively. The females consumed a greater number of aphids than males. The killing power of the ladybird, denoted by the *a* value increased curvilinearly with increase in predator density. We conclude that prey consumption is a function of body size and that the offspring of those that aggregate at low densities in prey rich habitats develop into large adults.

Keywords: conspecific predator; *Coccinella transversalis*; intraspecific competition; ladybirds; numerical response

Introduction

Knowledge of the predator-prey interactions of predatory ladybirds (Coccinellidae: Coleoptera) is important for understanding their effectiveness in the biocontrol of aphids. Quantitative estimates of ladybirds' searching efficiency and prey consumption at varying prey-densities indicate their potential as biocontrol agents (Bayoumy 2011; Bayoumy and Michaud 2012). The predator's functional response to the changes in prey density indicates density-dependent prey consumption (Holling 1959). However, the effect of predator density on prey density may also help predict biocontrol outcomes, estimate the effect of intraspecific competition and interference among ladybirds. The density-dependent predator-prey dynamics is described by numerous models (Pervez et al. 2018), of which the classical Nicholson and Bailey (1935) model defines "area of discovery" as a crucial parameter determining the searching efficiency of a predator. An inductive model (Hassell and Varley 1969) including the mutual interference constant (Hassell 1971; Bayoumy et al. 2014), further simplifies this model and indicates that the predator's searching efficiency declines with increase in its density. These models advocate predation to be a function of both prey- and predator dependent processes and account for the effect of mutual interference on prey consumption. This interference alters ladybird's foraging success or may compensate for the decline in foraging activity due to the time required for digestion at high prey densities (Papanikolaou et al. 2016). Kindlmann and Dixon (1993) questioned the biocontrol potential of aphidophagous ladybirds stating that even optimal foraging and laying of eggs may only result in a slight reduction of aphid abundance. Furthermore, the adults should maximize their fitness by deciding whether to stay in or leave an aphid-patch (Kindlmann and Dixon 2010). In addition, greater generation-time ratio of ladybirds makes them slow developers, thereby impeding the top-down regulation of aphid abundance (Kindlmann and Dixon 1999, 2001, 2015). Kindlmann et al. (2020) further concluded that it is generation-time ratio rather than voracity that drives the dynamics of insect-natural enemy systems, particularly aphid-ladybird system.

Predaceous ladybirds (Coleoptera: Coccinellidae) are potential biological control agents, as they prey upon numerous exotic and aphid pests (Hodek et al. 2012; Omkar and Pervez 2016; Pervez et al. 2020). They switch from extensive search to intensive search after capturing a prey (Pervez and Yadav 2018). Complex plant morphology further modifies intensive search (Legrand and Barbosa 2003). Mutual interactions impede their consumption of prey and searching efficiency (Omkar and Pervez 2004a; Bayoumy and Michaud 2012). Their searching efficiency and incidence of mutual interference might be dependent on the type of prey (Al-Dephairi et al. 2014). These coccinellid predators may switch from a rare stage of prey to an abundant stage of prey (Tahhapour et al. 2020) thereby suppressing prey abundance and increasing their body size. Dixon (2000) opined that variation in body size within the species and gender might be associated with the relative effects of food quality and quantity. Furthermore, smaller-sized ladybirds may exploit the aphid colonies earlier, which may later be overtaken by the large ladybirds when aphid densities increase (Dixon 2007). Sloggett (2008) argued that ladybirds' body size might not be just a function of aphid density, but other complex interactions between density and prey size are also operational. This further raises the question of whether con-

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ANTENNAL MORPHOLOGY AND SENSILLA OF THE PREDACEOUS LADYBIRDS, *MENOCHILUS SEXMACULATUS* AND *PROPYLEA DISSECTA*

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ABSTRACT

Menochilus sexmaculatus and *Propylea dissecta* (Coleoptera: Coccinellidae) are predaceous ladybird beetles with immense biological control potential. The morphology of the antennae of the adults along with the diversity and distribution of sensilla were investigated using a scanning electron microscope as they are the main sensory organs involved in chemical communication, thermo-reception, mate-recognition, gustation, etc. The antennae of males and females in both species were clavate and consisted of three parts: scape, pedicel and a 9-segmented flagellum. The antennae of male and female *P. dissecta* were significantly longer than those of *M. sexmaculatus* despite their overall body size being smaller, probably due to the much longer F9 flagellomere in *P. dissecta*. Antennae of female ladybirds of both species exhibited sexual dimorphism in being longer than those of males. Scape was longer than other antennal parts in both species of ladybirds. There was a great diversity of sensilla with most of them on the ninth flagellomere. We identified nine types of sensilla: chaetica, trichodea, basiconica, Böhm bristles, campaniformia, placodea, coeloconica, sporangia and styloconica. Coeloconica were restricted to flagellomere F9 in male *P. dissecta* and female *M. sexmaculatus*, respectively, indicating sexual dimorphism and mate-related functions of this sensillum.

Keywords: antennae; aphids; Coccinellidae; ladybirds; morphology; sensilla

Introduction

Majority of predaceous ladybirds (Coleoptera: Coccinellidae) can be utilized for the biological control of numerous phytophagous insect-pests: aphids, scale-insects, mealybugs and whiteflies (Hodek et al. 2012; Omkar and Pervez 2016) infesting several economically important crops (Pervez et al. 2020). The optimization of their predation potential (Pervez and Yadav 2018; Pervez et al. 2018), prey consumption (Pervez and Kumar 2017) and mating behaviour (Pervez and Singh 2013) may enhance the biocontrol potential of ladybirds.

Menochilus sexmaculatus (Fabricius) is an Oriental generalist aphidophagous ladybird, which occurs abundantly in agricultural and horticultural fields on the Indian subcontinent (Poorani 2002; Omkar and Pervez 2004). Its reproductive and mating behaviour was recently studied by Chaudhary et al. (2016) and Dubey et al. (2018). Similarly, *Propylea dissecta* (Mulsant) is also an important Oriental aphidophagous ladybird (Omkar and Pervez 2001) with marked sexual dimorphism (Omkar and Pervez 2000), which have facilitated mating studies on this species (Pervez et al. 2004; Omkar and Pervez 2005). These species of ladybirds coexist in most agro-ecosystems. Scanning electron microscopy of the antennal sensilla may help in achieving a better understanding of the ecological interactions between prey-predator and predator sharing a common prey resource. It may also help in behavioural studies on mate-recognition, courtship and mating. Evidence indicates that adult males use their antennae to examine females, which may indicate that antennae are important in mate recognition (Srivastava and Omkar 2003; Omkar and Pervez 2005). In addition, there is a marked sexual dimorphism in the shape and size of their antennae and diversity of antennal sensilla (Jourdan et al. 1995; Srivastava and Omkar 2003; Omkar and Pervez 2008). Therefore, a scanning electron microscopy study of the antennal sensilla of two aphidophagous ladybirds, *M. sexmaculatus* and *P. dissecta*, was carried out in order to (i) determine the morphological differences in the male and female antennal sensilla (ii) identify the sensilla on the terminal segments that are involved in mate recognition, and (iii) to identify the similarities and differences in the types and distribution of antennal sensilla in these two similar-sized, polymorphic and co-existing species of ladybird.

Materials and Methods

Insect culture

We collected adults of *M. sexmaculatus* and *P. dissecta* from agricultural fields near the city of Kashipur, India (29°2104 N, 78°9619 E) and to the laboratory they were sexually identified based on their genitalia viewed under a stereoscopic trinocular (Lynx) at 40× and 100× magnifications, which was connected to a personal computer (DELL). Conspecific male and female beetles were paired in plastic Petri dishes (9.0 cm diameter × 2.0 cm deep) containing an *ad libitum* supply of the aphid *Aphis craccivora* (Koch) as food. Then, these Petri dishes were kept under constant conditions (27 ± 2 °C; 65 ± 5% RH;

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ORIGINAL RESEARCH ARTICLE

Food preference, growth and development of three aphidophagous ladybirds preying on conspecific and heterospecific eggs

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Abstract
Larvae of aphidophagous ladybirds attack vulnerable stages, such as eggs of conspecific and heterospecific species during prey scarcity, especially when the aphid colony is declining. We investigated food-preference of all four larval instars of ladybirds, viz. *Propylea dissecta* (Mulsant), *Menochilus sexmaculatus* (Fabricius) and *Coccinella septempunctata* Linnaeus, towards various egg-diets and the influence of different monotypic egg-diets on the consumption rate, growth-rate, conversion efficiency, mortality, bodyweight and development. All larval instars of *P. dissecta* and *M. sexmaculatus* preferred egg-cannibalism over IGP, while lower instars of *C. septempunctata* showed no preference and its higher instars preferred vice-versa. The three species developed successfully on monotypic conspecific and heterospecific egg-diets. However, instars developed faster into heavier life stages with lesser mortality when fed on conspecific eggs. The fourth instars of the three ladybird species had higher consumption rates and conversion efficiencies, while the first instars had higher growth rates than other instars. These parameters were optimal when instars fed on aphids, while conspecific eggs were better diets than heterospecific eggs. The consumption rates of *C. septempunctata* were higher than the other two ladybird species, however it lagged behind the two in terms of growth rates and conversion efficiencies. The overall mortality was lowest when instars of three ladybirds were fed on aphids followed by conspecific eggs and heterospecific eggs. We also conclude that *C. septempunctata* eggs may be less palatable to both conspecifics and heterospecific predators and latter ensure survival by refraining intraguild predation and not risking their fitness.

Keywords Aphids · *Propylea dissecta* · *Menochilus sexmaculatus* · *Coccinella septempunctata* · Conversion efficiency · Development · Weight

Introduction

Aphidophagous ladybirds (Coleoptera: Coccinellidae) resort to cannibalism and intraguild predation (IGP) during prey scarcity for survival (Bezzik et al. 2017), nutritional gain (Bayoumy et al. 2016), and elimination of potential enemies and competitors (Getto et al. 2005). Cannibalism is a function of density, life stages and food supply (Bayoumy and Michaud 2015a) and such events prevail in the aphid declining colonies, where, older coccinellid larvae attack the vulnerable conspecific and heterospecific eggs and pupae (Ronkedet et al. 2012; Roocset al. 2017). Eggs are more vulnerable to larval instars and adults (Omkar et al. 2005, 2006; Pervez et al. 2006), as eggs contain protein and other nutrients. Neonates get instant nutritional gain enabling faster development and increased body growth (Bayoumy and Michaud 2015b). The predation of conspecific and heterospecific eggs could have costs related to growth and development. Diets that are mixed with conspecific eggs and aphids seemed advantageous to the larvae for developing into heavier adults (Martini et al. 2015). However, this diet mixing may also lead to delayed development and smaller adults in certain ladybirds (Ware et al. 2009). Furthermore, the naive larvae refrain from attacking the eggs, as surface egg hydrocarbons indicate the presence of both eggs and conspecific larvae (Hemptinne et al. 2000; Martini et al. 2015). Developing ladybird larvae consume inferior or immobile life ees- or heterospecific life stages during prey scarcity for instant survival and nutritional demands (Rondoni et al. 2012).

Seven-spot ladybird, *Coccinella septempunctata* L., is a generalist ladybird with a vast prey range, dominating the

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ORIGINAL RESEARCH ARTICLE

Variation in reproductive attributes and diapause behaviour among six populations of *Zygogramma bicolorata* Pallister

Kamlesh Bali[1] · Rakesh Kumar Gupta[2] · Ahmad Parvez[3] · Mushtaq Ahmad Guroo[2] · Ajay Gupta[1] · Mudasir Gani[2]

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Abstract

Zygogramma bicolorata Pallister is an effective biocontrol agent of *Parthenium hysterophorus* L. We evaluated the variability in reproductive attributes and diapause behaviour among populations of *Z. bicolorata* from six geographical locations of India, viz. Jammu, Poonch, Rajouri, Almora, Jabalpur and Coimbatore. This was done to optimize its augmentative rearing. We collected the adult insects from these locations and reared them in the laboratory. The eggs obtained from these adults were reared from egg-hatch to adult emergence to determine the development, reproduction, diapause and the influence of extremes of temperature on survival. The percentage of pupation (84.30 ± 1.41%), adult emergence (86.75 ± 1.31%), egg viability (77.30 ± 2.02%), fecundity (2159.5 ± 8.45 eggs), and longevities of males and females (86.5 ± 4.8 and 146.9 ± 6.1 days) were greater in the Coimbatore population of South India experiencing tropical climatic conditions than the other populations. In addition, this population had the lowest incidence of diapause in adult males (26.1 ± 1.9%) and females (26.1 ± 1.9%), and shortest mean diapause durations. The Coimbatore population had the highest survival when adult females were exposed to three suboptimal temperatures with the highest survival at 35 °C, followed by 45 °C and − 5 °C, while the Jabalpur and the Almora populations survival was the lowest. The adult survival percentage of this tropical population declined with an increase in the duration of exposure to the temperature extremes. We conclude that tropical climatic conditions favour development and reproduction, and minimize the prevalence of diapause in *Z. bicolorata* than the colder habitats of northern India. The findings may help in mass rearing of parthenium beetle under controlled conditions and to manage parthenium across various geographical habitats.

Keywords Biocontrol · Fecundity · Longevity · Weeds · Parthenium · Climate

Introduction

Zygogramma bicolorata Pallister (Coleoptera: Chrysomelidae), commonly known as Mexican parthenium beetle, is a potential global biocontrol agent against parthenium weed, *Parthenium hysterophorus* L. (Gupta et al. 2004; Bajracharya et al. 2021). It is native to Mexico and has been introduced in various countries including Australia (McFayden and McClay 1981), India (Jayanth 1987), and South Africa (Strathie et al. 2013) for the management of *Parthenium*. Thereafter, it successfully suppressed *Parthenium* in India (Jayanth and Vinalakshy 1996), Australia (Dhileepan et al. 2003; Dhileepan 2009), South Asia (Dhileepan and Senaratne 2006) and Africa (Kanagwa et al. 2020). The knowledge of its reproductive attributes is essential for its application as a biocontrol agent (McFadyen 1998). Reproductive attributes, viz. oviposition, fecundity, egg viability, longevity, and survival (Omkar and Afaq 2011, 2013) are influenced by environmental factors, particularly temperature (Omkar et al. 2008, 2009a), photoperiod (Omkar et al. 2013) and relative humidity (Gillespie et al. 2000; Mishra and Omkar 2005). These factors influence its ecological adaptability by affecting its development, survival and reproduction and indirectly the life cycle synchrony of natural enemy and host.

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COVID-19 AND ECONOMIC GROWTH IN INDIA: A TREND ANALYSIS

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Abstract

Economic growth is a concept that shows an increase in the production of economic goods and services in an economy. If the national product, GDP and per capita income are increasing, then it is predicted that the economic growth is also increasing. Many Economists, like Simon Kuznetz, Meier and Baldwin believe that the Net National Income is the most appropriate indicator for an economic growth. Professor Simon Kuznetz has accepted this method as the basis of measurement of an economic growth. Net National Product (NNP) is given more priority over the Gross National Product (GNP), as it provides better information about the growth of the nation. To bring the Indian economy back on track, our Prime Minister has announced a special economic package towards building a self-reliant India.

Keywords: *Gross Domestic Product, COVID-19, V-shape recovery, Unemployment rate.*

1. Introduction

Economic growth is a concept that shows an increase in the production of economic goods and services in an economy. Generally, aggregate economic growth is measured in terms of Gross National Product or Gross Domestic Product, although alternative metrics are also used for measuring an economic growth. Since India is lagging behind on several social parameters, henceforth the real progress of a country cannot be measured by only the GDP figures. However, for the real progress of a country, we have to take the help of Human Development Index (HDI). This index is a composite estimate based on per capita GDP, literacy and life expectancy. In the history of the world, year 2020 will be remembered as a very shocking time period of 'Corona Pandemic or COVID-19'. Many Economies around the world were badly affected by this pandemic. The Indian economy also witnessed a negative growth rate during this period. The growth rate for the first June, a quarter of the financial year 2020-21 was negative 24%. The main reason for this was the COVID-19 lockdown and the closing of all the economic activities due to the pandemic. Although, in the midst of the pandemic, many transformations were observed globally, the positive effects of which are likely to be visible in the coming years. Foreign direct investment (FDI), Portfolio flows investment (PFI) and Forex reserves strengthened during this period. However, imports declined as compared to exports in the first half of 2019-20.

2. Literature Review

The relationship between economic growth and other macro-economic factors, such as inflationary status, market interest rates, industrial development, employment generation rates etc. are well documented in numerous previous studies. **Aravind Veeramani (2019)** found in his study that the GDP growth rate in India has acquired an inverted U-shaped curve, i.e. accelerating from a low of 5.5% growth rate in 2012-13 to a peak of growth rate 8.2% in 2016-17, and thereafter decelerating to 6.8% growth rate in 2018-19. The growth rate of GDP is also declining due to the progress in the [illegible] real interest rates, enforcement of rigid norms on Bank NPAs and implementation of Indian Insolvency Code rule, decline in Gross fix capital formation and other associated factors. **Friedman (19[illegible]), Mallik & Chowdhury (2001), and Behera (2014)** have conducted their research in the area [illegible] economic growth and its relation with inflation. They found a long run positive correlation between the study variables, viz. inflation and economic growth. **Gallin et al. (2002)** discussed that the

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Pradhan Mantri Jan Dhan Yojana: An Initiative under Financial Inclusion

[1]*Dinesh Kumar Gupta*
[2]*Dr. Amaduddin Ahmad*

Abstract:

Indian Government consistently makes its efforts towards inclusion of vulnerable section in organized financial system. This system might not only provide huge amount of cash flow to boost Indian economy but it could also help the government to facilitate inclusive growth through offering different services scheme like MNAREGA payment, pension, various subsidies etc. For the inclusive growth of the Indian economy, the GOI started Pradhan Mantri Jan Dhan Yojanain 2014. Financial inclusion is an innovative idea in India, which empowers the alternative new techniques to encourage the banking traditions and acts for reducing the poverty. Household coverage of this scheme is better in the district wise account opening report of Uttarakhand state. We can say that PMJDY is playing a significant role in creating a universal platform for inclusive growth in India.

Keywords: Financial Inclusion; Pradhan Mantri Jan Dhan Yojana (PMJDY); Inclusive Growth.

Introduction:

Financial Inclusion is delivery of banking services at an affordable cost to the vast sections of vulnerable groups in India. The aims of this scheme are to providing easy access to financial services to those sections. It will enable the Government to provide social development benefits and subsidies directly to the beneficiary bank accounts, so that drastically reducing leakages and pilferages in social welfare schemes. Thus, financial inclusion could be an instrument to provide monetary fuel for economic growth and is critical for achieving inclusive growth.

Pradhan Mantri Jan Dhan Yojana (PMJDY), one of the biggest financial inclusion initiatives in the world, was introduced by Prime Minister, Shri Narendra Modi on 15th August 2014, and a National Mission on Financial Inclusion which has an integrated approach to bring

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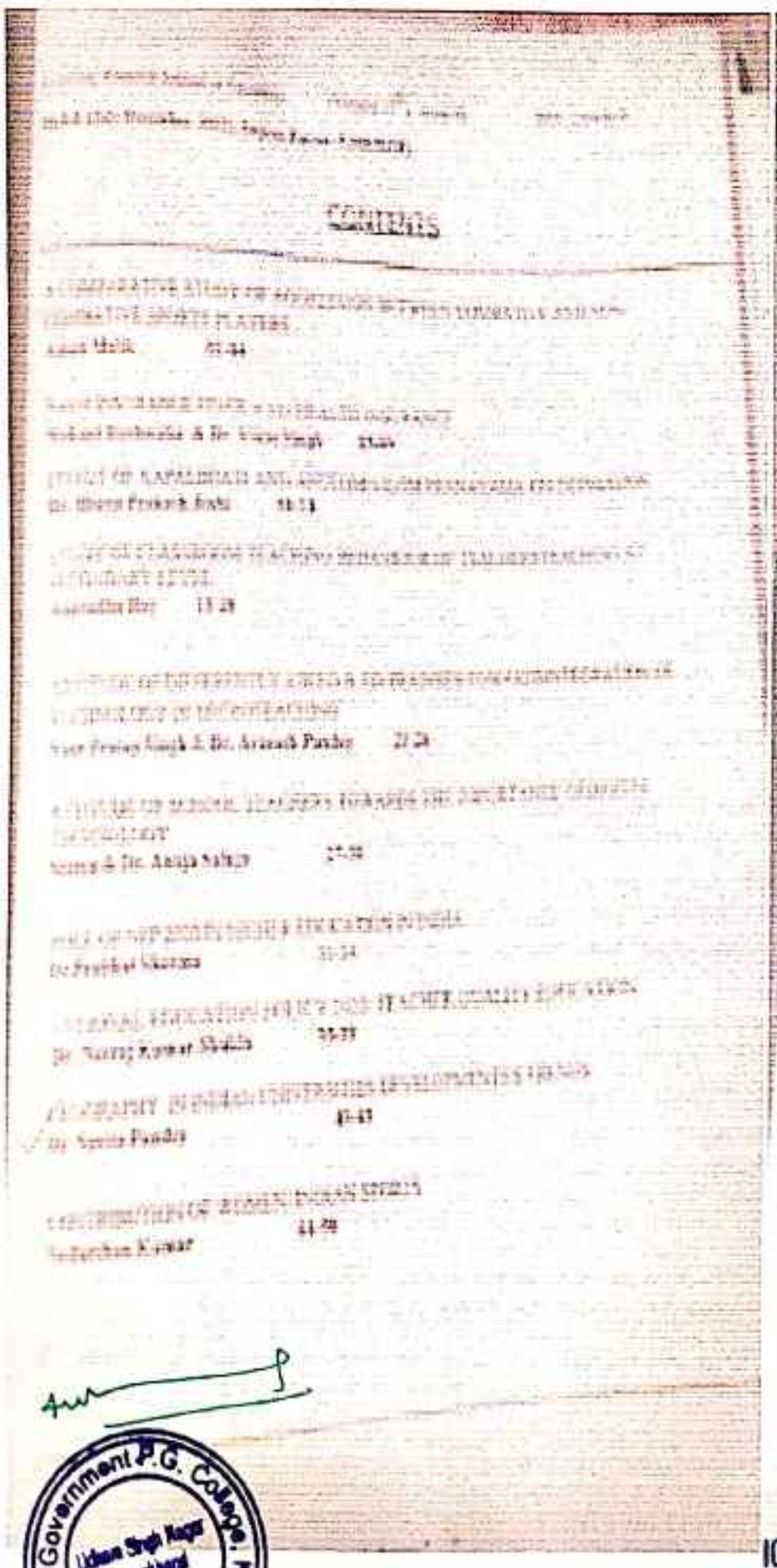

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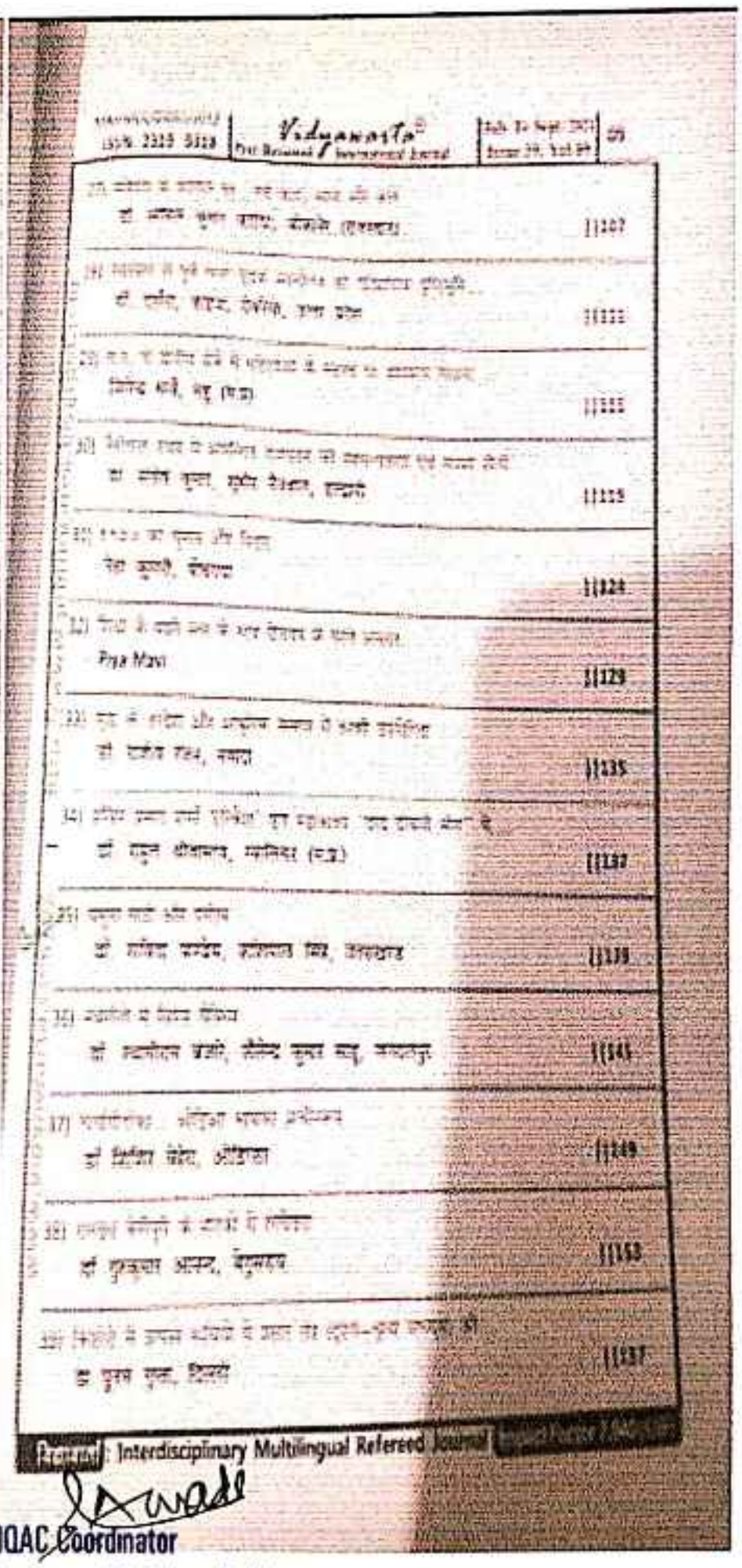

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असिस्टेंट प्रोफेसर इतिहास विभाग
राधेहरि राजकीय स्नातकोत्तर महाविद्यालय, काशीपुर, (ऊधमसिंहनगर)।

डॉ0 भीमराव रामजी अम्बेडकर के अनुसंधानी चिंतन, अनुशीलन एवं शोध का सारभूत तत्व है आदर्श समाज की उनकी परिकल्पना, जिसे साकार करने के लिए वे जीवनपर्यन्त संघर्ष करते रहे। वे यह मानते थे कि भारतीय समाज यदि अपने को बनाए रखना चाहता है और अपने खोए हुए गौरव को फिर से हासिल करना चाहता है तो इसके लिए जरूरी है कि वह अतीत में की गई अपनी गलतियों को ठीक से समझे और उन्हें सुधारने के लिए ईमानदारी से यत्न करे। उनका मानना था कि दो समाज अपने अतीत की इतिहास को नहीं समझता वह किसी नए इतिहास की रचना नहीं कर सकता (मूल 1917) कहने का तात्पर्य यह है कि भारतीय समाज संबंधी अम्बेडकर की जो परिकल्पना थी उसमें न केवल एक आदर्श समाज संरचना सामाहित थी अपितु अतीत की विसंगतियों के रूप में समाज में जो बुराईयां और विसंगतियां आ गई थी उनका यथार्थ बोध भी था और उनके निदान का उपायतत्व भी।

डॉ0 अम्बेडकर एक सिद्धान्त विवेचक और बुद्धिवादी लेखक थे। वे एक निर्भीक वक्ता, जुझारू संपादक व पत्रकार एवं उच्चकोटि के राजनेता थे। उनके जीवन का एकमात्र लक्ष्य संस्कृति और परम्परा के नाम पर अमानवीयता को प्रोत्साहन देने वाले तत्वों को समूल नष्ट करना था। इस संदर्भ में उन्होंने कहा, "मैं घृणा करता हूं अन्याय से, अत्याचार से, बनावटी गौरव और वैभव से, बकवास से और जाति के विवाद से और मेरी घृणा की लपेट में वे सभी व्यक्ति आते हैं जो इन सब बातों से ग्रस्त हैं।" उन्होंने स्पष्ट किया कि वे समाज के सवर्ण वर्ग द्वारा दलित वर्ग के प्रति किये जा रहे अत्याचारों को समाप्त कराने के लिए दृढ़ संकल्प हैं। बाबासाहेब का मानना था कि दलित और सवर्ण समाज दो हाथों के समान है, यदि मनुष्य का एक हाथ अतिविकसित होगा है तो वह पशु सी जाएगा, इसी प्रकार दलित वर्ग का सर्वांगीण की अवहेलना होने पर समाज की व्यवस्था पशु सी जाएगी। अतः समाज में वर्ण भेद नहीं होना चाहिए। सत्य तो यह है कि दलितों और सवर्णों के परस्पर सहयोग से ही देश की प्रगति संभव है। बाबासाहेब ने अपने जीवन की रक्षा हेतु से बौद्ध धर्म स्वीकार कर भगवान बुद्ध की शरण ली तथा वो साढ़े भी पूरे नहीं हो पाए थे कि मानवता का यह सजग प्रहरी 06दिसम्बर 1956 को इस संसार से चल बसा। दलितों और शोषितों के लिए उनके बलिदान एवं समर्पण के लिए उन्हें "भारत रत्न" के सर्वोच्च सम्मान से अलंकृत किया गया है जो उनकी जन्म शताब्दी के अवसर पर उनके प्रति सच्ची श्रद्धांजलि है। इसमें संदेह नहीं कि सामाजिक क्रांति के प्रतीक के रूप में डॉ0 बाबासाहब अम्बेडकर का नाम भारत के इतिहास में सदैव अमर रहेगा।

उत्तर भारत में बुद्धप्रिय मौर्य, संघप्रिय गौतम कांशीराम और मायावती जैसे नेताओं ने पहले बाबासाहेब अम्बेडकर से ही सामाजिक–परिवर्तन और दलित जाति का पाठ पढ़ा। यद्यपि इन नेताओं के विचार और कार्य शैली अलग–अलग रही। मौर्य और गौतम अलग अलग आरपीआइआईडीकांग्रेस भाजपा में रहे। कांशीराम ने डीएसफोर एवं बाद में बहुजन समाज पार्टी की स्थापित की और सुश्री मायावती को सत्ता की कुर्सी पर आसीन किया। उनके योगदान की समीक्षा इतिहासकार का काम है।

दुनिया को सूरज रोशनी देता है। सांझ ने अंधकार मिटाने में सदमा का भी योगदान है। पर चमकते हुए सितारे भी सभी भाते हैं। सामान्य जीवन में एक दीपक भी अंधेरा मिटाता है। नेता छोटा या बड़ा यदि वह सामाजिक है और लोगों के हित की बात सोचता है अपनी क्षमता और योग्यता के अनुसार जितना भी योगदान करता है वही वरेण्य है। आधुनिकता के युग में सामाजिक परिवर्तन को अभी को रोकना समाज के लिए घातक हो सकता है जो कि तथाकथित समाज के रखवालों द्वारा ही इसका अवरोध किया जा रहा है एवं सामाजिक उन्नति के नाम पर समाज के सबे कुरसे लोगों का और अधिक शोषण किया जा रहा है। सामाजिक परिवर्तन और क्रांति को निर्णय समय सदैव सिद्ध कर देगा। सामाजिक–आर्थिक क्रांति भारत की दहलीज पर दस्तक दे रही है, जिसे अब रोकना किसी के वश की बात नहीं।

हम गैर–ब्राह्मण आंदोलन और दलित आंदोलन को शीर्ष पर ले जाने वाले सभी छोटे–बड़े कार्यकर्ताओं–नेताओं का कृतज्ञ होना चाहिए जो अपने समय में रोशनी देने के लिए अंधेरे से लड़े। सामाजिक–न्याय, समता, सामाजिक परिवर्तन के लिए अभी–सबको एक जुट होकर एक लंबी लड़ाई लड़नी होगी।

[illegible] विरासत के रूप में जो समाज आजादी के समय लोगों को मिला वह असमानता और भेदभाव पर आधारित था। अम्बेडकर का मानना था कि असमानता और भेदभाव दुनिया के दूसरे समाजों में भी थे लेकिन वहां ये लोगों पर थोपे नहीं गए थे जबकि भारतीय समाज में [illegible] कुछ लोगों द्वारा दूसरे लोगों पर जन्म–जन्मान्तर के लिए थोप दिये गये थे। इसलिए भारत में समाज व्यवस्था [illegible] थी। अम्बेडकर की विभिन्न रचनाओं विशेष रूप से "कास्ट्स इन इंडिया (1917)", "एनिहिलेशन ऑफ कास्ट

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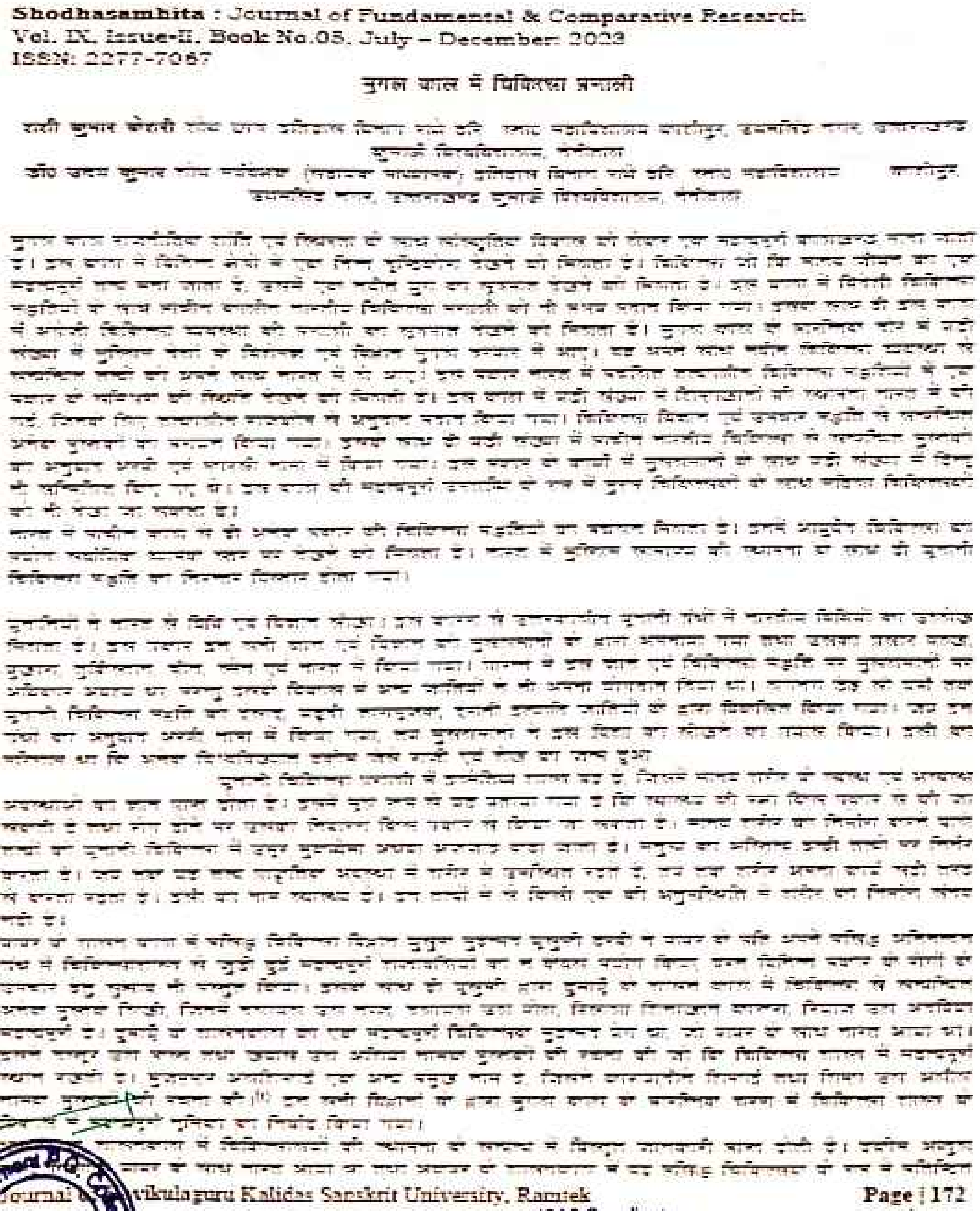

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मध्यकालीन आयुर्विज्ञान में आयुर्वेद

शशी कुमार केसरी* व डॉ0 सदन कुमार**

प्राचीन कालीन भारतीय संस्कृति में एक सम्पूर्ण प्रणाली के रूप में आयुर्वेद का विकास भारतीय वातावरण में फलीभूत एवं विकसित हुआ। आयुर्वेद चिकित्सा की वह प्रणाली है, जो न केवल भारत में विकसित एवं परिष्कृत हुई वरन विश्व के एक बड़े क्षेत्र को व्यापक स्तर पर प्रभावित किया। प्राचीन काल से लेकर वर्तमान समय तक अपने सशक्त एवं विशिष्ट ढंग/पद्धति के रूप में अस्तित्व में है। आयुर्वेद के इतिहास का अध्ययन एवं अन्य भारतीय विज्ञान प्रणालियों की उत्पत्ति तथा विकास चिकित्सा क्षेत्र में इसके स्थान का निर्धारण करने के लिए इसका विस्तृत विश्लेषण आवश्यक हो जाता है। किसी भी विज्ञान से विधियों की उत्पत्ति एवं विकास का अध्ययन रोचक विषयवस्तु होता है। आधुनिक चिकित्सा द्वारा प्राप्त किए गए शानदार परिणामों के बाद भी प्राकृतिक विज्ञान के माध्यम से लोगों के विशाल क्षेत्र में जानकार उपलब्धि प्राप्त की जा सकती है। आयुर्वेद चिकित्सा की एक प्रणाली के रूप में समय की कसौटी पर खरा उतरा है। यह मानव पीड़ा के शमन करने में अपना उपयोगी योगदान देने में सक्षम है।

मध्यकाल के पूर्व युग में अरब एवं यूरोपीय लोगों द्वारा चिकित्सा सम्बन्धी ज्ञान एक लम्बे काल से चले आ रहे थे। बाद के कालों में मानवाद, स्थान तथा जलवायु को महत्वपूर्ण माना जाता है, जिनको व्यावसायिक सम्मान की दृष्टि से उच्च स्थान प्रदान किया जाता है। मध्यकाल में आयुर्वेद के विकास गति में स्थिरता देखने को मिलती है, जिसका मुख्य कारण राजनीतिक प्रश्रय का अभाव माना जा सकता है। यद्यपि पूर्वकाल की तरह इसका विस्तार विश्व के व्यापक क्षेत्रों में देखने को मिलता है। इस प्रकार आयुर्वेद की प्रतिष्ठा भारत तक ही सीमित नहीं थी। मिस्रवासियों, भारत आने वाले विदेशी विद्वानों तथा चिकित्सकों से जुड़े हुए प्रवासी व्यक्तियों के माध्यम से यह ज्ञान दुनिया के सुदूर कोनों तक प्रवाहित होता रहा। उत्तर में मंगोलोयड से लेकर दक्षिण में सीलोन तक तथा पश्चिम में भूमध्यसागरीय प्रदेशों से पूर्व में इंडोचाइना देशों तक इसका विस्तार देखा जा सकता है। इन देशों के द्वारा भारतीय ग्रन्थों, चिकित्सा पद्धतियों तथा सिद्धान्तों को अपनाया तथा भारतीय चिकित्सा ग्रन्थों को कई भाषाओं में अनुवाद किया। टीपिन, 1982, 1996)इसके साथ इस बात का प्रमाण है कि आयुर्वेद भारत में प्रचलित चिकित्सा पद्धतियों का सबसे महत्वपूर्ण भाग थी।

1200 ई0 तक आयुर्वेद अपने चरम पर पहुँच चुका था। यद्यपि बौद्धिक खोजों एवं वैज्ञानिक अनुसन्धान, जिसने इसके विकास एवं प्रगति में महत्वपूर्ण योगदान दिया था। अब अतीत की बातें हो चुकी थीं। अरबों के बौद्ध एवं हिन्दू शासकों के द्वारा राजकीय स्तर पर औषधालयों, अस्पतालों एवं चिकित्सा सेवाओं का स्तर स्थापित किया जाता था। चिकित्सा छात्रों को नवीन पीढ़ी को व्यावसायिक एवं सैद्धान्तिक प्रशिक्षण के लिए बड़े पैमाने पर अपने निजी शिक्षकों पर निर्भर रहना पड़ता था। सामाजिक रूप से स्थिर एवं प्रतिष्ठित समाज में बौद्धिक एवं व्यावसायिक वर्गों की प्रतिष्ठा तथा सुरक्षा सतत बौद्धिक विकास की मुख्य आवश्यकता के रूप में सम्पन्न हो चुकी थी। इसका कारण यह था कि भारत लगातार विदेशी आक्रमणों से प्रभावित होता रहा। इन आक्रमणकारियों ने न केवल भूमि पर शासन किया वरन् सामाजिक पदानुक्रम में बुद्धिजीवियों को प्रमुख वर्ग के रूप में प्रतिस्थापित कर दिया। (मोर, बोन एण्ड सुब्बारायप्पा, 2009, 484)

यद्यपि इस कथनानुसार ने आयुर्वेद के सहयोग एवं क्षय के लिए केवल राजनीतिक कारकों को ही महत्वपूर्ण नहीं माना जा सकता। इसके पीछे भारतीय विचार, पारंपरिक विश्वासों तथा सामाजिक व्यवस्था भी निहित थी, जिसने भारतीय विद्वानों को गहराई से प्रभावित किया था। चिकित्सा विज्ञान को भी इससे अलग नहीं माना जा सकता। प्रायोगिक अनुसन्धान के लिए बौद्धिक जिज्ञासा जो तार्किक एवं रचनात्मक आत्मा से जुड़ी हुई थी, वह भी विकास में मिले कारणों के कारण समाप्त हो गए थे।

भारतीय इतिहास के इस व्यापक अवधि के दौरान पहले के युगों का महत्वपूर्ण चिकित्सा प्रणालियों के अन्वेषण आदेश से पहले से मूल्यवान मध्यकालिक ग्रन्थों की एक प्रभावशाली शृंखला के निर्माण का हाथ

*शोध छात्र इतिहास विभाग, राधे हरि राजकीय स्नातकोत्तर महाविद्यालय, काशीपुर, उधमसिंह नगर, उत्तराखण्ड (मुक्त विश्वविद्यालय, हल्द्वानी)

**शोध पर्यवेक्षक (सहायक आचार्य) इतिहास विभाग एवं डीन राधे हरि राजकीय महाविद्यालय, काशीपुर उधमसिंह नगर उत्तराखण्ड (मुक्त विश्वविद्यालय, हल्द्वानी)।

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योग विज्ञानः स्वास्थ्य विज्ञान के सन्दर्भ में

डॉ० उदय कुमार

असोसिएट प्रोफेसर, इतिहास, राधे हरि राजकीय स्नातकोत्तर महाविद्यालय, काशीपुर, उधमसिंह नगर, उत्तराखण्ड

श्री लालता कुमार सिंह

असिस्टेंट प्रोफेसर (गणित), योग शिक्षक शिक्षार्थ शीघ्र पाठ्य विश्वविद्यालय, अल्मोड़ा उत्तराखण्ड

सारांश

आधुनिक युग में मनुष्य जीवन शैली में जिस प्रकार के परिवर्तन दृष्टिगत हो रहे हैं उनके परिणामों की तरफ संपूर्ण विश्व प्रयत्नशील हो रहा है. संपूर्ण मनुष्य समाज आधुनिक जीवनशैली में जो व्यापक परिवर्तन होने जा रहा है। उसके कारणों को पहचानने प्रयास कर रहा है। इसके परिणाम स्वरूप अनेक वैज्ञानिकों ने विश्व स्तर पर उपायों खोजने की दिशा में कार्य किया है। विशेषकर प्रयास के क्षेत्रों के अनुसार विभिन्न प्रकार के व्यायाम प्रणाली का विकास हुआ है। इसका मुख्य कारण व्यक्ति रोग के मूलभूत कारणों को जानकर उपयुक्त व्यायाम प्रणाली को अपनाकर स्वस्थ रहने के प्रयास में जुट गया है। इन प्रणालियों में व्यक्ति रोग के मूल कारणों को पता लगाकर रोगमुक्त होने के लिए उपाय किये जाते हैं। यह कार्य योग के द्वारा संभव है। योग व्यायाम मात्र को व्यक्ति रोगमुक्त रहने का ही उपाय बताता है।

वर्तमान भारत एवं विश्व में व्याप्त एक महामारी कोरोना है। एक व्यक्ति जानकर या एक व्यक्ति द्वारा एक निर्दोषित संसार को संक्रमण हो सकता है। व्यक्तियों का कोई संसार से संबंध टूटने लगते हैं, परन्तु इसका सकारात्मक पक्ष यह है कि अनेक व्यक्तियों परिवार को साथ रहने का अवसर मिला है. अनेक, परिवार में व्यक्तियों को अपने पुराने दिनों में लौट जाने की याद होने लगी है। इसके साथ ही योग व्यायाम को अपने जीवन में अपनाने की प्रवृत्ति बढ़ी है। योग एक व्यायाम है जो व्यक्ति को शारीरिक एवं मानसिक दोनों रूप से स्वस्थ रखता है। इस व्यायाम को करने तथा अनुभूति द्वारा ही व्यक्तियों द्वारा इस व्यायाम को अपने जीवन का अंग बनाया जा सकता है। यह व्यक्ति को संसार विशेष की प्रतिभा को विकसित करने का प्रयास रहता है।

योग शब्द अनुशासन, नियंत्रण का व्यक्तियों द्वारा अपने जीवन में व्यवहार को सदैव अपने को रखने का प्रयास करना है. प्रत्येक व्यक्ति के जीवन में कुछ इच्छाएँ है. मनुष्यों द्वारा ये इच्छाएँ कभी न कभी पूरी होती रहती हैं। यदि ये इच्छाएँ पूरी नहीं होती हैं तो व्यक्ति में तनाव उत्पन्न होता है। तनाव होने के कारण ही व्यक्ति में अनेक प्रकार के रोग उत्पन्न होते हैं। यदि व्यक्ति अपनी इच्छाओं को नियंत्रित नहीं किया जा सकता है तो कि व्यक्तियों व्यक्ति रोग ग्रस्त। व्यक्ति रोग को कभी व्यायाम व्यायाम अपने होते थे। व्यक्तियों रोगों के साथियों के विषय रोगों को दूर होने में ही अधिक है। और इसे व्यक्तियों को पुनर्जन्म करने में लोग के लिए व्यायामशाला लोग आते हैं। विभिन्न प्रतियोगिता एवं प्रशिक्षण व्यायाम होने पर लोग दूर, होने को अधिकतर यह आता है।

व्यक्तियों शिक्षितों में रोग होने को व्यायाम विभाग होता है. जिन्हें ही इस रोग के ज्ञान हो, व्यक्ति व्यक्ति होने को व्यक्तियों। व व्यक्तियों होने से विभिन्न करने होता है. विभिन्न होने को व्यक्ति होने को व्यायाम करने का चाहिये है। इसी प्रकार व्यक्ति के व्यायाम से ही व्यक्ति व मन को प्रोत्साहित रोगमुक्ति है। व्यक्ति व्यायाम होने को व्यक्ति व्यक्ति व्यायाम व्यायाम के व्यायाम का करना करने है व्यक्ति होने व्यक्ति, हो व्यायाम होने। इस प्रकार योग एवं व्यक्ति पूर्ण रोगमुक्ति पद्धतियों को एक व्यापारी होकर देखने होते हैं। इस विषय को व्यायाम करने से व्यायाम प्रकार को व्यक्ति, व्यक्तियों पूर्ण हो जाते हैं और मनुष्य व्यक्तियों, मुख्यतः व्यायाम व्यायाम करने व व्यक्ति हो जाते हैं। आधुनिक जीवन शैली एवं रोगमुक्ति के दुष्प्रभावों से उत्पन्न संसार होने व्यक्ति के व्यायाम से व्यायाम व्यक्ति करने का संकल्प है।

मनुष्य जीवन व्यक्तियों में मुख्यतयाँ होता है। आधुनिक मुख्य भूमिकाओं को निभाने वाले व्यक्ति व्यक्ति विशेष में व्यक्ति व्यक्तियों एवं व्यायामिक होने की व्यक्ति में रोगमुक्त पूर्ण हो रहे हैं। आधुनिक रोगमुक्त पद्धति के रोग को व्यक्तियों के रूप में व्यक्ति व्यायाम होने को व्यक्ति में पूर्ण व्यक्ति का रोग होने है। इस होने को प्रोत्साहित के रूप में व्यक्ति का संकल्प है। व्यक्ति व्यायाम एवं व्यक्ति व्यायाम व्यक्ति होने को व्यायाम विभाग, व्यक्ति व्यायाम होने एवं व्यक्ति का कि मुख्य व्यायाम विभाग है। इस व्यक्ति को रोग व्यक्ति रोगमुक्ति पद्धति को, इस एक व्यायामशाला होने को व्यक्ति में व्यक्ति है।

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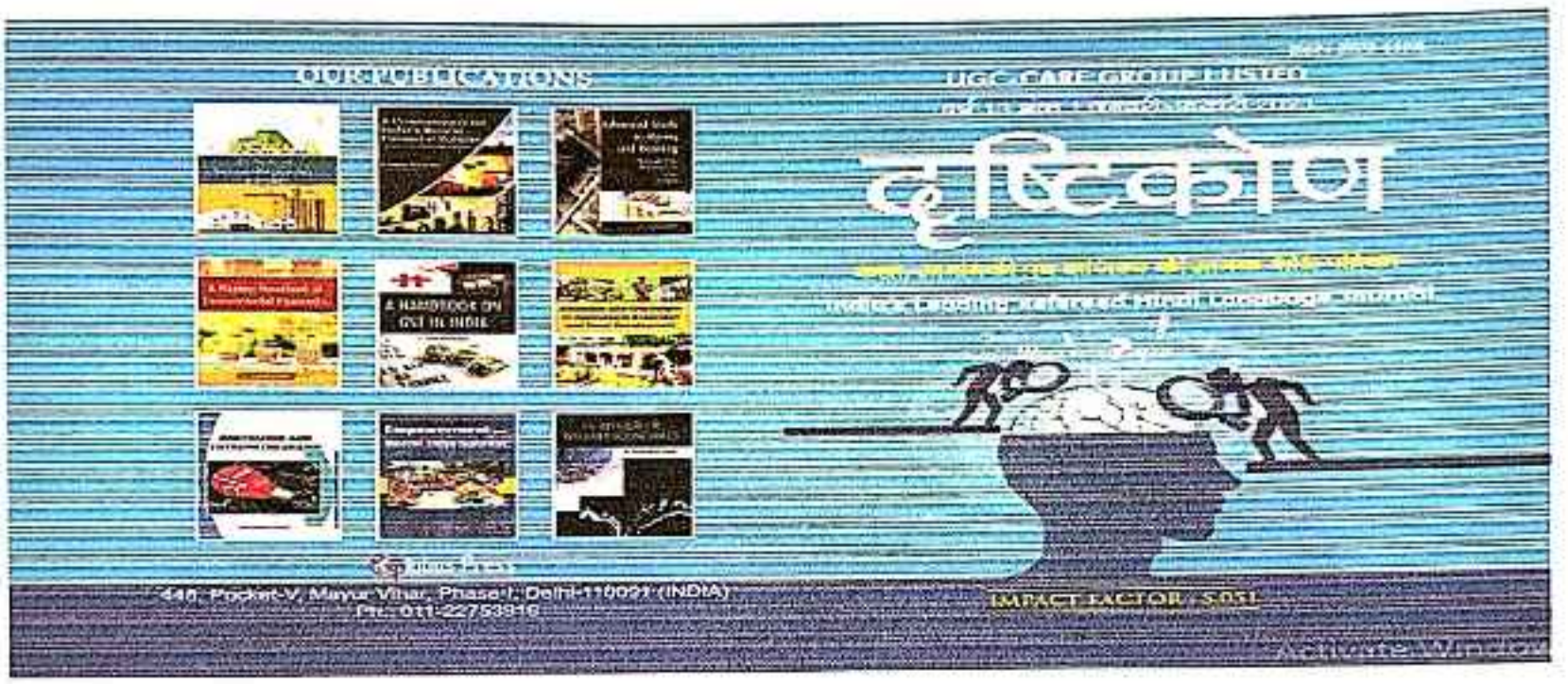

प्रतिलिपि

योगविद्या एक ऐतिहासिक विश्लेषण

डॉ० उदय कुमार

असिस्टेन्ट प्रोफेसर, इतिहास, राधे हरे सरकारी स्नातकोत्तर महाविद्यालय काशीपुर, उधमसिंह नगर, उत्तराखण्ड

श्री पवन कुमार सिंह

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भारत का इतिहास अनेक उतार-चढ़ावों से भरा रहा है, जिसमें राजनीतिक, सामाजिक, धार्मिक, सांस्कृतिक व आर्थिक परिवर्तनों ने भारत को एक अद्वितीय पहचान दी है। इन विभिन्न परिवर्तनों के बावजूद कुछ ऐसी विशेषताएँ रही हैं जिन्होंने भारत को एक सांस्कृतिक राष्ट्र के रूप में स्थापित किया है। योग भी भारत की एक ऐसी ही विशेषता है। योग के अभ्यास से ज्ञान, वैराग्य, भक्ति, कर्मठता, सहिष्णुता, अहिंसा आदि के भाव तो पनपते ही हैं साथ ही शारीरिक व मानसिक स्वास्थ्य भी सुदृढ़ होता है। योग के इन्हीं महत्व के कारण ही भारत में अनादिकाल से योग का अभ्यास किया जाता रहा है। योग के इतिहास को जानने के लिए हमें वेदों, उपनिषदों, पुराणों, महाकाव्यों, स्मृतियों, जैन एवं बौद्ध साहित्य, शिलालेखों, मूर्तियों, चित्रकला, वास्तुकला, विदेशी यात्रियों के विवरण, पुरातत्व के साथ-साथ आधुनिक इतिहासकारों का अध्ययन करना आवश्यक है। इन सभी के अध्ययन से ही योग के विकास के विभिन्न चरणों का पता लगाया जा सकता है। योग के विकास के विभिन्न चरणों को निम्नलिखित रूप में देखा जा सकता है।

मुख्य शब्द: योगविद्या, योगसाधना, योगाभ्यास।

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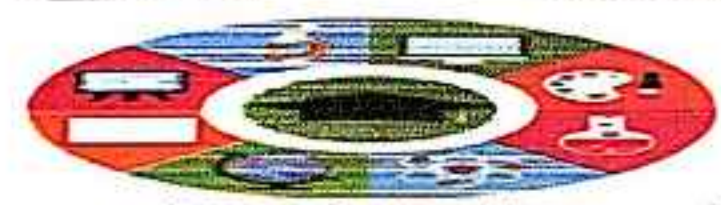

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श्रमिक समानता एवं सामाजिक न्याय :-एक राजनीतिक अध्ययन

डॉ० महेश मवाफरोश
असि० प्रो० राजनीति
राजकीय विद्यालय विभाग, स्नातक एवं स्नातकोत्तर महाविद्यालय काशीपुर

सारांश

राजकीय विद्यालय विभाग, स्नातक एवं स्नातकोत्तर महाविद्यालय काशीपुर (उधमसिंहनगर) उत्तराखण्ड ।

समानता और सुरक्षित समाज के मूलाधार हैं। समानता एक सुन्दर और सुरक्षित समाज की वह नींव है जिसमें पल विकसित होते हैं। समानता के अभाव में सुरक्षा संकट में पड़ जाती है और सुरक्षित समाज की कल्पना नहीं की जा सकती है। समानता के अभाव में सुरक्षा संकट में पड़ जाती है और सुरक्षित समाज की कल्पना नहीं की जा सकती है।

आधुनिक समाजशास्त्री का मानना है कि अर्थ के समाज में मानवीय व्यवहार मुख्यतः के व्यवहार प्रतिबिम्बित होते हैं। समाजशास्त्र के अनुसार, व्यक्ति के व्यवहार में अनुकूलनता की प्रवृत्ति होती है। व्यक्ति के व्यवहार को समाज द्वारा निर्धारित मानदण्डों के अनुरूप ढालने की प्रक्रिया को समाजीकरण कहते हैं। समाजीकरण के द्वारा ही व्यक्ति में सामाजिक गुणों का विकास होता है। समाजीकरण के द्वारा ही व्यक्ति में सामाजिक गुणों का विकास होता है।

कुंजी शब्द :-

श्रमिक समानता, सामाजिक न्याय, राजनीतिक दृष्टिकोण, भारत अधिवेशन, वैश्विक अनुसंधान।

परिचय

श्रमिक और सुरक्षित समाज के मूलाधार हैं। समानता एक सुन्दर और सुरक्षित समाज की वह नींव है जिसमें पल विकसित होते हैं। सुरक्षा की व्यवस्था सुरक्षित की व्यवस्था एवं समाज की प्रमुख आवश्यकता है। व्यक्ति और परिवार विकास और सुरक्षा के लिए समानता एवं सामाजिक न्याय की पूर्ति आवश्यक है। समानता विकास की आधारशिला है। समानता के अभाव में सुरक्षा संकट में पड़ जाती है और सुरक्षित समाज की कल्पना नहीं की जा सकती है।

के एस० सिंह के अनुसार :-

"श्रमिक एवं अधिवक्ता का कानूनी, राजनीतिक तथा सामाजिक अधिकार से पूर्ण समानता की भावना समानता तथा सामाजिक न्याय से संबंधित विभिन्न परिभाषाओं का विश्लेषण कर सकती है। तथा सदियों के दौरान में विभिन्न समाजों तथा दौरान में विभिन्न समाजों।"

श्रमिक समानता एवं सामाजिक न्याय का आधार है विभिन्न क्षेत्रों में जैसे- आर्थिक भागीदारी, आर्थिक अवसर में सामाजिक सशक्तिकरण विशेष रूप से वंचित समूहों समानता के लिए एक पुरुष एवं महिलाओं के बीच के अन्तर से सम्बन्धित। समाज में आर्थिक व्यवस्था और सामाजिक संरचना, राजनीतिक, सामाजिक, सांस्कृतिक एवं धार्मिक सभी क्षेत्रों में महिलाएं अपनी भूमिका का निर्वाह कर रही।

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Mn2+ - dependent thermo	Kedia, V.K. and S	Botany	Annals of R.S.C.B.	2020	1583-6258		http://annalsofrscb.ro/index.php/journal/article/view/11360/8033
Pseudomonas sp.: A prom	Kedia, V.K., Sharma,	Botany	Journal of Mountain Res	2023	2582-5011		https://doi.org/10.51220/jmr.v1i1.27
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11	A Comparative study on chemical composition and antibacterial activity of essential oils from the aerial parts and roots of Laportea bulbifera (Siebold and Zucc.) Wedd. growing in the Central Himalayan region	Manisha Palni, Leelawati Nitwal, Anand B. Melkani, Deepshikha Joshi & Rajendra Prasad	Department of Chemistry, Kumaun University, Nainital, India	Natural Product Research	2023	1478-6419		https://doi.org/10.1080/14786419.2023.2269187
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...economical importance of Asteraceae plants among Tharu tribe in Udham Singh Nagar, Uttarakhand,	Sheetal Sharma & **Sneh Lata**	Botany	Ethnobotany Research and Applications 23:34: 1-17.	2022	ISSN No.1547-3460	...rg/index.php/era	...1-176
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Efficient removal of organic pollutants in wastewater using tin oxide nanospheres under photo irradiation	Mandeep Kaur, Mamta Belwal, Aakriti Sharma, Ashish Kumar* and Venkataraman Vishwanathan	Mamta Belwal		2020	ISSN: 2689-1204	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.opastpublishers.com/open-access-articles/efficient-removal-of-organic-pollutants-in-wastewater-using-tin-oxide-nanospheres-under-photoirradiation.pdf	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.opastpublishers.com/open-access-articles/efficient-removal-of-organic-pollutants-in-wastewater-using-tin-oxide-nanospheres-under photoirradiation.pdf
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