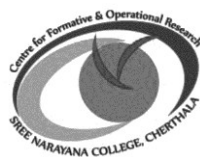


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Editorial

The issues in the concrete world are multidimensional and thus require knowledge of several subjects. The realm of epistemology in its perfect sense is so wide that the notion of absolute truth is a mere illusion. The problems addressed are so complex that we need approaches equally complex to grapple with them. Since objects and notions are having many characters they are the objects of all sided knowledge. The approach which tries to deny the full meaning of an object by employing one-sided knowledge cannot be the perfect one. Here comes the relevance of multidisciplinary approach which epistemologically discards absolute judgements. Knowledge is always multidimensional (anekāntic). In short pluralism in its correct sense is the demand of the new age. Integrity of truth definitely comes from the variety of aspects within the rational premise.

A multidisciplinary perspective incorporating those professionals with academic competence is necessary to achieve the ideal. Exploring more in the field of research is of great importance. A more developed perspective is the focus of any multidisciplinary academic journal. It makes diverse academic disciplines to discourse on the same issues from each of their perspectives. Pluralism in the field of research and development opens a platform for discourse from various disciplines that will eventually enhance equality of disciplines.

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Preface



Dr. Ravishankar C.N.
Director

In an era of increasing academic engagement that includes several disciplines under one subject, it is imperative to understand the nuances of multi-disciplinary research to engage with academia. Multi-disciplinary research is a pursuit of truth with the help of numerous specialized branches of learning which aims at achieving a common aim with the aid of knowledge of other disciplines. It can be defined as a search for knowledge through objective and systemic method for an original contribution to the existing stock of knowledge involving a combination of several disciplines and methods. I am happy to present herewith the latest issue of “Academic Spectrum” – the multi-disciplinary peer reviewed research journal of Sree Narayana College, Cherthala.

The articles included in this issue are truly multi-disciplinary. The discussed and deliberated subjects varies from Human rights issues to Gender issues, Nature to Economics, Environmental pollution mitigation to Nanotechnology, Micromolecules of seaweeds and the like. The paper on indigenous communities and human rights based on the autobiographical work “Akkarmashi” (The Outcaste) written by Sharankumar Limbale in Marathi gives a clear idea of how the Dalits of Maharashtra are suffering from socio-economic exclusion and discrimination as well as physical and mental torture. A study on the work and life balance of women

employees in the much sought after IT sector reveals that too much of emphasis on work or home creates imbalance which leads to conflict in the work and family domains resulting in emotional and physical stress. This should be an eye opener to everyone in similar situations. Another beautiful article titled 'Nature, kids and the mesmerizing animated world' takes the reader to an entirely different world as the author introduces two coveted animation films, 'Finding Nemo' and 'Delhi Safari'. The author concludes her article that harmony between all the living and non-living factors in the nature is imperative for its preservation. When the whole world is looking at the Happy Planet Index (HPI) and the Gross National Happiness (GNH) as indices of development, the subject of development economics emerges out as different yardstick for measuring the standard of living of a country. As such the inclusion of an article on the subject should be well appreciated. Heavy metal ions could be eliminated from water by several traditional techniques, including chemical precipitation, reverse osmosis, electrochemical treatment techniques, ion exchange, membrane filtration, coagulation, extraction, irradiation, and adsorption. The most recent innovation in this field is using nanoparticles. ICAR-CIFT, Cochin is in the forefront of these type of researches using chitosan-based nanoparticles. An interesting article in this issue indicate that lower generation PAMAM dendrimers (modified silica nanoparticles) are equally efficient to purify water compared to that of higher generations of dendrimers. A related article included is on a novel biosynthesis of cadmium-zinc nanocomposites. Its structural properties and antibacterial application are also detailed. In the current scenario world-wide there is a renewed vigour in seaweed research, the Hon'ble Prime Minister of India himself is closely monitoring the research activities on the subject in the country. Hence the inclusion of the article on "Seaweeds and their important bio-active constituents" in this issue is fully justified.

As a concluding statement I would like to compliment the editors for bringing out such an amazing issue and wish the journal all success.

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ACADEMIC SPECTRUM—2015 December

Guidelines to the authors

Academic Spectrum is a Multidisciplinary Peer Reviewed Annual Research Journal of Sree Narayana College, Cherthala, Alappuzha devoted to the publication of original research papers in all disciplines.

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Preparation of Manuscript

General style: Manuscripts must be typed double spaced with margins of one inch at the top, bottom and the sides. Pages should be numbered consecutively, and the matter should be arranged in the following order: title, abstract with keywords, introduction, materials and methods, results and discussion, acknowledgement and references.

Title: Manuscript title should be a brief phrase describing the content of the paper.

Author information: Complete name and department of the authors, including those of corresponding authors should be mentioned.

Abstract: Abstract should be self-explanatory and should briefly represent the topic.

Keywords: Author(s) must give about 4-5 key words which can identify the most important subjects covered by the paper.

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Acknowledgement: People, funding agencies and grants should be acknowledged.

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In science and social science—use APA style

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Manuscripts for submission should not normally exceed 15 pages of typing. The font shall be Times New Roman and the font size for titles shall be 14, and the font size for the body of the article shall be 12.

INDIGENOUS COMMUNITIES AND HUMAN RIGHTS-- AKKARMASHI (THE OUTCASTE)

Atheena M. N.

Assistant Professor, N. S. S. College, Cherthala

Abstract

*The indigenous communities are the ones who are mostly affected by human rights violations. Dalits still suffer socio-economic exclusion and discrimination; physical and mental torture. The Mahars of Maharashtra, India is such a community. We get a clear idea of the unprivileged life that they had to live, from the autobiographical work **Akkarmashi** (The Outcaste) written by Sharankumar Limbale in Marathi. It reflects the Dalit experience and sensibility, attempting to define and assert Dalit identity from a primarily Dalit point of view. In a number of ways, it becomes a protest literature which faithfully mirrors the stark realities of the Dalit situation and becomes an important weapon to strengthen the Dalit political movement. We hear lots of human rights' violations happening against these communities even now. Their attempts to assert their rights are often met with strong resistance even today. Hence the study of such a work gains relevance during the present times.*

The Universal Declaration of Human Rights (UDHR) is a declaration adopted by the United Nations General Assembly (10 December 1948 at Palais de Chaillot, Paris). There are 30 articles which start with Article 1 which in turn says "All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood.", Article 2 says "Everyone is entitled to all the rights and freedoms set forth in this Declaration,

without distinction of any kind, such as race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth or other status. Furthermore, no distinction shall be made on the basis of the political, jurisdictional or international status of the country or territory to which a person belongs, whether it be independent, trust, non-self-governing or under any other limitation of sovereignty.” and so on.

The very existence of such a declaration from UN points to the fact that human rights violations exist in plenty. The indigenous communities are the ones that are mostly affected. The term “indigenous” can be interchangeably used for tribes, first peoples/nations, aboriginals, ethnic groups, adivasi, janajati or for occupational and geographical terms like hunter-gatherers, nomads, peasants, hill people etc. Dalits are such an indigenous community in India. They are one among the communities who are still experiencing the ill effects of human rights’ violation. There are conscious efforts from within and outside this community against such violations. The Mahars of Maharashtra, India is such a community. Fortunately, we have some outstanding narrations of the sufferings they had to undergo from their own people. One such colossal effort is *Akkarmashi* (The Outcaste) an autobiography of Sharankumar Limbale. We get a clear idea of the unprivileged life that they had to live, from this book.

The word Dalit became popular in the 1970s by the Dalit Panther Movement in Maharashtra. But this was in use in Maharashtra to denote the downtrodden even before this movement. Dalits are the people, who are looked down upon even by other backward communities. They were

treated worse than animals till the end of 19th century. They were not allowed to mingle with, touch or even come in sight of the upper class.

The caste system with the history of more than 3000 years in India, is a shameful social segregation which works on the principal of purity. Economic division is reflected in social classification. Within Hinduism 'chaturvarnya' or the caste system was predominant. But this does not mean that other religions were not practising this. Most of the well-known religions also practised the caste system in their own levels. But none of them were as bad as the one that was practised within Hinduism. Untouchability was formally outlawed by the constitution of India in 1950. But in practice the Dalits still suffer socio-economic exclusion and discrimination; physical and mental torture. As per Minority Rights Group International's records as of 2006, there are approximately 170 million Dalits in India. Unfortunately, majority of this population are still below the poverty line. We hear lots of human rights' violations happening against these communities even now. Their attempts to assert their rights are often met with strong resistance even today.

In Marathi the word Dalit is used for 'the spurned'. There are many different names proposed for defining this group of people like, 'Panchamas', 'Aspursh', 'Harijans' etc. While we look into the Mahar community of Maharashtra, they constitute almost 10% of the state's population. This community can be seen in Madhya Pradesh, Karnataka, Gujarat and the Sindh state of Pakistan. Almost whole of this scheduled caste has been converted to Buddhism under the influence of Dr. B. R. Ambedkar. The community was mostly engaged in duties like those of

village watchman, messenger, wall mender, adjudicator of boundary disputes, street sweeper and remover of carcasses. They also worked as agricultural labourers.

William Wordsworth defines poetry as “the spontaneous overflow of powerful feelings arising from ‘emotions recollected in tranquillity’”. In a way, Dalit Literature is also a poetry that came out of powerful emotions which have been recollected from their [Dalit writers’] state of oppression. It is the forum and the medium of expression of the experiences of the communities that have been ex-communicated, marginalized, exploited, and humiliated for ages in the Indian caste-ridden Hindu society. It reflects the Dalit experience and sensibility, attempting to define and assert Dalit identity from a primarily Dalit point of view. In many ways, it is a protest literature which faithfully mirrors the stark realities of the Dalit situation and becomes an important weapon to strengthen the Dalit political movement. The Dalit author Sharankumar Limbale calls it “the burning cry of untouchables against the injustices of thousands of years”.

The first known Dalit writer is the 13th century untouchable Bhakti poet of Maharashtra, Chokkhamela (14th AD). The origins of Dalit literature, in the contemporary usage of the term which is largely written and published in regional Indian Languages, are in the late 19th century. In modern times, because of the legacy of Ambedkar, Dalit literature got impetus in Maharashtra. Although most of the pioneering works have been produced in Maharashtra and the adjacent Gujarat, Dalit Literature has today taken substantial shape in a variety of Indian Languages like Kannada, Tamil, Hindi and Malayalam. A large number of these texts are also available in English translations for a wider audience. Some of the most

widely read writers of Dalit literature available in English translation include, Laxman Gaekwad (*The Branded*), Sharankumar Limbale (*The Outcaste—Akkarmashi*), Omprakash Valmiki (*Joothan—a Dalit's Life*), T. K. C. Vaduthala (*TKC Vaduthalayude Kathakal*), Narayan (*Kocharethi*).

We can see that many of the writers born in upper castes have also written about the quandary of Dalits. But Sharankumar Limbale and a few others, view that the Dalit literature is the forte of writers who were born in Dalit communities. As he rightly argues a Dalit writer should have undergone the trials and tribulations of Dalit existence. Hence, we may not call Mahasweta Devi (*Breast Stories*), Sara Joseph (*Thaikulam*), Kumaran Asan (*Chandalabhikshuki*), Mulkuraj Anand (*Untouchable*) and Premchand (*Kafan*) Dalit writers, even though they have effectively communicated the trauma of the lower caste.

As noted earlier, Sharankumar Limbale's autobiography, *Akkarmashi (The Outcaste)* is an outstanding Epilogue which perfectly describes an 'Outcaste's' struggle for survival. He paints a painful picture of the Mahar community by citing his own experiences. Limbale has around 24 books to his credit. He has won 14 awards for literary and social contribution. Currently he serves as the regional director of the Yshwantrao Chavan Maharashtra Open University, Nasik, India. Most of his writings are in Marathi and have been translated into English and other languages. Of the people who have influenced Limbale, Ambedkar, who himself was a Dalit and was from Mahar community, is the most prominent.

According to MGK Nair, a freelance writer and currently the editor of Quilon Public Library Journal, "Books are often divided into three

categories. Some come unheralded but leave a deep impression on the human mind. The second category, if absorbed, goads one to action even if all that they say is not palatable or even correct. The last type of books reflects the state of affairs at one point in human history and carries a message that cannot be ignored.” According to him *Akkarmashi* belongs to the third category. This is being somewhat vouched by Sharankumar Limbale himself. He wanted to treat Dalit literature as a representation of social change and not to measure it by its aesthetic elements.

Akkarmashi (The Outcaste) was first published in 1984. It was unusual for a 25 year- old to publish an autobiography. But the way Limbale presented the anguish and irreverence of the cultural ferment of the Mahar community answered all questions. One would really wish that Limbale would have followed his autobiography, which came too early in this life, with another one. He chose Mahar dialect so as to make sure that he projects the lost identity of the Mahar community correctly. He effectively used the original language, idiom, metaphor and imagery for this. This is a commentary by a person who himself has struggled against poverty, deprivation, discrimination and violence. The book successfully throws open the dehumanizing impact of caste oppression in Hindu society. The narrator raises many uneasy questions like “Am I an Upper caste or an Untouchable?” towards the society. The acceptance of the book can be understood by the fact that the original Marathi publication went through four editions.

Limbale starts his autobiography with an account of one of his schooldays. The one in which their class was having a picnic. But more

than the joy of this occasion, he remembers the division between the upper caste children and the lower caste children. The lower caste children were not allowed to mingle with the upper caste even though they were their classmates. Even the teachers encouraged the upper caste children to offer food crumbs to the lower castes. He himself felt insulted by these divisions between his classmates. He identifies hunger as the cause of all these. It could be these bad experiences from his school days that helped him think about the discrimination based on caste and creed. The author remembers the harassment that he had to suffer from his fellow upper caste children by being called by his caste name. For being a Mahar, even the village barber refused to cut his hair. Limbale was not able to justify this act as he saw the same barber cut even the hair of buffalos. He realized that Mahars were placed even below animals.

It was the 'kshetra pravesana vilambaram' in 12th November 1936 that opened up temples in Kerala for all Hindus. The situation in Maharashtra was no better. The lower caste Hindus were not allowed to enter temples there as well. Limbale remembers that most of the schools were attached to some temple in those days. It was his duty to besmear the school floor with cow dung. He enjoyed this duty as he was able to enter the temple premises to perform his duty. It is said that children are the flowers of temples, but it was not the case with lower caste children. They were just rubbish for anyone.

The Mahars had the right over dead cattle. Whenever cattle were dead in the village, the owners came to the Mahars and informed them about this. The Mahars would pick the dead cattle from the owner's place

and used this as their meal. The owners had to pay the Mahars with grains as their wages for removing the dead carcass. So, they were days of celebration for the Mahars when they heard of the death of cattle in the village. Later on, Limbale found it very difficult to dine on dead animal's meat. His change influenced many of his friends as well. And finally, all of them avoided this dish. His grandmother and mother were involved in preparing hooch and its supply. We can see that throughout the book hunger is the dominant theme. And as a child he firmly believed that it was hunger that controlled men, and if there had been no hunger, there would have been no strife and no war.

Being an "Outcaste", he realized that he had no identity, no home or place of belonging. This lack of identity followed him forever as his shadow. Once, the school authorities refused to accept him as a Mahar or as a Patil. They were not willing to accept his grandmother as his guardian as she lived with a Muslim. Tromila Wheat, who reviewed *The Outcaste* writes, "When it came time for marriage he could not even get married to an outcaste girl because his blood was not pure; he was not wanted anywhere." (p. 27)

Against all odds, Limbale showed incredible strength and bravery to trash off the walls of oppression. He pursued his education and was eventually successful in publishing his autobiography which shot him to fame. Being a victim of caste divisions, he was able to realize the depth of division. This might have been the reason why he embraced Buddhism at a later stage.

Analyzing human rights violations, through Limbale's eyes, in the indigenous community of the Mahars, we realize that this is not just the story of Limbale, or that of a Mahar. It is the story of millions of the underprivileged lots who still suffer these human rights' violations.

Limbale experienced human rights' violation right from his birth. His mother was from Mahar community, a scheduled tribe and his father was a powerful land lord from an upper caste community called the Lingayaths. So, he was treated as an outcaste (Akkarmashi). Being born as an illegitimate child he was really unlucky regarding the basic identity of any human being like the place of belonging, language, father, mother, religion and caste. Anyone who was born in the castes from Brahmin to Sudra was very proud of his own community. This was at a time when Limbale and others, with no identity of their own, were living like criminals for no fault of theirs. The main reason for this lack of identity, he believes, is that he was the unwanted sprout of a rape victim. He explains that his existence is identical to that of a raped woman.

His mother was legally married to a young man from their own community. But his father, the village head had an eye on her. Being influential and being an upper caste, he was able to tactically separate her husband and force her to be his concubine. Here Limbale asserts that the illegal relation of his parents is nothing but a rape. His father had the backing of caste, community, religion, authority and a blind social belief to justify his relationship with an untouchable. But his mother—poor 'Aspursh' becomes an outcaste by this forced intrusion. If at all, she were from an upper caste, she might have had the courage to counter this intrusion. Limbale was able to distinguish this wide disparity between an upper caste and a lower caste.

Maybe it is hunger more than identity; being an outcaste or being the product of sexual harassment, that gave birth to such an outstanding autobiography. Throughout the book Limbale successfully makes us feel the immense predicament of not having enough or anything to quell their hunger. The menu included 'Bhakri' (a type of bread made from Jowar flour) with chutney, meat of dead cattle, pig meat etc. The use of arrack to them was just like people having daily tea or coffee. They were forced to drink 'Gomutra' (Cow Urine) by their grandmother, under the pretext of resisting diseases. He vividly remembers a few occasions when his grandmother washed out millet from cow dung and made their day's meal out of it. But the children were spared from this meal.

Maharwada, where Limbale and other Mahars lived, was a remote village in Maharashtra. Normally one would expect a narration of the serene beauty of the remote village. But Limbale could only remember a large number of dump yards, tin thatched huts, stray dogs and mud laden pigs. Cholera was as common as a fever to that village. Limbale was lucky enough to stay near a bus stand so that they could use this as their shelter during rainy days.

Many people think that the author was not mature enough to write an autobiography at the age of 25. Until this time, there have been autobiographies of eminent personalities who were already popular and would have been in their 60s or 70s. For this reason, many argue that this is just an imaginary narration and there is no element of truth in it. A few others were not able to appreciate the presented facts as the prevailing caste system does not truly reflect the bitter experiences of olden days. A

good many within the Mahar and other Dalit communities were of the view that Limbale's book had in fact disparaged the Dalit community. They were unhappy the way he openly narrated about their huts, diet, customs etc. and thought that he utilized their life for his own hype. They were cynical about Limbale, a Dalit narrating the raping of Dalit women by the village head, land lords, merchants and other upper caste people.

The book was rejected in the early days by calling it 'Gutter literature'. This has changed by now and the book is getting its due respect from its readers. Other criticisms are—the book is not a well edited one, it is not chronologically organized, readability is missing, creative and narrative elements take the upper hand than the factual elements, etc. 'Who am I?' and 'Why am I an untouchable?'—these questions loomed large in Limbale's mind. His success story starts from the search to find answers to these fundamental questions. Thus, he paid close attention to Dalit movements and Dalit literature. It was his headmaster Mr. Bhosle who had made public the identity of his father Hanumantha Limbale. Mr. Bhosle had to stand his ground on offers and threats from Hanumantha and a few of his associates for this. Thus, Limbale established his identity. One of his uncles, Mr. Yashwanth had motivated him at a very young age itself to write about the sufferings of this community. This might have ignited Limbale's thoughts of freedom.

To be brief, it is a harsh reality that the conditions of outcastes are worse than those of low castes. And that the Dalit literature is a representation for social change and should not be measured only by aesthetic theories. Dalits, who want to express themselves, are crippled by

the fact that they cannot use their dialect either due to the lack of popularity or the lack of script. *Akkarmashi* is an exception as it has been written in Mahar dialect itself.

References

- [1] Aravindakshan, A. *Ramakdhayilninnoru Keezalasabdam*, Sahitya Lokam, Jul-Aug, 1998.
- [2] Bolleddu, Siva Nagaiah - <http://www.the-criterion.com/V2/n1/Siva.pdf>
- [3] Damodaran, K. *Bharatiya Chintha*, Kerala Bhasha Institute, Triruvanthapuram, 1992.
- [4] Krishnapillai, N. *Kairaliyude Katha*, NBS, Kottayam, 1975.
- [5] Limbale, Sharankumar. *Akkarmashi*, Mathrubhumi books, Kozhikode, 2005.
- [6] Nair, M.G.K., http://www.samyukta.info/archives/vol_4_1/book%20review/sharankumarlimbale/the%20story%20of%20an%20outsider-the%20outcaste.htm
- [7] Omved T., Gail. *Ambedkar*, Penguin Viking, 2004.
- [8] Pokker, P. K. *Puraogamanakavithayoude varthamanam*, Deshabhimani Weekly, Aug, 1999.
- [9] Purushothaman, K. C. *Dalit Sahitya Prasthanan*, Kerala Sahitya Academy, Thrissur, Aug. 2008.
- [10] Rod, Sonali- <http://www.ssmrae.com/admin/images/706b8f72e48443b9a87cee7296cfc423.pdf>
- [11] Satyanarayana, K. and Susie Tharu (Editors) - *No Alphabet in Sight*, Penguin books, 2011.
- [12] Shinde, Sam-<http://www.allfreeessays.com/essays/Dalit-Literature/193507.html>
- [13] The Universal Declaration of Human Rights -<http://www.un.org/en/documents/udhr/index.shtml#a1>
- [14] Wheat, Tromila. *Southeast Review of Asian Studies*, January 1, 2005 | [http://shodhganga.inflibnet.ac.in/bitstream/10603/9863/11/11_chapter%205.pdf\(p.27\)](http://shodhganga.inflibnet.ac.in/bitstream/10603/9863/11/11_chapter%205.pdf(p.27))

**NATURE, KIDS AND THE MESMERIZING ANIMATED WORLD:
AN ANALYSIS OF *FINDING NEMO* AND *DELHI SAFARI***

Babitha B.

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Grandmother narratives and folk tales with a sprinkle of morals expose the worlds of kings, queens, fairies, gods and goddesses, birds and animals and excite young minds. Children are taught to love nature and their fellow beings under the proper guidance of grandparents. With the shift from joint families to nuclear families, in this urban, industrial, globalized, postmodern era, children are alienated and discouraged from outdoor exposure and original nature. Technological advancements in the form of computers, internet, video games and mobile phones allure and trap them from enjoying the real rhythm and beauty of nature. The hectic and busy life schedule of parents make them sit in front of cartoon shows and video games which estrange the kids from nature to the anthropomorphised world of technoculture through which they view and learn the world.

Advertisements and media inform them about the need to be cautious while playing with sand and nature thereby creating an image that we should keep a distance from nature infested with dangerous microbes (ads of Lifebuoy soap and Dettol keep on warning us about harmful germs). Children are thus getting only limited opportunities to stay tuned with nature. In the words of Dobrin and Kidd:

Many activities that occupy the time of young children take place in settings that isolate them from the natural world or present only simulations of that world. The impact of this may

very well be that considerable numbers of children may develop the positive attitudes towards the environment that are so crucial to its preservation. They may never achieve the familiarity with nature that is vital to environmental planning and activism.” (p.7)

In this fast-growing world with improved technologies and the ensuing industrial revolution there is dire need of warning the future generation about the increasing environmental issues and about the cruelties that man mete out to nature.

Socially committed animators and film directors like Andrew Stanton and Nikhil Advani with some pedagogical motives introduce green themes in their movies *Finding Nemo* (2003) and *Delhi Safari* (2012) respectively. These “enviro-toons” like any other ecocritical work introduce and realize the need in fighting against human encroachment towards land, water and air in the form of deforestation, pollution, e-wastage, global warming etc. *The Eco criticism Reader* reminds us about this realization:

Regardless of what name it goes by, most ecocritical works share a common motivation: the troubling awareness that we have reached the age of environmental limits, a time when the consequences of human actions are damaging the planet’s basic life support systems. We are there. Either we change our ways or we face global catastrophe, destroying much beauty and exterminating countless fellow species in our headlong race to apocalypse. (p. 20)

The characters in these animated movies with the quest motif decide to fight against the evil forces to regain their lost territory—the beautiful vast ocean in *Finding Nemo* and the wild forest in *Delhi Safari*. Nemo’s father (clownfish Marlin) along with Dory, a regal tang undertakes a long journey to Sidney through water in order to find his lost son. *Delhi Safari* is the quest of a leopard cub, his mother, a monkey, a bear and a parrot moving to the capital of India to raise certain questions before the government: “Why has man become the most dangerous animal? Doesn’t man understand that if the forests and the animals don’t exist, man will cease to exist?” In both the movies they travel from pure ‘nature’ to city ‘culture’.

Ecocritics are always concerned with the nature/culture binaries and the existence of pure nature (virgin land) is doubtful in today’s world: “... no true wilderness any longer exists on the planet, for every region is affected by global warming, and other ‘anthropocentric’ problems, such as toxic waste and nuclear fall- out” (Barry, p.248). *That’s all Folks? : Ecocritical Readings of American Animated Features* traces the distance between nature and culture: “Industrialization widened the gap between humans and the natural world. Nature, then, was seen as either a resource to be exploited or an enemy to be controlled.” (p.12)

Peter Barry gives a clear-cut distinction about the different areas of ‘outdoor environment’ in his essay on ‘Ecocriticism’:

Area one: ‘the wilderness’ (e.g. deserts, oceans, uninhabited continents)

Area two: ‘the scenic sublime’ (e.g. forests, lakes, mountains, cliffs, waterfalls)

Area three: ‘the country side’ (e.g. hills, fields, woods)

Area four: ‘the domestic picturesque’ (e.g. parks, gardens, lanes)

As we move mentally through these areas, it is clear that we move from pretty well ‘pure’ nature in the first two what is predominantly ‘culture’ in the fourth (p. 246)

Finding Nemo and *Delhi Safari* take an attempt to bring children to ‘pure’ nature from the human centered ‘culture’.

Finding Nemo, a reaction against the home aquarium culture opens up the exotic beauty of ‘wilderness’ before the viewers. The underwater beauty and the bounty of the deep ocean, created by the magical techniques of animators appear real and are enough to charm the curious young minds. Through Marlin’s quest in finding Nemo who is captured and made captive in a dentist’s aquarium in Sidney, children are getting exposed to the world of underwater creatures and fishes which are new and unknown to them. Each and every character Marlin encounter, gives the viewers a chance to learn more about the secrets of ocean—sea turtles and their migratory details, the life style of jelly fishes, sharks and whales are unveiled before the spectators.

In contrast to the ocean familiar to Nemo, he reaches a different place, an aquarium where he and other fishes are denied freedom and introduced to a new ‘culture’. Inmates of the aquarium are astonished to hear that Nemo is from the ‘ocean’. Nemo’s constant attempts to escape from the aquarium create sympathy in the minds of the fellow inmates as well as the viewers and thereby they acquire a negative attitude towards

the home aquarium culture. There is danger within the ‘space’ of the aquarium in the form of a girl named Darla who killed a fish by constantly shaking its bag: here young viewers are made to think twice about their naughty behaviour and how that might harm other beings.

Nemo’s constant attempts to escape from the aquarium and to reach his father shows his love towards his homeland ‘ocean’, and the kind of friendship he makes with the inmates of aquarium helps him a lot. He represents the rustic, country life and the fishes in the aquarium shows the city life; and his innocence changed their attitudes towards him. And the end we can see that the whole creatures in the aquarium are taking part in his rescue. All his friends from the aquarium also wishes to join him but they decided to stay back as ocean is something unknown to them, so the fear of the unknown pulled them back, this is what happens to the city people.

Delhi Safari is a protest against the human encroachment into their territory, ‘the wilderness’. In the name of development, the builders are destroying the forests and felling down the trees on a large scale thereby creating a threat to animals and birds, making the forest no longer safe to live. ‘Culture’ is engulfing ‘nature’. Animals and birds gather together to find a solution in the form of a journey to the Indian Parliament to meet the authorities and convince them about the cruelties they are perpetrating towards nature. The spectators empathize with their situation and feel one among them.

The journey of the animals: a leopard cub and his mother, a monkey, a bear and a talking parrot excite the kids and make them think about the condition of animals, birds and plants in this man-centered

world created by man. The entertaining movie with lots of fun is capable enough to create environmental awareness among kids as these four animals and a bird succeed in changing the decision of the country, their forest is no longer under threat.

Rather than knowing nature through the ‘domestic picturesque’ areas like parks and garden (which adults consider safe), both these movies introduce before the children the ‘pure nature’ and help in developing an optimistic attitude towards nature. Thus, it becomes evident that with the help of film industry and animation technology our children can be taught of a ‘green culture’ to save our planet from the environmental threats like global warming, deforestation, pollution, ozone layer depletion etc. Children should realize that this beautiful earth is home to all living creatures and that ‘man’ is not essentially the centre of the universe; the one who decides and controls everything. A harmony between all the living and non-living factors in the nature is imperative for its preservation.

References

- [1] Barry, Peter. “Ecocriticism”. *Beginning Theory: An Introduction to Literary and Cultural Theory*. New Delhi: Viva Books, 2010. Print.
- [2] Dobrin, Sidney I., and Kenneth B. Kidd., ed. *Wild Things: Children’s Culture and Ecocriticism*. Detroit: Wayne State University, 2004. Print.
- [3] Glotfelty, Cheryll, and Harold Fromm. *The Ecocriticism Reader: Landmarks in Literary Ecology*. Athens: University of Georgia, 1996. Print.
- [4] Murray, Robin L., and Joseph K. Heumann. *That’s All Folks? Ecocritical Readings of American Animated Features*. Lincoln: University of Nebraska, 2011. Print.

DEVELOPMENT ECONOMICS: UNDER ALTERNATIVE INDICES OF EXPANSION

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Abstract

Development economics is now enriched with the emergence of a different yardstick for measuring the standard of living of a country. The present research study focuses on the pooling of various alternative theories and indices used to measure the standard of living by placing man at the central norm in development economics. When GDP, as an index of development, developed, Simon Kuznets warned that it should not be used for any other purpose related to the overall well-being of man. The HDI, as an alternative index, emerged due to the problems associated with the GDP per capita, as a measure of welfare. The PQLI as an index of development also focused on the quality of life and the wellbeing of a country. The Happy Planet Index (HPI) and the Gross National Happiness(GNH), as indices of development, focused on the happiness and the life satisfaction of the present and the future generation. In the context of the development of various alternatives to the GDP per capita, like the Human Development Index(HDI), the Inequality Adjusted HDI (IHDI), the Happy Planet Index(HPI), the Physical Quality of Life Index(PQLI), the Genuine Progress Indicators (GPI), Measures of Economic Welfare(MEW), Net Economic Welfare(NEW), Index of Sustainable Economic Welfare(ISEW), Global Prosperity Index etc, an index is to be made sufficient for capturing the complexity of the human situations.

An Overview of Different Alternative Indices of Development

“What you can do measure as national income statistics is the output resulting from the market-oriented activity. The key to market-oriented activity is the presence of the price tags—the essential ingredient is an objective standard of measurement. Price tags enable you to sum up physicians’ prescriptions and photograph records and pounds of steaks and packages of beans, or the things that money can buy. But if you were to be seduced by your ethics into inventing price tags neither exists nor can be reasonably approximated for the things that money can’t buy, you would have **sacrificed the objective yardstick.**”

- **Arthur Okun**

Introduction

Development economics is now enriched with the emergence of a different yardstick for measuring the standard of living of a country. The present research study is focusing on the pooling of various alternative theories and indices used to measure the standard of living by placing man at the central norm in development economics. When GDP as an index of development developed, Simon Kuznets warned that it should not be used for any other purpose related to the overall well-being of man. The HDI as an alternative index emerged due to the problems associated with the GDP per capita as a measure of welfare. The PQLI as an index of development also focused on the quality of life and the well-being of a country. The Happy Planet Index (HPI) and the Gross National Happiness (GNH), as indices of development, focused on the happiness and the life satisfaction of the present and the future generation. In the context of the

development of various alternatives to the GDP per capita, like the Human Development Index (HDI), the Inequality Adjusted HDI (IHDI), the Happy Planet Index(HPI), the Physical Quality of Life Index (PQLI), the Genuine Progress Indicators (GPI), the Measures of Economic Welfare (MEW), the Net Economic Welfare (NEW), the Index of Sustainable Economic Welfare (ISEW), the Global Prosperity Index etc., an index is to be made sufficient for capturing the complexity of the human situations.

The Physical Quality of Life Index (PQLI)

This measure was originally conceived by Jan Timbergen (1976). It is an attempt to measure the quality of life or wellbeing of a country. The index is based on the average of three variables like the basic literacy rate, the infant mortality rate, and the life expectancy at age one. This index was prepared by the Overseas Development Council due to the dissatisfaction with the GDP as an Index of Development. Encouraged by James Grant, it was Morris David Morris who developed the PQLI. The index summarises infant mortality, life expectancy at age one and basic literacy on a zero to 100 scale. The study showed that there is lack of congruence between GNP Per Capita and the PQLI. The results of the study of PQLI pose a general equilibrium problem involving nutrition, health, education, degree of social participation, employment levels, income earning capacity etc. Further, there is no automatic and necessary connection between income and the life quality results that can be attained. The PQLI is a composite measurement which not only encourages to think along novel lines and also serves as a constant reminder of the crucial interrelatedness at the core of the analytical task. Morris David Morris, (1996)

The Human Development Index (HDI)

The Human Development Index (HDI)(1990) was introduced by the United Nations Development Programme (UNDP). The CDS-UNDP study of the Kerala economy in 1975 under Dr. K. N. Raj also influenced the formulation of this index.

The GDP per capita is adjusted in HDI and become inclusive of the human resources aspects like life expectancy and literacy and made it as people centred.

HDI= 1/3 (life expectancy index) + 1/3 (education index) + 1/3 (GDP Index).

For the calculation of the Human Development, fixed maximum and minimum values for Hay (2000), the three-dimension indices are required. Life expectancy at birth has minimum and maximum values between 25 years and 85 years. For the adult literacy, the minimum and maximum values are between 0 and 100 per cent. The minimum and maximum values for combined gross enrolment are between 0 and 100 per cent. proposed different indices of development involving improved social welfare- 'adjusted' GNP, to replace conventional GNP estimation.

To Sen (1999), capability approach has been explicitly accepted by the World Bank (2000), and thereby included the 'voice of the poor' in its idea of poverty. In a clear-cut way to change its development perspective, the World Development Report 2000-2001 of the World Bank has included income, health, education, vulnerability, powerlessness and human development in its depiction of poverty. However, the Bank's

perspective of development remains unaltered from the basic approach of market-oriented development. The Bank's recent idea of development showed a conceptual difference due to the incorporation of a number of excluded elements in its policy directive.

However, these developments of different indices failed to get adequate attention in the academic circles and other political and social fields.

Inequality-Adjusted HDI (IHDI)

The Inequality-adjusted HDI (IHDI) takes into account not only the average achievements of a country on health, education and income but also how these achievements are distributed among the population of a country. According to the Human Development Report (2016), IHDI can be interpreted as the level of human development when inequality is discounted for. It is done by discounting each dimension's average value according to the level of inequality.

Environmentally Adjusted Economic Performance Indicator (EAEPI)

Common (1995) developed Environmentally-Adjusted Economic Performance Indicator (EAEPI) by using the variables like, (i) GDP per capita, (ii) Longevity, (iii) Environmental impact measured from data of net greenhouse gas emission. This new index has the formulae:

$I = YL/G$; where Y= the GDP per capita, L= longevity, G=an index to net greenhouse gas emission (expressed as equivalent metric tons of

carbon per capita), I =Life time per capita income per unit of environmental impact.

There are two reasons for using G in this new index as a measure of environmental impact. First, an increasing use of greenhouse gas is major threat to our environment and thereby our existence. Second, according to Common, 'G' may serve as a good proxy for the overall environmental impact of economic activity because greenhouse gases are produced largely by the combustion of fossil fuels and land use changes like deforestation. To him, the index $I=YL/G$ is not to be seen as a definitive indicator for environmentally adjusted economic performance.

The Happy Planet Index (HPI)

This index of human well-being and environmental impact was introduced by the New Economics Foundation (NEF), London in July 2006. It uses survey-based data on life satisfaction in addition to their "hard" variables to arrive at the index.

$HPI = \text{Life Expectancy} + \text{Life Satisfaction} + \text{Ecological footprint}$.

The index was designed to challenge the validity of the indices like the GDP per capita and the HDI. These indices failed to take into account the environmental sustainability and the happiness or the life satisfaction of the people. The HPI value is an average of the subjective life satisfaction, life expectancy at birth, and ecological footprint per capita. The HPI as an index of development was developed to challenge the validity of the GDP per capita and the HDI.

The world's wildlife populations have reduced by around a quarter since the 1970's, according to a report by the World-Wide Fund For nature (WWF). The alternatives such as Bhutan's Gross National approach have been critically examined by Priesner (1999)

The Gross National Happiness (GNH)

The term was coined by Bhutan's former King Jigme Singye Wangchuk, in 1972. The objective behind the development of such an index was to show the positive impact of Buddhist spiritual values in Bhutan's culture. The concept was developed in an attempt to define an indicator that measures the quality of life. The GDP per capita as an index of development has numerous flaws. It measures the amount of commerce in a country, but counts remedial and defensive expenditures such as the costs of security, police, pollution clean-up, etc. as positive contributions to commerce. A holistic measure of economic wellbeing would deduct these types of costs and include other nonmarket benefits such as volunteer work, unpaid domestic work, and unpriced eco system services. The GNH helps in assessing the social and psychological wellbeing of the persons. The elements that contribute to GNH are subject to quantitative measurement.

The GNH is structured around nine domains and the index was calculated on the basis of the contribution of each domain to overall happiness. GNH is the combined value of these nine broad domains.

Table 1: Percentage Contribution of Sufficiency of each Domain to Overall Happiness

Percentage Contribution of Sufficiency of each Domain to overall Happiness	
Psychological Well-being	11.97
Health	14.07
Time Use	10.45
Education	9.06
Cultural Diversity and Resilience	9.91
Good Governance	9.32
Community Vitality	11.83
Ecological Diversity and Resilience	12.11
Living Standards	11.27
TOTAL	100

Source: GNH Index (2012), Centre for Bhutan Studies

The Centre for Bhutanese Studies carried out the first GNH survey on December 2007. The 2010 GNH survey was conducted nationwide with representative samples from stratum (Rural and Urban) as well as districts. The sampling unit is the household and representatives are above 14 years of age.

Recent Developments Associated with the Index of Development

More recently a number of literatures and researches are coming up in the field of reviewing the index of development. The prominent among them are the recommendations in the Report by The Commission on the Measurement of Economic Performance and Social Progress (CMEPSP) (2009). While attempting for an inclusive and sustainable index of development, it is worthwhile to incorporate the recommendations of the commission.

One of the recommendations of the commission is that when evaluating the material wellbeing; look at the income and consumption, rather than production. The GDP measures the market value of market production expressed in money units. Material living standards are more closely associated with measures of net national income, real household income and production which can be expanded while income decreases or vice versa. Second suggestion is that the trends in material living standards are better followed through measures of household income and consumption. The available national accounts data show that in a number of OECD countries, real household income has grown quite differently from real GDP per capita, and typically at a lower rate. When properly defined, household income and consumption should also reflect in-kind services provided by government such as subsidized health care and educational services.

The third important recommendation of the Commission is to consider the income and consumption jointly with wealth. The commission accepts the fact that income and consumption are crucial for measuring living standards. But ultimately, they have to be measured in conjunction with information on wealth.

Fourthly, the Commission highlighted the problem associated with the average since the average do not tell about the living standards. So, the Commission recommended that the average measures of income, consumption and wealth should be accompanied by the indicators of their distribution.

Fifthly, the Commission recommended for broadening the present income measures to include all non-market activities which has long been excluded. Many of the services people received from other family members in the past are now purchased from the market. This mere shift in consumption translates into a rise in income as measured in national income statistics which may give a false impression of a change in living standards.

Sixthly, according to the commission, the quality of life depends on people's objective conditions and capabilities. It recommends for improving people's health, education, personal activities and environmental conditions. To predict life satisfaction, substantial efforts are required to measure social connections, political voice and insecurity. Because, quality of life depends on people's health and education, their everyday activities, their participation in the political process, the social and natural environment in which they live.

Seventhly, quality of life indicators in all the dimensions should assess inequalities in a comprehensive way. And inequalities in quality of life should be assessed across people, socio-economic groups, gender and generations, with special attention to inequalities that have arisen recently such as those linked to immigration.

Eighthly, surveys should be designed to assess the links between various quality of life domains for each person, and this information can be used for designing policies in various fields. To the commission, developing measures of these cumulative effects requires information on the joint distribution of the most salient features of quality of life across everyone in a country through dedicated surveys.

Ninthly, the commission recommended that the statistical offices should provide the information needed to aggregate across quality of life dimensions, allowing the construction of different indices. To the commission, several summary measures of the quality of life are possible, depending on the question addressed and the approach taken. Other summary measures similar to the Human Development Index could be implemented if the national statistical system makes the necessary investment to provide the data required for their computation.

Tenthly, the commission recommended the need for getting information regarding both subjective and objective well-being which provide key information about people's quality of life. Thus, statistical commission should incorporate questions to capture people's life evaluations, hedonic experience and priorities in their own survey. Researches show that it is possible to collect meaningful and reliable data on subjective as well as objective well-being.

Eleventhly, the commission stated that the sustainability assessment requires a well-identified dashboard of indicators. And, the distinctive feature of the component of this dashboard should be that they are interpretable as variations of some underlying 'stocks'. A monetary index of sustainability has its place in such a dash board but, presently it should remain essentially focused on economic aspects of sustainability.

The twelfth is that, the environmental aspect of sustainability deserves a well-chosen set of physical indicators. To the commission, there is need for a clear indicator of our proximity to dangerous levels of environmental damage (such as associated with climate change or

the depletion of fishing stocks). Thus, placing monetary value on the environment is often very difficult and separate set of physical indicators are required to monitor the state of the environment. Another important research area should be the fault in the standard depreciation measures, which are not taking into account the depreciation due to environmental depreciation or improvements. Further, GDP mainly measures the market production and treating it equally as a measure of economic wellbeing.

The CDS-UNDP Study-1975 and the Kerala Model of Development

The CDS-UNDP study was done under the leadership of Dr.K.N.Raj. The study was conducted in a sample survey manner which selected the three districts of Kerala – Thiruvananthapuram, Ernakulam and Kannur. To Sen (1999), the Kerala economy resembles the development phenomenon of Srilanka, Malaysia, etc. The study is following a centered approach by putting man at the centre of economic activity which will give an orientation for the policy formulation of the Kerala economy, especially in the context of development related environmental and resource availability issues.

Human Development Index- India and Kerala

HDI classifications are relative and it is based on quartiles of HDI distribution across countries and denoted very high, high, medium and low HDI. For the contribution of HDI, the position of the Indian economy and Kerala is comparable. It is also possible to see the position of the Indian economy compared to other countries of the world. Norway attained the number one position in terms of HDI while the USA is in the 4th position. The SAARC country Sri Lanka is in a remarkable position of

97 where as China stands in the 101th position. India's position is very dismal in terms of HDI having a rank of 134th.

Table 2: Human Development Index of Selected Countries of the World

Country	HDI value	HDI rank	Life Expectancy
Norway	0.943	1	81.1
USA	0.910	4	78.5
Japan	0.901	12	83.4
Italy	0.874	24	81.9
UK	0.863	28	80.2
UAE	0.846	30	76.5
Malaysia	0.761	61	74.2
Sree Lanka	0.691	97	74.9
China	0.687	101	73.5
South Africa	0.619	123	52.8
India	0.547	134	65.4
Pakistan	0.504	145	65.4
Bangladesh	0.500	146	68.9
Congo	0.286	187	48.4

Source: Human Development Report 2011.

India's position was 134 in Human Development in 2011 and ranked under the countries having medium human development in the world. However, over the last three decades, the HDI value has improved. The HDI value for the Indian economy was 0.344 in 1980, enhanced to 0.410 in 1990, which in turn was raised to 0.461 in 2000. During the period, 2005, the HDI value was 0.504, and it improved to 0.547 in 2011.

Table 3: List of Top Ten Countries by Human Development Index

Ranking	Country	HDI (2016 estimates for 2015)
1	Norway	0.949
2	Australia	0.939
3	Switzerland	0.939
4	Germany	0.926
5	Denmark	0.925
5	Singapore	0.925
7	Netherlands	0.924
8	Ireland	0.923
9	Iceland	0.921
10	Canada	0.920
10	United States	0.920
131	India	0.624

The list of countries by the inequality-adjusted Human Development Index (IHDI) was published by the UNDP in its 2016 Human Development Report. In HDI, the inequality is not accounted for, whereas in IHDI, the inequality is accounted for and therefore, it is a measure of Inclusiveness in the realm of HDI. The list of countries by Inequality-adjusted Human Development Index (IHDI) was published by the UNDP in its 2016 Human Development Report. The IHDI can be interpreted as the level of human development when inequality is accounted for. This index is very valuable in the context of inclusiveness of the GDP Per Capita, as an index of development. The Table shows the top 10 countries and some other prominent countries' ranking in Inequality-adjusted HDI (IHDI). The United State stands in the 19th position in IHDI compared to 10th position in HDI. In the inequality-adjusted HDI (IHDI), India's position

is 97th among the World countries. Compared to the GDP Per Capita Index, the HDI Ranking is a bit higher for India. The position improved in the Inequality-adjusted HDI.

Table 4: List of Countries by Inequality adjusted HDI (IHDI)

Ranking	Country	IHDI
1	Norway	0.898
2	Iceland	0.868
3	Australia	0.861
3	Netherlands	0.861
5	Germany	0.859
5	Switzerland	0.859
7	Denmark	0.859
8	Sweden	0.851
9	Ireland	0.843
10	Finland	0.843
11	Canada	0.839
13	United Kingdom	0.836
18	France	0.813
19	United States	0.796
97	India	0.454

The Happy Planet Index provides a compass to guide nations and shows that it is possible to live good lives without costing the Earth. Calculating the Happy Planet Index results, the Happy Planet Index combines four elements to show how efficiently residents of different countries are using environmental resources to lead long, happy lives. Figure 1 shows, approximately, how those elements are brought together to calculate the PI scores. 1 Wellbeing: How satisfied the residents of

each country feel with life overall, on a scale from zero to ten, based on data collection.

Life expectancy: The average number of years a person is expected to live in each country based on data collected by the United Nations.

Inequality of outcomes: The inequalities between people within a country in terms of how long they live, and how happy they feel, based on the distribution in each country's life expectancy and wellbeing data.

Ecological Footprint: The average impact that each resident of a country places on the environment, based on data prepared by the Global Footprint Network.⁵ Figure 1: The Happy Planet Index formula Wealthy Western countries, often seen globally as representing success, do not rank highly on the Happy Planet Index. Instead, several countries in Latin America and the Asia Pacific region lead the way by achieving relatively high and fairly distributed life expectancy and wellbeing with much smaller Ecological Footprints.

The table of Happy Planet Index (HPI) showed that the countries who topped in other indices of development like GDP per capita, performed low in HPI. Costa Rica topped the list and Mexico bagged second in this index. India's position is better in HPI compared to all other indices of development with a ranking of 50. The United States performed lower in HPI with a ranking of 108th position compared to the below 10th position in GDP Per Capita and HDI.

Table 5: Happy Planet Index (HPI)-2016 Report

Rank	Countries	HPI	Wellbeing	Life Expectancy	Inequality of Outcomes (in %)	Ecological Footprint
1	Costa Rica	44.7	7.3	79.1	15	2.8
2	Mexico	40.7	7.3	76.4	19	2.9
3	Colombia	40.7	6.4	73.7	24	1.9
4	Vanatu	40.6	6.5	71.3	22	1.9
5	Vietnam	40.3	5.5	75.5	19	1.7
6	Panama	39.5	6.9	77.2	19	2.8
7	Nicaragua	38.7	5.4	74.3	25	1.4
8	Bangladesh	38.4	4.7	70.8	27	0.7
9	Thailand	37.3	6.3	74.1	15	2.7
10	Ecuador	37.0	6.0	75.4	22	2.2
18	Netherlands	35.3	7.5	81.2	4	5.3
28	Sri Lanka	33.8	4.2	74.6	17	1.3
50	India	29.2	4.6	67.3	31	1.2
72	China	25.7	5.1	75.4	17	3.4
105	Australia	21.2	7.2	82.1	8	9.3
108	United States of America	20.7	7.0	78.8	13	8.2
116	Russia	18.7	5.6	69.5	16	5.7

The table shows the comparative position of certain prominent countries in terms of GDP Per Capita (Nominal), GDP Per Capita PPP, HDI, IHDI and HPI. It also shows the average ranking of the countries in terms of GDP Per Capita Nominal and HPI. There is some wide variation among countries in terms of these prominent indices.

Table 6: Comparative Ranking of Countries in GDP Per Capita and Other Alternative Indices

Sl. No	Country	Ranking 2016					Average Ranking	Average Ranking (GDP Per Capita Nominal & HPI)
		GDP Per Capita (Nominal)	GDP Per Capita (PPP)	HDI	IHDI	HPI		
1	India	134	113	131	97	50	105	92
2	USA	8	9	10	19	108	31	58
3	China	66	70	90	67	72	73	69
4	Sri Lanka	104	85	73	46	28	67	66
5	Bangladesh	141	137	139	110	8	107	75
6	Norway	4	8	1	1	12	5	5
7	Luxemburg	1	2	20	15	139	35	70
8	Mexico	65	64	77	68	2	55	34
9	Australia	11	17	2	3	105	28	58
10	Japan	20	22	17	21	58	28	39
11	UK	18	21	16	13	34	20	26
12	Russia	61	52	49	38	116	63	89
13	South Africa	85	82	119	102	128	103	107
Spearman's Rank Correlation Coefficient								-0.36

Source: World Bank Report 2016, New Economic Foundation 2016, UNDP 2016

India Ranked 134th in Nominal GDP Per Capita, 113th in GDP Per Capita PPP, 131th in HDI, 97th in IHDI, and a high rank of 50th in HPI. The USA performed better with 8th, 9th, 10th and 19th position in GDP Per Capita Nominal, GDP Per Capita PPP, HDI and IHDI but performed worse in HPI with a ranking of 10th. Bangladesh performed better in HPI with a ranking of 8th compared to above hundred positions in all other indices of development. Norway is the only country who has a better position in all indices of development. Its average index position is 5th

compared to the 31st position of the USA, the 105th position of India, the 107th position of Bangladesh and the 28th and 20th position of Japan and UK respectively.

As per the Spearman's Rank Correlation Coefficient the association between the GDP Per Capita(Nominal) and HPI is not at all significant.

To make the GDP Per Capita more inclusive and sustainable, there should be a genuine search for what development is and which is the basic pillar of development or the normative norm of development. Nataraja Guru (1960), tried to show 'Man' as the basic norm of development. In GDP Per Capita and other alternative indices of development there is a basic norm of development implied in it. GDP Per Capita as an index of development rests on 'Money' or the 'Market Value' as the basic norm of development. The Human Development Index (HDI) focuses on the basic norm of 'Human Capital'. The Happy Planet Index (HPI) rests on the development norm of 'Happiness'.

Table 7: The Index of Development and the Normative Notion of development

Index of Development	Normative Notion of Development
GDP per capita	Market value in money terms
HDI	Human development centered
PQLI	Human development centered
Happy Planet Index(HPI)	Happiness of people centered
Social Progress Index(SPI)	Societal total wellbeing centered
Gross National Happiness (GNH)	Happiness of the nation centered
GDP Plus per capita	Man centered embracing all values

Among the norm of development stated here 'Man' stands as a unique one, since it is the only norm which embraces all other separate norms like human capital, happiness, social progress, etc.

Presenting 'GDP Plus Per Capita' as an Ideal Measure of development

From the above discussion based on the results of our study, it is obvious that development goes beyond the materialistic advancement measured in terms of GDP, years of education and certainly the longevity of people. As aforementioned, there are many things which the existing indices of development desperately fail to capture. Such things which remain outside the reach of existing indices are often seen in advanced economies, and Kerala being on par with the advanced economies as claimed by the pioneers of Kerala model, development connotes more than just quantitative and qualitative enhancement. In this context, we propose to present a new index which could be called 'GDP Plus Per Capita'.

The **GDP Plus Per Capita** indicates a function of GDP Per Capita.

$$\mathbf{GDP\ Plus = f(GDP, \sum n, X)}$$

In other words, it is the sum total of GDP per capita and 'n' number of economic variables (X) which are excluded from the current GDP Per Capita.

GDP= Market Value of all Goods and Services(monetised) + Value of all bartered goods and services (non-monetised) + Value of all self consumed Goods and Services.

GDP Plus= GDP + Value of the duties of the Housewives + Value of the Environment/Natural Capital + Value of Human Resources/Human Capital + Value of the subjective happiness of the people + Value of the Societal Wellbeing + Indirect Value addition in the Digital Economy + Value of the Freedom enjoyed by the people of a country + Value of Health due to the changes in Communicable and Life Style Illness + Value of Good Governance and Political wellbeing of the people.

Conclusion

There are different alternative indices of development developed after the GDP Per Capita as an index of development. The alternative indices like the Human Development Index (HDI), the Happy Planet Index (HPI), the Gross National Happiness (GNH), the Physical Quality of Life Index (PQLI), the Social Progress Index (SPI), the Environmentally-Adjusted Economic Performance Indicator (EAEPI), etc. have highlighted the excluded factors of development. The Commission on the Measurement of Economic Performance and Social Progress (CMEPSP) (2009), also highlighted the flop in the use of GDP Per Capita and suggested for considering consumption, income and wealth together in the measurement of the standard of living. The committee also suggested for a dashboard of indices to compensate the GDP Per Capita to make it inclusive and sustainable. The CDS-UNDP study of the Kerala economy also highlighted the Kerala Model of Development in development literature which stresses the human development aspect of development. This also led to the emergence of the Human Development Index (HDI) by the UNDP in 1990.

References

- [1] Advisory Committee on “Environmental-Economic Accounting” at the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety Environmental-Economic Accounting (2002), Wiesbaden.
- [2] Beyond GDP: Classifying Alternative Measures beyond GDP: Classifying Alternative measures for Progress, Online publication 10th August 2011, Springer Science Business media.
- [3] Common, Michael S. (1995). “Economic growth and environmental degradation: The environmental Kuznets curve and sustainable development”, *World Development* 24 (7), pp.1151-1160.
- [4] Human Development Report, 2016. United Nations Development Programme.
- [5] Morris, Morris D. (1978).”A Physical Quality of Life Index”, *Urban Ecology*, 3(3), pp. 225-240.
- [6] Nataraja Guru, (1996) “*Experiencing One World*”, D.K. Print world (p) Ltd, New Delhi.
- [7] Priesner. S, (1999). “Gross National Happiness-Bhutan’s Vision of Development and its Challenges”, *Gross National Happiness*, pp. 1-29.
- [8] Sen, Amartya (1999), “Commodities and Capabilities”, Oxford University Press India, New Delhi.
- [9] The Commission on the Measurement of Economic Performance and Social Progress (CMEPSP)-(2009).
- [10] Timbergen, Jan (1976), “Reshaping the International Order”, *Futures*, 8 (6), pp.553-556.

REMOVAL OF HEAVY METALS, DYES AND ORGANIC POLLUTANTS FROM WATER USING LOWER GENERATION PAMAM DENDRIMER BASED NANOPARTICLES

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Abstract

Lower generations of PAMAM dendrimers, modified by silica nanoparticles, have been employed as a good system for water purification. The nano-sized hybrid structures were characterized by FT-IR spectroscopy, scanning electron microscopy (SEM), and dynamic light scattering techniques. The highlights of the present study are: (a) results indicate that lower generation PAMAM dendrimers are equally efficient to purify water compared to that of higher generations of dendrimers, (b) unlike the reported cases, the dendrimer-silica nanoparticles were capable of removing organic dyes and polycyclic organic pollutants from water, in addition to the toxic metal ions and (c) the desorbed nanoparticles can be reused for water purification.

Introduction

Water is the vital component of living beings. It has been identified as the largest living sources for human beings, animals, and plants. 97 percent of the water on earth belongs to oceans and only the rest is useful for drinking and domestic needs¹. Due to industrial revolution and increase in population, the availability of pure water has decreased^{2,3}. Water pollution is

an important issue that affects living beings. There are wide varieties of pollutants that are responsible for water contamination⁴. These pollutants pose major threats to all of us. Heavy metal ions⁵, organic pollutants⁶, and organic dyes⁷ are the major water contaminants which are targeted in this work. Heavy metal ions such as Cd (II), Hg (II), Pb (II), Fe (II), Ni (II) etc are the major outrageous water pollutants⁸. The textile industries are responsible for contaminants of organic dyes in water. The use of pesticides is the cause for the presence of aromatic hydrocarbons in water⁹.

There are several techniques available for water purification¹⁰⁻¹³. Scientists are still worried about developing different methods to purify water. Water purification using nanoparticles¹⁴⁻¹⁹ is a wide area; several methods have been reported in this area. Generally, dendrimers²⁰ are macromolecules with symmetrically branched chains starting from a core unit. Dendrimers are well defined hyper branched polymers, where the terminal groups can be modified for achieving desired functional property^{21,22}. The dendrimers are prepared in systematic reaction²⁰ using step wise addition of components. They have a central core, repeating unit and a surface functional group. Nanosystem based on dendritic molecular networks have been reported for several applications such as water purification²³, catalysis²⁴ etc. Since the inception of the field, the nanosized macromolecules have been identified as a potential candidate for drug-delivery²⁵, and host-guest chemistry²⁶. Dendrimers can act as effective host systems due to their symmetrical structure and the presence of internal cavities where specific guest molecules can bound through non-covalent interactions. Recent studies suggest that higher generations of poly (amido amine) {PAMAM} and/or poly (propylene imine) {PPI}

dendrimers have been employed for water purification, by attaching the dendritic structures to ceramics²⁷, TiO₂, or silica surface²⁸. Poly (propylene imine) {PPI} based dendritic networks on porous ceramics have been employed for removing organic waste from water; these works were done by M. Paloes et.al.in 2005. A few hyper branched polymer based hybrid systems have been reported in the literature where they have been used to detect heavy transition metal ions (HTM) and organic pollutants²⁹. There, they have used poly (ethylene imine) hyper branched polymer based silica nanospheres. They have reported that, the system can encapsulate toxic heavy metals as well as polycyclic aromatic hydrocarbons from polluted water. Silica nanoparticles have the advantage of low toxicity. It has been reported that silica nanoparticles can be prepared by sol-gel methods in room temperature and controlled pH^{30,31}. They have suggested that dendrimer can act as a good template for silica nanoparticle formation. Especially, PAMAM dendrimer which can aggregate in solution phase, helps silica synthesis.

However, PAMAM based dendrimers, especially lower generation PAMAM dendrimers, have not been reported for this purpose even though PAMAM is an important class of compounds in dendrimer family. PAMAM based dendrimers have the potential ability to coordinate to metal ions and encapsulate organic molecules. We have investigated the use of relatively lower generations of PAMAM dendrimers, modified by silica nanoparticles, for water purification. The present work describes the synthesis of lower generation PAMAM dendrimer based organic/ inorganic hybrid silica nanoparticles through covalent attachment of organosilane and its application towards water purification by removing toxic heavy metal ions, poly cyclic

organic hydrocarbons and organic dyes from water. The nano-sized hybrid structures were characterized by FT-IR spectroscopy, scanning electron microscopy (SEM), and dynamic light scattering techniques. The highlights of the present study are: (a) results indicate that lower generation PAMAM dendrimers are equally efficient to purify water compared to that of higher generations of dendrimers, (b) unlike the reported cases, the dendrimer-silica nanoparticles were capable of removing organic dyes and polycyclic organic pollutants from water, in addition to the toxic metal ions and (c) the desorbed nanoparticles can be reused for water purification.

Experimental section

Materials

Amine terminated PAMAM dendrimers G1 were synthesized according to a procedure reported by Tomalia and co-workers. Tetraethyl orthosilicate (TEOS), disodium hydrogen phosphate and sodium dihydrogen phosphate were purchased from Spectrochem Pvt ltd. 4-(2-pyridylazo) resorcinol (PAR) was obtained from sigma Aldrich Chemical Co. All the metal salts and polycyclic aromatic hydrocarbons were purchased from Sisco research laboratories Pvt ltd. Organic dyes were obtained from Spectrochem Pvt. ltd. Ammonia solution was purchased from Rankem India Pvt. ltd.

Methods

FT-IR spectra of dendrimer modified silica nanoparticles were taken by using Jasco 4100. DLS properties of nanoparticles were measured by Malvern zeta-sizer nano series with a path length of 1cm. SEM images of nanoparticles were taken by FEI Quanta FEG 200 High Resolution Scanning Electron Microscope. Absorption spectra were recorded by

JASCO V-660 spectrophotometer. Fluorescence spectra were recorded by Jobin Yvon Fluoromax-4 fluorescence spectrophotometer.

Preparation of Lower generation PAMAM dendrimer based organic /inorganic hybrid Silica Nanoparticles.

Dendrimer modified silica nanoparticles was prepared based on slightly modified procedure as discussed by M.R. Knecht et al. A dendrimer reaction solution of 10 ml was prepared with primary amine concentration of 20mM in doubly distilled water. TEOS (1 ml) was stirred with HCL (1mM), ammonia was added to the mixture and the pH=7.5 was maintained by Phosphate buffer (scheme I). After the silica precipitation, the solution was stirred for 5 minutes with constant magnetic stirrer and the reaction was allowed to complete at room temperature for one hour, the mixture was centrifuged for 20 min, and the residue was washed with water and dried at 60⁰c for four hours for characterization.

Preparation of heavy metal ion solutions

Pb²⁺(10ppm), Hg²⁺(10ppm), Cd²⁺(10ppm) solutions were prepared by dissolving 10 mg of Pd(NO₃)₂, Cd (SO₄)₂, and Hg(SO₄)₂ in doubly distilled water. Fe²⁺(200 ppm), Cu²⁺(200 ppm), Ni²⁺(200 ppm), and Co²⁺(200 ppm) were prepared by dissolving 200 mg of corresponding salts in one litre doubly distilled water. The pH of the solution was adjusted by using dilute HCL and NaOH solutions.

Preparation of polycyclic aromatic hydrocarbons solutions

Polycyclic aromatic hydrocarbon solutions were prepared by adding pyrene (100 mg),β-naphthol(300 mg) and anthracene (100mg) in one litre doubly distilled water and diluted to corresponding parts per billion level.

Preparation of dye solutions

The preparation of organic dye solution was done by dissolving methylene blue (200mg), rhodamine B(200mg) and methyl orange (200mg) in one litre doubly distilled water. The pH of the solution was maintained by adding dilute HCL and NaOH solutions.

Adsorption Experiments

Adsorption of toxic metal ions

Adsorption of toxic metal ions were carried out by stirring solution containing toxic metal ions Pb^{2+} (10ppm), Hg^{2+} (10ppm), Cd^{2+} (10ppm), Cu^{2+} (200ppm), Fe^{2+} (200ppm), Ni^{2+} (200ppm), Co^{2+} (200ppm) in 100 ml water with 50 mg dendrimer modified silica nanoparticle at PH -6.5 for 2 days. 5ml of the sample collected at each interval of time and the concentration of Pb^{2+} , Cd^{2+} and Hg^{2+} were found out using UV-VIS spectrometer by complexation of these metal ions with PAR indicator (PAR-2,4-pyridylazo resorcinol). PAR complexes were prepared by following the method proposed by Dagnall etal. PAR- Metal complexes were obtained by adding .0.01M PAR to 2.9 ml water containing ammonia-ammonium chloride solution at pH 10. While the concentration of other metal ions was monitored by ICP-OES method.

Adsorption of organic wastes

Dendrimer silica nanoparticle (50mg) was added to 100ml water contaminated with pyrene(100ppb), β -naphthol(100ppb), and anthracene (100ppb), and stirred for one day.5 ml sample was taken out at definite

interval of time; fluorescence spectrometer was used to find out the concentration of these polycyclic aromatic hydrocarbons in water.

Adsorption of cationic and anionic organic dyes

Textile dyes are the main contaminants of water. There are two categories of dyes; one is anionic dyes and the other is cationic dyes. The dendrimer modified silica nanospheres were prepared and, 50 mg of the compound was stirred with 200ppm of rhodamine B, methylene blue (cationic dyes) and methyl orange (pH-2.2, anionic dye) for 12 hr. The pH of the solution was adjusted by adding dilute HCL and NaOH solutions.

Adsorption Kinetics

The adsorption kinetics of heavy metal ions {pb²⁺ (10ppm), Hg²⁺ (10ppm), Cd²⁺(10 ppm)} were studied by the following method. 50 mg of nanoparticles was stirred with 100 ml water containing heavy metal ions and polycyclic aromatic hydrocarbons for 2 days. At each time interval, say 5 ml sample was taken out and centrifuged. The concentration of metal ions and organic pollutants were monitored by UV-VIS spectra and fluorescence spectrometer. The adsorption capacity was calculated by using the equation 1 where C_e is the equilibrium concentration, q_e corresponds to the adsorption amount at equilibrium,

C_o is the initial concentration of metal ions and organic waste, where V and m are the volume of solution and mass of the nanoparticles.

$$q_e = \frac{(C_o - C_e)}{m} V \dots\dots\dots (1)$$

Desorption Experiment

The recovery of dendrimer modified silica nanoparticles was confirmed by stirring 50mg of metal-ion absorbed nanoparticles with 50ml of doubly distilled water at pH =2. After overnight stirring, the reaction mixture was centrifuged and the supernatant liquid was subjected to UV-VIS spectrum analysis by the complex formation of the recovered metal ions with PAR indicator.

Results and Discussion

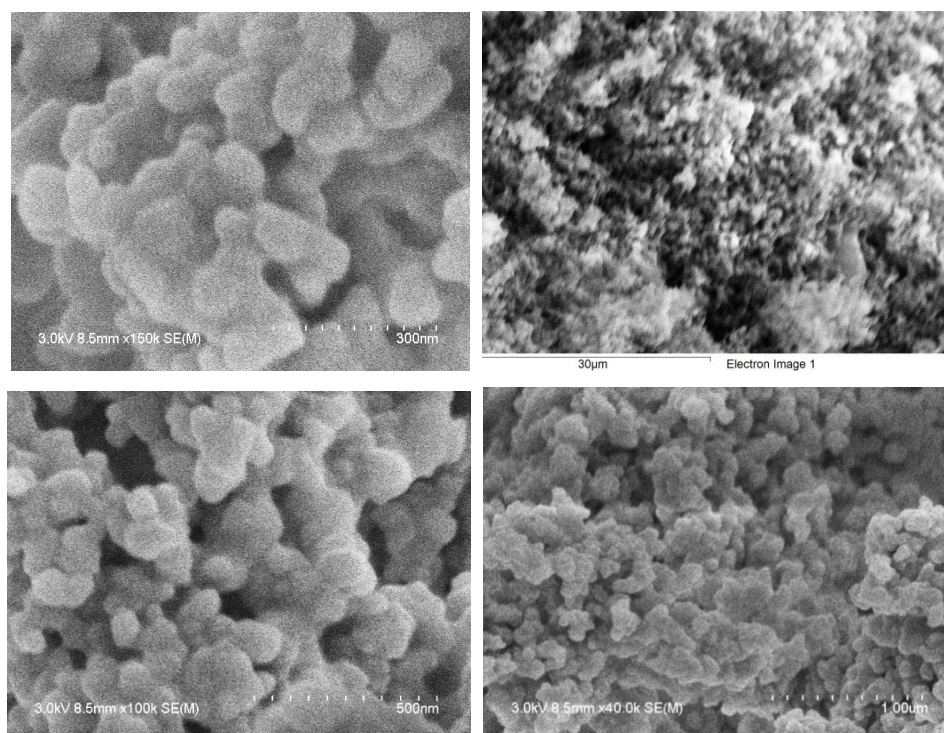


Figure 1. Scanning electron microscope images of G1 PAMAM dendrimer silica nanoparticles.

The dendrimer silica nanospheres were developed by adding 20mM primary amine concentration PAMAM G1 dendrimer to the solution

containing phosphate buffer and ammonia with 1M silicic acid. Silica precipitation depends on several factors such as concentration of phosphate buffer, concentration of was a sudden process and formed nanospheres having specific size. Silica growth on dendrimer template is dependent amine group etc. In the absence of phosphate buffer, there was no silica precipitation. The aggregation properties of template have played an important role in size determination of silica nanoparticles. The diameter of the silica nanoparticles is dependent on monomer template³¹.SEM analysis demonstrated that the average size of silica nanospheres formed by G1 PAMAM dendrimer is in the range of 300-500nm. Actually, this particle size is totally in good agreement with reported analysis of PAMAM silica nanospheres. The above SEM analysis suggests that in the case of G1 PAMAM dendrimer intercalation between dendrimer molecule leads to produce an aggregated template structure for silica condensation³¹. Since the template produced an aggregated structure, the particle size of the silica nanoparticles gets larger.

G1 PAMAM

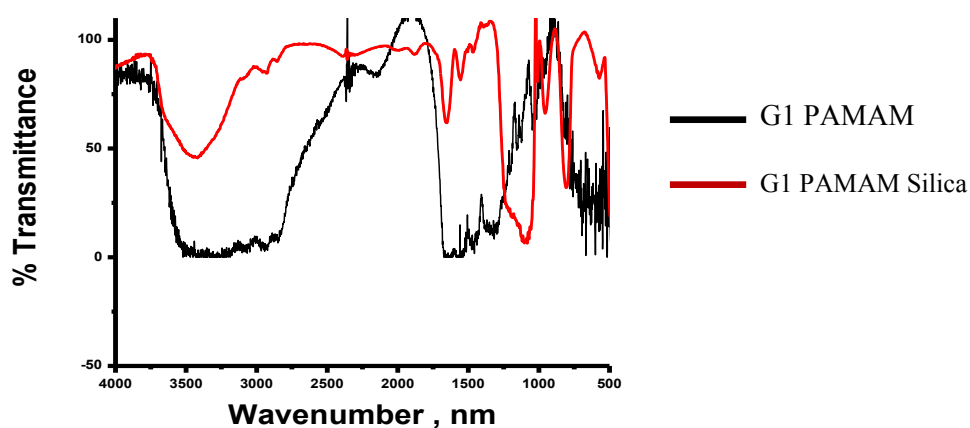


Figure 2. Infrared spectra of G1PAMAM dendrimer and G1 PAMAM dendrimer silica nanoparticles.

Infrared red spectra of both dendrimer and silica nanospheres that are shown in fig.2 are in good agreement with those reported in G1 PAMAM silica nanospheres. This clearly suggests the silica growth on G1 PAMAM dendrimer template. The C=O stretching frequencies of PAMAM-silica and PAMAM dendrimer are 1650 cm^{-1} and 1595 cm^{-1} respectively. C=O stretching bands of PAMAM silica have slightly shifted when compared to PAMAM where it is broad, this is attributed to the protonation of amine group in PAMAM templated silica nanospheres. The silica condensed N-H stretching band and PAMAM dendrimer N-H stretching band were observed clearly in Figure 2. The shift in the N-H stretching frequencies of G1 PAMAM silica while compared to G1 PAMAM is due to the condensation of silica, both stretching frequencies are 3420 cm^{-1} and 3223 cm^{-1} respectively. Band at 795 cm^{-1} corresponds to CH_2 vibrations. The Si-O-Si stretching band of silica in G1 PAMAM silica was observed at 1105 cm^{-1} .

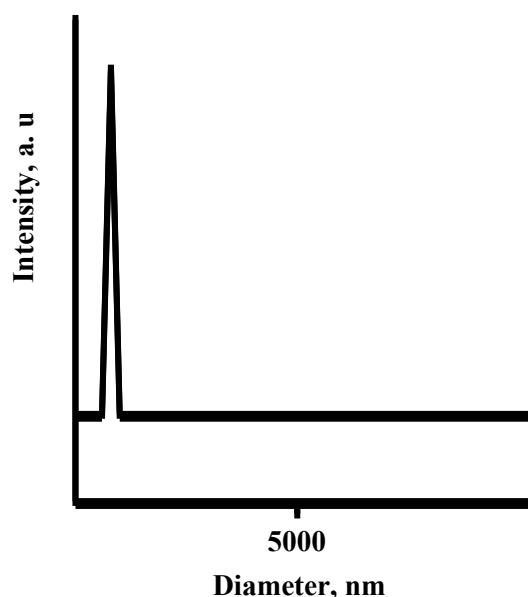


Figure 3. Dynamic light scattering plot of G1 PAMAM silica nanospheres

The dynamic light scattering studies also support the idea regarding particle size distribution of dendrimer template silica nanoparticles. It suggests that the range of aggregated monomer template silica particle size is around 400nm-500nm. This information also supports the idea of intercalated lower generation dendrimer aggregation providing the room for silica growth.

Heavy metal ion adsorption study

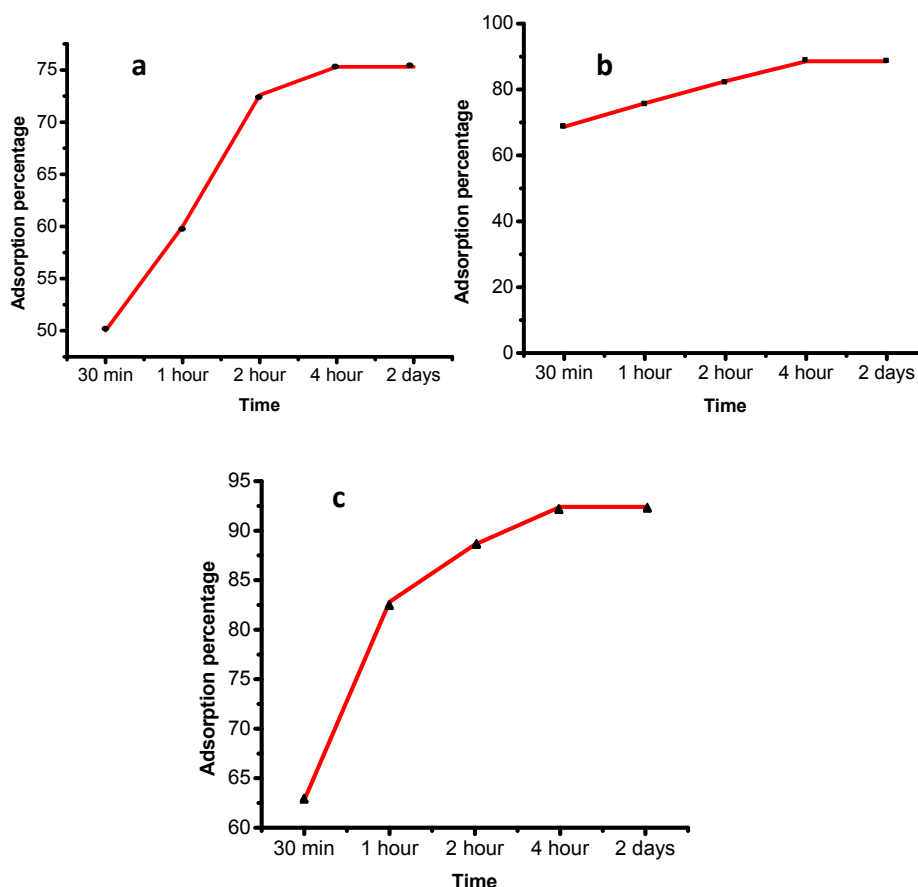


Figure 4. Adsorption percentage of Heavy metal ions (a) Cd^{2+} , (b) Hg^{2+} , and (c) Pb^{2+} versus time graph by using G1 PAMAM silica nanospheres.

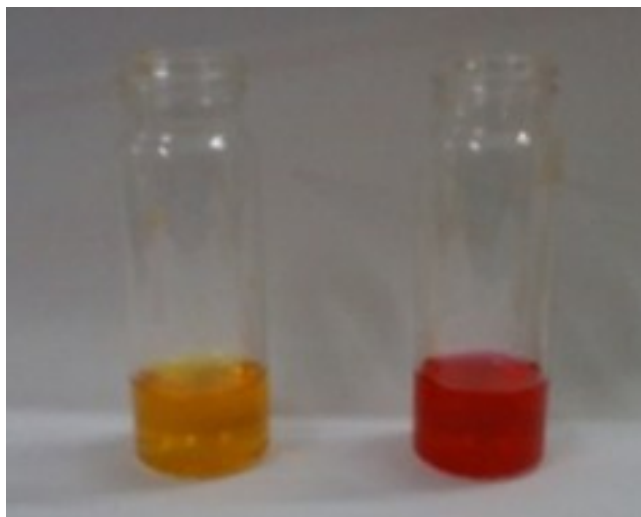


Figure 5. Photograph of PAR-metal complex solutions before (right) and after (left) stirring with silica nanospheres.

Table 1. ICP-OES analysis data of heavy metal ion adsorption to silica nanospheres.

Sample	Element symbol (Wavelength, nm)	Concentration(mg/l) of sample before treatment	Concentration (mg/l) of sample after treatment
1	Cu (327.393)	200mg/l	38.37mg/l
2	Fe (238.204)	200mg/l	BDL(below detection limit)
3	Ni (231.604)	200mg/l	142.7mg/l
4	Co (228.616)	200mg/l	37.94mg/l

Formation of dendrimer templated silica nanoparticles were confirmed by FT-IR, SEM, and DLS methods. These nanospheres were successfully used to remove pollutants from water. The adsorption kinetics of heavy metal ion such as Hg^{2+} , Pb^{2+} , and Cd^{2+} can be elaborated from the figure 4. In these three metal ions, 88.6% Hg^{2+} , 92.4% Pb^{2+} and 75.3% Cd^{2+} could be removed from water. Figure 5 is the photographic image of PAR-metal complex solution before and after stirring, this has also supported the considerable removal of toxic metal ions from water using lower generation dendrimer template silica nanoparticles. ICP-OES analysis data of metal ions in water before and after stirring in table 1 indicates 80%, 29%, 81 % adsorption of Cu^{2+} , Ni^{2+} , and Co^{2+} from contaminated water. Fe^{2+} ion shows below detection point to the instrument that indicates concentration which was less than 25 mg/l after stirring.

The variation in the adsorption rate of metal ions is due to the difference in co-ordination capacity to the negatively charged silica as well as amine and carbonyl oxygen in monomer template. The size difference in metal ions also played an important role in adsorption kinetics. Generally electrostatic attraction between positive metal ions and negatively charged silica as well as lone pairs in amine and carbonyl oxygen group is the major driving force behind the adsorption. After a definite period, of 2 days, no adsorption was observed, which indicates that equilibrium was attained after 2 days.

Organic pollutants adsorption study

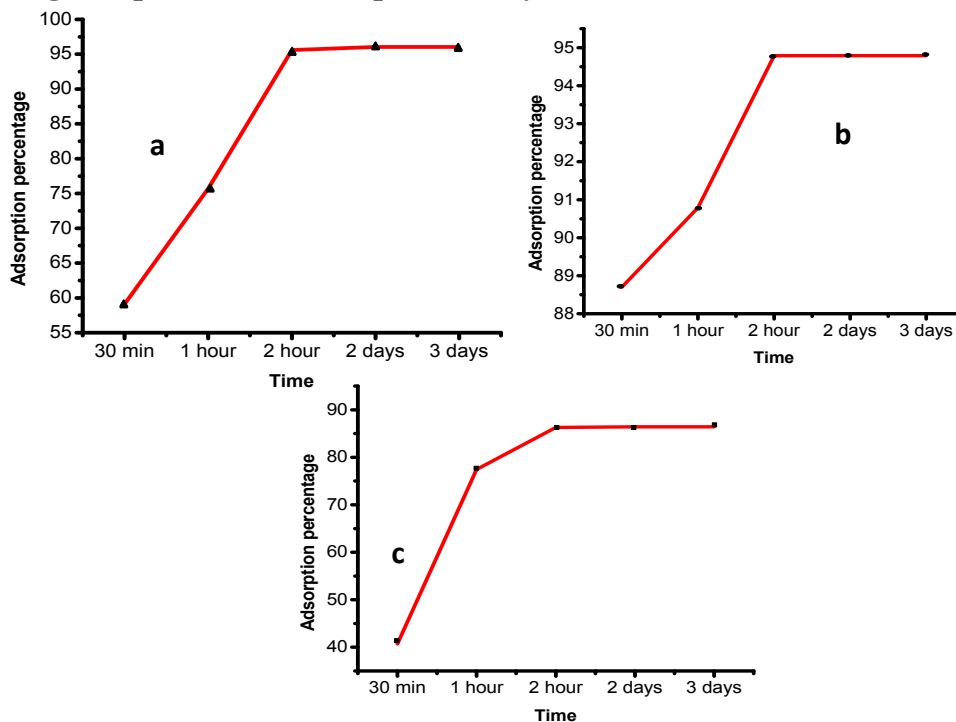


Figure 6. Adsorption percentage of polycyclic aromatic hydrocarbons (a) anthracene, (b) Pyrene, and (c) β -naphthol versus time plot by using G1 PAMAM silica nanospheres.

Due to the advantage of having lipophilic terminal group and hydrophilic interior part for the dendrimer, it was identified as an excellent candidate to remove organic pollutants especially polycyclic aromatic hydrocarbons from water. Figure 6 represents adsorption kinetic studies of polycyclic aromatic hydrocarbons using G1PAMAM silica nanospheres. The adsorption rate was increasing with contact time and after 2 days it reached equilibrium. The designed system could remove 96% of anthracene, 94% of β -naphthol, and 86% of pyrene from polluted water. The variation in the adsorption percentage was because of the difference in solubility of pyrene, anthracene and phenanthrene in water.

From the following results, the lipophilic group of dendrimers play an important role in the adsorption of organic pollutants. This was due to the hydrophobic interaction between dendrimer and polycyclic aromatic region. Actually, polycyclic aromatic hydrocarbons are included into the dendritic monomer template region. The hydrophilic regions in the G1 PAMAM such as amine and carboxyl group forms charge transfer complex with the polycyclic aromatic hydrocarbons during the adsorption³², this also amplifies the adsorption phenomenon.

Adsorption studies of organic dyes.

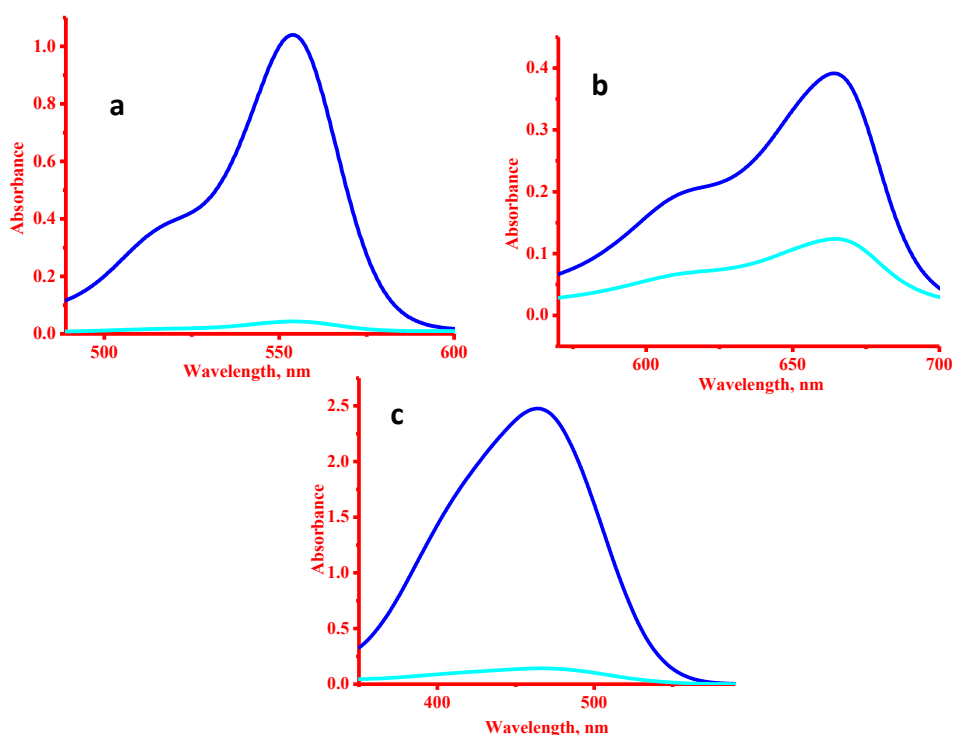


Figure 7. UV absorption spectra: (a) Rhodamine B, (b) methylene blue (cationic dye) and (c) methyl orange (anionic dye) before (above) and after (below) stirring.



Figure 8. Photograph of dye solution(a) Rhodamine B,(b) methylene blue,(c)methyl orange before (right) and after (left) stirring.

The adsorption of cationic (Rhodamine B, methylene blue) as well as anionic (methyl orange) dyes was confirmed by UV-VIS spectroscopic analysis. Rhodamine B, methylene blue, and methyl orange were almost completely adsorbed by silica nanospheres. The figure 7 and 8 shows UV-VIS spectra analysis and photographic observation of organic dyes before and after adsorption. As seen in organic adsorption, here also lipophilic part and hydrophilic part have major roles in removing organic dyes. In addition to this, electrostatic attraction plays an important role in adsorption. Both dyes are trapped in the cavities provided by the nanospheres also has a vital role in these studies. Silica was also seen to provide better room for cationic dyes due to negatively charged regions. All these results confirmed the effective adsorption of cationic and anionic dyes from water using dendrimer modified silica nanoparticles.

Effect of pH on organic dye adsorption

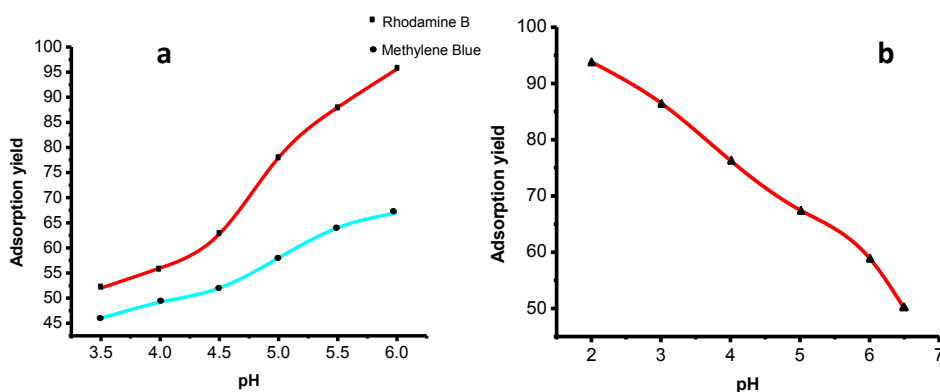


Figure 9. pH versus adsorption yield plot of organic dyes (a) Rhodamine B and methylene blue, (b) methyl orange

From the figure 9, rRRFA the adsorption yield of Rhodamine B and methylene blue increase with increasing pH. While in the case of methyl orange, the adsorption yield decreases with increasing pH. While the adsorption yield of rhodamine B and methylene blue increased up to 95% and 67%, methyl orange showed an adsorption yield of 93%. In the case of cationic dyes (Rhodamine B and methylene blue), at low pH all the amine group, carbonyl oxygen and silica are protonated, which decreased the capacity to bind positively charged dyes. The adsorption of anionic dye (methyl orange) at pH is high due to protonated amine and carbonyl group. As the pH increases, the number of protonated amine and carbonyl group decreases, so the inclusion of methyl orange is less.

Desorption study

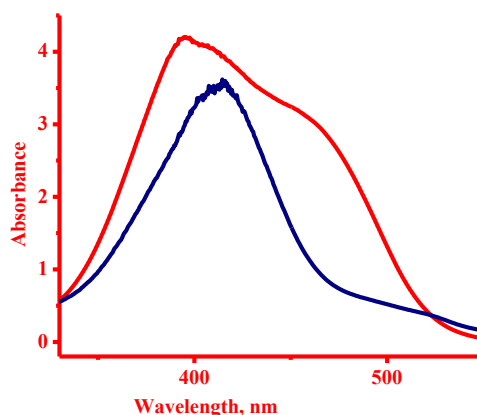


Figure 10. UV-VIS spectra of Cd²⁺ solution recovered from dendrimer modified silica nanoparticles at pH 2 after one hour (below) and overnight (above) stirring.

Desorption studies were done by overnight stirring of 50mg metal ion absorbed nanoparticles with 50ml of doubly distilled water at PH=2. After overnight stirring, the supernatant was analyzed by UV-VIS spectrometer. The figure 10 shows the UV-VIS spectra of before and after stirring. As seen in the figure, there is an increase in the absorbance value in the curve shown as above at 510 nm which is the wavelength of Cd-PAR complex, this means that the metal ions were released from the silica nanoparticle at pH 2 by overnight stirring. The metal ions were desorbed from the silica nanosystem as a result of the high acidic protons in the solution at low ph. This experiment also indicates that the dendrimer modified silica nanoparticles can be recovered successfully and reused.

Conclusion

Lower generation dendrimer templated silica nanoparticles were synthesized effectively by sol- gel method. This system was identified as effective material in water purification. The nanomaterials could effectively encapsulate several toxic metal ions, polycyclic aromatic hydrocarbons and organic dyes dissolved in water. The pH dependant study on the adsorption of organic dyes were done. The initial results suggest that the system can be effectively utilized for water purification. The designed system was recovered for reuse.

References

- [1] Butts, K.; H. *parameters*. Spring **1997**, 65.
- [2] Tchobanoglous, G.; Franklin, L. B. *Wastewater Engineering: Treatment, Disposal and Reuse*. **1991**.
- [3] Imran, A. *Chem. Rev.* **2012**, 5073
- [4] Laws, E.; A. *Aquatic Pollution :An Introductory Text*, **2000**.
- [5] Bayramoglu, G.; Arica, M. Y. *J. Hazard. Mater.* **2007**,144, 449.
- [6] Roza, A.; Michael, A.; Gerold H.; Dimitris T. *Water Research.* **2007** 41, 476.
- [7] Sudipta, R.; Apurba, K. D.; Arindam B. *Chem. Mater.* **2007**, 19, 1633.
- [8] Sigel, H.; Sigel, A. *Concepts of Metal Ion Toxicity*; Marcel Dekker, Inc.; New York, **1986**.
- [9] Damia, B.; *Ed Emerging Organic Pollutants in Waste Water and sludge*, Springer; **2005**.
- [10] Ali,I.; Khan, T. A.; Asim, M. *Sep. Pur. Rev.* **2011**, 40,25.
- [11] Gupta, V. K.; Saleh, T. A. *J. Colloids Interface Sci.* **2011**,362, 344.
- [12] Gupta, V. K.; Agarwal, S.; Saleh, T. A. *J. Hazard. Mater.* **2011**, 185, 17.
- [13] Lin, S. H.; Chen M. L. *Water Research.* **1997**, 31, 868.

- [14] Pacheco, S.; Tapia, J.; Medina, M.; Rodriguez, R.; *J. Non-Cryst. Solids.* **2006**, 352, 5475.
- [15] Skubul, L. R.; Meshkov, N. K.; Rajih, T.; Thurnaur, M. *J. Photochem. Photobiol. A.* **2002**, 148, 393.
- [16] Gao, Y.; Wahi, R.; Kan, A. T.; Falkner, J. C.; Colvin, V.L.; Tomson, M.B. *Langmuir.* **2004**, 20, 9585.
- [17] Wu, D.; Zheng, P.; Chang, P.R.; Ma, X. *Chem. Eng. T.* **2011**, 174, 489.
- [18] Stephen, I. B.; Chen, B. H. *Bioresour. Technol.* **2011**, 102, 8868.
- [19] Pena, M. E.; Koratis, G. P.; Patel, M.; Lippincot, L.; Meng, X. *Water Reaserch.* **2005**, 40, 2040.
- [20] Fréchet, J. M. J., Tomalia, D. A., *Dendrimers and Other Dendritic Polymers.* Eds.; Wiley Series in Polymer Science; John Wiley & Sons Ltd: Chichester and New York, **2001**.
- [21] Sideratou, Z.; Tsiourvas, D.; Paleos, C. M. *Langmuir***2000**, 16, 1766.
- [22] Dvornic, P.R.; De Leuze-Jallouli A.M.; Owen M. J.; Perz, S.V. *Macromolecules*, **2000**, 33, 5366.
- [23] Micheal, A.; Roza, A. Dimitris. T.; Eva, M. M.; Reinhard, P. *Environ. Sci. Technol.***2006**, 40, 2771.
- [24] Reetz, M. T.; Giebel, D. *Angew. Chem., Int. Ed.* **2000**, 39, 3604.
- [25] Boas, U.; Heegaard, P. M. H. *Chem. Soc. Rev.***2004**, 33, 43.
- [26] Mamadou, S.; Diallo, K. F.; James, H. J. Jr.; William, A. G.; *Environ. Sci. Technol.*, **2007**, 41, 6521.
- [27] Micheal, A.; Dimitris. T.; Constantinos, M. P. *Chem. Mater.***2005**, 17, 3439.
- [28] Chih-Chien C.; Norio U.; and Toyoko I. *Chem. Mater.* **2008**, 20, 2669.
- [29] Micheal, A.; Dimitris. T. *Journal Of Hazardous Materials.* **2009**, 170, 35.
- [30] Marc,R. K.; Sarah, L. S.; David, W.W. *Langmuir*, **2004**, 20, 4728.

A NOVEL BIOSYNTHESIS OF $Cd_xZn_{1-x}S$ NANOCOMPOSITES: STRUCTURAL AND OPTICAL PROPERTIES - ANTIBACTERIAL APPLICATION

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Abstract

The biological application of alloyed nanocomposites is very much interesting and increasingly recognised for their utility, especially in bio-nanomedicine. The present investigation is a bio-synthesis approach to the fabrication of $Cd_xZn_{1-x}S$ nanocomposites carried out using the extract of *Aloe Barbadensis*, *Cynodon Dactylon* and *Ajwain* leaves by Sonochemical synthesis in order to investigate as prepared and post treatment samples. The structural and optical properties were characterized by XRD, FESEM, DRS and PL spectrophotometric analysis. The XRD analysis shows that the synthesized $Cd_xZn_{1-x}S$ nanocomposites are of hexagonal structure with an average crystalline size of 8nm-47nm and at annealing temperature 500°C for 2h, it increases the crystallinity. The surface morphology was analysed from FESEM images and it confirms that the nanosheet was obtained. Optical absorption studies indicated that the E_g value for the as prepared samples lies around 1.5 eV to 2eV and for the post treatment samples the E_g value lies around 1.47eV to 1.90eV. Photoluminescence spectra were recorded for an excitation wavelength of around 400 nm. After the post treatment, the photon emission intensity increases and significantly enhances the absorption in the visible region. Green synthesised $Cd_xZn_{1-x}S$ nanocomposites exhibit excellent antibacterial properties and it is actively used for biomedical and food packaging applications.

In this work, two novel results were obtained

- Ternary compound can also be synthesized by the effective biosynthesis method.
- Cadmium Zinc Sulphide also has the best antibacterial activity.

Keywords: Biosynthesis, $Cd_xZn_{1-x}S$ nanocomposites, Sonochemical synthesis, Structure and Optical properties, Anti-bacterial activity.

1. Introduction

Current materials-science requires the creation of new, simple and low-cost ternary and quaternary semiconductor materials with controllable chemical and physical properties. The chalcogenides have received attention for their relatively easy ability to form binary, ternary and quaternary compounds. The physical and chemical properties of these compounds principally depend on their compositions [1].

The polycrystalline chalcogenide semiconductors play an important role in solar cell due to their favourable electrical and optical properties. Among the different ternary II-IV semiconductors, CdZnS is one such material which is important for the development of various modern technologies, which are used to produce solid state devices such as solar cells, light emitting diode, detector etc. This is because of its lattice matching with absorber materials and the presence of band gap in visible region [2, 3]. CdZnS nanomaterials have been widely used as window materials in hetero-junction solar cells [4] and photoconductive devices [5].

ZnCdS nanomaterials are group II-VI semiconductors, where these nanoparticles have been synthesized using various methods such as electro deposition, chemical bath deposition, successive ionic layer absorption and reaction (SILAR), metal organic chemical vapour deposition [6] and solid-state reaction [7]. Most of these methods are complicated and have drawbacks like the use of hazardous organic solvents, expensive reagent, toxic by-product, drastic reaction condition, difficulty in isolating nanoparticles, longer time etc. There arises a growing need to develop green synthesis routes for the particles. By following several principles of

green chemistry, new routes for the synthesis of nanoparticles using plant extracts and microorganism are given emphasis as compared to the commercial and traditional synthesis. The worldwide revolution in nanotechnology has predicted the impact on several areas of biotechnology, biomedical research and scientific and engineering applications. Nanoparticles are being used in drug delivery, cell imaging and cancer therapy and hence are part of important bio-medical applications of nanotechnology and nanobiotechnology [8].

No earlier studies report the use of biosynthesis method for the production of CdZnS nanocomposites. In the present study, CdZnS nanocomposites were prepared by a novel synthesis technique using leaf extract as a reducing agent and their applicability in the field of biological science have been studied. Detail characterisation and the effect of annealing on the properties of CdZnS nanocomposites have also been investigated. The work further investigates how CdZnS nanocomposites interact with antibacterial activity inducing bacteria such as *Escherichia coli*, *Micrococcus luteus* and *Staphylococcus aureus*.

2. Materials and Synthesis

2.1 Preparation of the extract

The leaves have been collected from our campus Manonmaniam Sundaranar University, India. Individual 100 g of green leaves of Aloe Barbadensis, Cynodon Dactylon and Ajwain have been collected. The obtained leaves were washed thoroughly in tap water and finally rinsed with de-ionised water until no foreign materials remain behind. After washing, the collected leaves were kept in 100 ml of de-ionised water

overnight and macerated. Then, it was finely crushed by the mortar and filtered by using cotton; finally, the extract was collected in a beaker.

2.2 Preparation of the Cd_xZn_{1-x}S Nanocomposites

All the reagents used for the reactions were analytical grade chemicals obtained from Himedia and used without further purification. Redistilled de-ionised water was used for the sample preparation.

For the preparation of Cd_xZn_{1-x}S nanocomposites, a solution of 0.1M CdCl₂ was prepared in 100 ml of de-ionised water, another solution of 0.9M ZnCl₂ was prepared in 100 ml de-ionised water and a third solution of 0.1M CS(NH₂)₂ was prepared in 100 ml de-ionised water. The solution of the above three solutions mixed together was stirred using magnetic stirrer under room temperature. In chemical synthesis, the NH₄ solution was used as a reducing agent. NH₄ solution was added drop wise into the above mixed solution and kept at ultrasonic bath for 30 min. The particles were collected and washed with distilled water, and with ethanol, twice for purification and the collected sample was dried in hot air oven at 100° C for 1 h. Finally, the dried samples were finely ground in the mortar to collect the nanocomposites. The same procedure was followed for the biosynthesis of Cd_xZn_{1-x}S nanocomposites. Instead of NH₄ solution, the leaf extracts were used as reducing agents. Various chemical compositions of Cd_xZn_{1-x}S nanocomposite samples are shown in table 1.

The effect of annealing at 500° C for 2h on the samples A3, B3, C3 and D3 are investigated.

2.3 Antibacterial Activity of CdZnS nanocomposites

The end products of the CdZnS nanocomposites were used to study the antibacterial activity against gram positive bacteria *Staphylococcus aureus* and *Micrococcus luteus* and also the gram-negative bacteria *Escherchia coli* with disc diffusion method by culturing the micro-organisms in Muller Hinton agar. The sterile discs were dipped into the synthesised CdZnS nanocomposites. After a few minutes of air drying, the dried discs were gently placed into the agar and incubated for 24h. After 24h incubation at 35° C, the zone of inhibition round the well of nanocomposites against bacteria, was observed.

3. Result and Discussion

3.1 XRD Analysis

The XRD crystallographic studies were made using Analytical XPERT PRO Diffractometer of wavelength 0.154 nm over 2θ range of 20°-80°. The analysis clearly indicated the effect of alloying on the crystalline quality of the synthesized nanocomposites. The XRD pattern of Fig. 1 confirmed the crystalline nature of the synthesized Cd_xZn_{1-x}S nanocomposites using three different leaves (Aloe Barbadensis, Cynodon Dactylon & Ajwain) and chemical synthesis.

Fig. 1(a) shows the XRD pattern of Cd_xZn_{1-x}S nanocomposites with three different contents; 'x=0.1M, 0.15M and 0.2M', using the chemical synthesis. The presence of sharp diffraction peaks at 2θ = 24.7⁰, 28.2⁰, 50.9⁰, 54.6⁰ and 60.9⁰ confirms the formation of Cd_xZn_{1-x}S nanocomposites. They are crystalline in nature with hexagonal structure. The observed peaks

matched well with the standard data (JCPDS Card no: 491302) and show the hexagonal structure. Moreover, there is no structural change when we increase the 'x' content. At the same time, some weak intensity peaks represent the ZnS nanoparticles.

Fig. 1(b, c & d) represents the XRD pattern of $\text{Cd}_{0.1}\text{Zn}_{0.9}\text{S}$, $\text{Cd}_{0.15}\text{Zn}_{0.85}\text{S}$ and $\text{Cd}_{0.2}\text{Zn}_{0.8}\text{S}$ nanocomposites, got by the biosynthesis of three different leaf extracts of $x=0.1\text{M}$, 0.15M and 0.2M , respectively. The observed peaks at $2\theta = 25.5^\circ$, 27.1° , 28.8° , 37.50° , 52.3° , and 55.7° in three XRD patterns confirm the crystalline nature of the CdZnS nanocomposites and possess hexagonal structure. The observed peaks match well with the standard data (JCPDS card no: 400836). From that we confirmed that by using leaf extract, CdZnS nanocomposites were formed.

From all XRD patterns of fig. 1 it is confirmed that the samples are originated from hexagonal structure, and that no phase transition occurred when we changed the leaf extract used as a reducing agent and also with the increase of $x=0.1\text{M}$, 0.15M and 0.2M in the compounds. Since there is no phase separation or separated nucleation of ZnS or CdS in the $\text{Cd}_x\text{Zn}_{1-x}\text{S}$ phase due to the changes occurred in the lattice parameters with the increase of 'x' content. This change is due to the Zn^{2+} incorporated in the CdS lattice entering the lattice and/or interstitial sites because of the smaller radius of Zn^{2+} ion (0.74\AA), compared with that of Cd^{2+} (0.97\AA) [5,9]. The $\text{Cd}_{0.2}\text{Zn}_{0.8}\text{S}$ nanocomposite exhibits the improved crystalline quality than the intermediate and lower $\text{Cd}_x\text{Zn}_{1-x}\text{S}$ nanocomposites. The grain size of the nanocrystalline $\text{Cd}_x\text{Zn}_{1-x}\text{S}$ compound is estimated by the Debye Scherer's formula [3, 6] and summarized in table 2.

$$D_{hkl} = \frac{K\lambda}{\beta \cos\theta}$$

where, D_{hkl} is the mean grain size of the ordered (crystalline) domains, K is a dimensionless shape factor (0.94), λ is the wavelength of the X-ray, β is the line broadening at half the maximum intensity (FWHM), and θ is the Bragg's angle.

The micro structural parameters such as Dislocation density (δ) and Micro strain (ϵ) of Cd_xZn_{1-x}S nanocomposites have been calculated using the following relations [6] and their values are summarized in table 2.

$$\text{Dislocation density } (\delta) = 1/ D^2$$

$$\text{Micro Strain } (\epsilon) = \frac{(\beta \cos\theta)}{4}$$

Fig. 2(a) shows the XRD pattern of chemically synthesised Cd_{0.2}Zn_{0.8}S nanocomposites annealed at 500°C for 2h. The observed peaks are at $2\theta = 28.33^\circ, 30.32^\circ, 39.36^\circ, 47.33^\circ, 51.46^\circ, 55.22^\circ, 55.99^\circ, 58.63^\circ, 63.14^\circ, 65.59^\circ$ and they match well with the standard data (JCPDS card no: 24-1136) of hexagonal phase of CdZnS nanocomposites. The peak intensity of hexagonal CdZnS has improved and this indicates that the CdZnS nanocomposites is well crystallized [3], which means that longer annealing temperature leads to better crystallization.

Fig. 2(b) shows the XRD pattern of Cd_{0.2}Zn_{0.8}S nanocomposites prepared using the three different leaf extracts (Aloe Barbadensis, Cynodon Dactylon & Ajwain) and annealed at 500°C for 2h. The presence of diffraction peaks is at $2\theta = 24.9^\circ, 28.2^\circ, 36.7^\circ, 43.8^\circ, 47.9^\circ$,

51.0⁰, 54.7⁰, 58.4⁰, 60.9⁰ and it matches well with the standard data (JCPDS card no: 491302). The strong diffraction peaks indicate that all samples showed good crystalline structure and that annealing improved the crystallinity of the CdZnS nanocomposites. A similar feature was reported that by increasing the annealing time, it tends to increase in intensity and form better crystallized structure (Yi Feng Chai et al., 2014) [10].

The hexagonal phase remains stable in annealed CdZnS nanocomposites. Moreover, ZnS peaks are still present in the annealed CdZnS nanocomposites and it reveals that CdZnS formation is incomplete or that Zn content is dominant.

The FWHM of the plane (1 0 1) decreases with increase in annealed temperature. But at longer annealing time, strains have enough energy to combine together to form large grains, which leads to the decrease of the FWHM of (1 0 1) plane. Moreover, the decrease in FWHM and the increase in the crystalline size at annealed temperature indicate improved packing density and better crystallinity. Therefore, we conclude that the FWHM of XRD depends on the crystalline quality of each grain size and the distribution of grain orientation.

The average crystalline size, micro strain and dislocation density are calculated using the relation and summarized in table 3. The average crystalline size increases at annealing temperature. The observed features indicate that CdZnS is polycrystalline in nature and possess hexagonal structure.

So far from the XRD analysis, we conclude that by increasing the concentration of 'x= 0.1M, 0.15M and 0.2M' content for chemical as well as

three different leaf extracts, the hexagonal phases of CdZnS nanocomposites were formed, the intensity of peaks also increased and the grain size was found to be decreasing. Moreover, in fig. 2, the sample (S1-S4) annealed at 500°C for 2h indicate that the hexagonal phase of CdZnS nanocomposites is well crystallized and increases in crystalline size.

3.2 Fesem Analysis

The surface morphology of Cd_xZn_{1-x}S nanocomposites are studied using Field Emission Scanning Electron Microscope (FESEM) – Supra 55.8

Fig 3(a) shows the FESEM images of sample A3. The general surface morphology shows that the particles are in cluster form under 1 µm magnification. A closer look at the micrograph shows that the cluster exhibited a needle like shape.

Fig 3(b) shows the FESEM images of sample B3. It shows that the size and the shape of the Cd_xZn_{1-x}S nanocomposites are in platelet like aggregate. The aggregate of the surface originated from the high surface energy of nanoparticles. Such an aggregation makes it difficult to evaluate the grain size from FESEM images. Fig 3 (c) shows the FESEM images of annealed sample S2. After the post treatment, it shows the sheet like structure. The surface of the nanosheet is smooth and its length and thickness are measured in several nanometers.

Fig 3(d) shows the FESEM images of sample C3. It shows that the composites are in the form of a cluster, and hence the grain size could not be determined. This implies that the growth of the composite is mostly

considered to be the result of surface agglomeration of colloidal particles (cluster by cluster growth).

Fig. 3(e) shows the FESEM images of sample S3. It reveals that the synthesised nanocomposites were fluffy. The larger particles exhibit numerous spherical perturbances on the surface suggesting that they are formed through fusion of much smaller particles. From this we conclude that the as prepared $Cd_xZn_{1-x}S$ nanocomposites are in cluster form, but after annealing, the sample transforms into spherical shape.

3.3 DRS Analysis

The light absorption properties of semiconducting materials are characterized using Cary 300 UV-Vis Diffuse Reflectance Spectrophotometer. The reflectance spectra are recorded in the wavelength region of 200-900 nm and the measurements are carried out under room temperature. The absorption spectra for as prepared samples A3, B3, C3, D3 and annealed samples S1, S2, S3, S4 are shown in figures.

Fig. 4 (a) shows that the absorption band edges for the as prepared and annealed $Cd_{0.2}Zn_{0.8}S$ nanocomposites by chemical synthesis. It can be seen that as prepared $Cd_{0.2}Zn_{0.8}S$ exhibits an absorption range from 340-520 nm. The absorption edge of annealed $Cd_{0.2}Zn_{0.8}S$ falls into the visible region at the wavelength of 380-540 nm and is shown in fig. 4(a). $Cd_{0.2}Zn_{0.8}S$ is systematically red shifted to higher wavelength from 340 to 380 nm after the post treatment, which indicates that the absorption edge of those nanocomposites can be varied towards UV to the visible, this shift suggests an increase in the particle size. The energy bandgap was determined from the $(\alpha h\nu)^2$ versus $h\nu$ plots where the interception of

linear portion onto the energy axis gives the energy band gap of the material [3,6,11,12]. Fig. 4(b) shows the linear variation of band gap of as prepared and annealed Cd_{0.2}Zn_{0.8}S nanocomposites. It is clear that, the optical band gap of Cd_{0.2}Zn_{0.8}S nanocomposites decreases from 2.01 eV to 1.75 eV when the temperature increases [1].

Fig. 4(c) shows the optical absorption spectra versus wavelength of Cd_{0.2}Zn_{0.8}S nanocomposites for as prepared (B3) and annealed sample (S2) by using Aloe Barbadensis. It can be seen that the absorption increases at a shorter wavelength, below 500 nm. The fast increase below 500 nm is due to the absorption of light caused by the excitation of electrons from the valence band to the conduction band. However, the as prepared sample shows higher absorption than the annealed one. From fig. 4(d), the obtained optical band gap of sample B3 and S2 are 1.51 eV and 1.47 eV, respectively.

Fig. 4(e) shows the absorption spectra of Cd_{0.2}Zn_{0.8}S nanocomposites for sample C3 and S3 by using Cynodon Dactylon. For as prepared Cd_{0.2}Zn_{0.8}S, the broad peak was located between 390 nm – 470 nm and the strong absorbance peak at 670 nm. The broadening of the peak is due to the quantum confinement effect, occurred during the size reduction of nanoparticles. (Chelladurai et al., 2013) [13]. After the post treatment, Cd_{0.2}Zn_{0.8}S nanocomposites have a wide band of absorbance within the visible region wavelength of around 405 nm-810 nm. From fig. 4(f), we observe that the band gap is decreasing from 1.80 eV to 1.74 eV due to annealing [1].

From fig. 4(g), we observed the absorbance spectra for the sample D3 and S4. In as prepared sample (D3), the broad absorbance peak

occurred within the wavelength range 350 nm-442 nm and the strong absorbance peak was around 670 nm. For the annealed sample (S4), the wide band of absorbance occurred in the range of 387 nm-850 nm. In fig. 4(h), the optical band gap of Cd_{0.2}Zn_{0.8}S nanocomposites decreases from 1.88 eV to 1.76 eV when the temperature is increased [1].

For all the samples having band gaps less than or equal to 2.0 eV, it suggests that the samples can absorb solar light in the visible to near IR region more efficiently [14].

XRD results clearly demonstrate that, the crystalline size of Cd_{0.2}Zn_{0.8}S nanocomposites has increased due to heating rate. The observed band gap energy decreases from DRS, is in agreement with the XRD results of increasing crystalline size.

3.4 Photoluminescence Analysis

The Photoluminescence technique has been widely used to investigate the energy levels of materials. PL spectra of as prepared and annealed CdZnS nanoparticles were measured using an excitation wavelength of 400 nm in the range of 200 to 900 nm by PERKIN ELMERLS 45.

Fig. 5 (a & b) shows the excitation and emission spectra of as prepared samples A3, B3, C3, D3 and annealed samples S1, S2, S3, S4. In the excitation spectra, an intense peak was observed at the wavelength of 400 nm. By using the excitation wavelength of (400 nm), the corresponding emission was recorded. In the emission spectra three emission peaks (one strong and two weak) peaks appear at 390 nm, 520 nm and 790 nm in visible region, which are equivalent to 3.17 eV, 2.38 eV and 1.56 eV respectively.

A strong emission was observed with its peak position centred at 390 nm; it may be attributed to the transition of electrons from the shallow state near the conduction to sulphur vacancies in the valence band [15] and it may also be assigned to free-exciton recombination [16]. Salavat Niasari et.al., assigned a peak at ~ 3.15 eV to sulphur vacancies [3,17].

The green emission at about 520 nm (2.38 eV) corresponds to the transition from the conduction band to the sulphur vacancies level [16]. The PL spectra of all the samples show a two weak shoulder peak at around 520 nm and 790 nm. The origin of this shoulder at lower energy (2.38 eV and 1.56 eV) compared to the main peak can be attributed to the recombination of electron-hole-pair at the surface traps [18]. Comparison of as prepared and annealed sample, showed that the peak intensity of 390 nm, 520 nm and 790 nm increases due to annealing effect.

On annealing, the samples become sulphur deficient because sulphur is volatile and might dissociate from CdS at higher temperature [3]. However, there is no significant change in the emission peak position. The PL enhancement is due to an increase in the crystallinity of the sample. Moreover, the XRD data are in consistent with PL data, which showed that PL intensity for the annealed sample is high compared to that of as prepared sample and is shown in fig 5.

3.5 Antibacterial Activity Analysis

The synthesized CdZnS nanocomposites were further subjected to study, for the antibacterial activity against skin infection pathogens such as *E. Coli*, *S. Aureus* and *M. Luterus* by disc diffusion method.

Fig. 6 shows the results of the antibacterial activity of the CdZnS nanocomposites for the chemically synthesized sample A3, S1 and the biosynthesised sample C3, S3, by using Cynodon Dactylon leaf extract. It is done along with positive and negative control antibiotic gentamycin against the three selected bacteria *E. Coli*, *S. Aureus* and *M. Luterus*. For the chemically synthesised as prepared sample, the Microbe-Mediated CdZnS nanocomposites had the maximum zone of inhibition against disease causing *S. Aureus*. The minimum zone of inhibition was observed against *M. Luterus* and *E. Coli*. For the biosynthesised as prepared sample, it has been observed from the data that, as compared to positive control antibiotic gentamycin shows less zone inhibition than the negative control antibiotic gentamycin. Gram negative bacteria showed more inhibition zone than the gram-positive bacteria due to the cell wall nature of the bacteria.

In both cases, for the annealed sample no zone formation occurred due to the fact that the smaller size nanocomposites having large surface area, available for interaction, would give more bactericidal effect than the larger size nanocomposites. The structure of the cell wall difference between the gram-positive and gram-negative bacteria plays a role in the formation of the zone [19].

In gram-positive bacteria, the cell wall consists of a deep layer membrane, comprising of linear polysaccharide chains. And the gram-negative bacteria possess a slender layer of membrane [19]. The formation zone was clearly observed around the disc of chemical as well as biosynthesised as prepared CdZnS nanocomposites, including clearly

moved antibacterial materials of CdZnS nanocomposites. The measured values of the zone are shown in table 4.

The antibacterial effects of stabilised CdO nanoparticles can be helpful in the treatment of infectious disease caused by *E. Coli*. Shukla et al. [13] reported that microbes transmit a positive charge. This creates an “electromagnetic” attraction between the microorganisms and the treated cell outer membrane [19]. The present study demonstrates that CdZnS nanocomposites have bacterial activity against the entire test organism. Since it is easily available, it is used in hospitals as a biomedical agent; the energetic nano compound can be prepared from this and used effectively for preventing the growth of microbial pathogens.

4. Conclusion

In conclusion, we have successfully synthesised Cd_xZn_{1-x}S nanocomposites using chemical as well as biosynthesis method. The synthesised Cd_xZn_{1-x}S nanocomposites were characterised by using XRD, FESEM, DRS and PL spectrophotometer. The XRD patterns confirm the hexagonal crystalline structure of Cd_xZn_{1-x}S nanocomposites. The morphology of the nanocomposites observed using FESEM reveals that sheet and spherical perturbances were formed. From DRS analysis, all the samples showed an absorption in the visible region and a reduction of the band gap energy was observed for annealed samples. The PL emission at 390 nm, 520 nm and 790 nm corresponds to band gap energies of 3.17 eV, 2.38 eV and 1.56 eV respectively. And the synthesised nanocomposite has potential antibacterial activity against clinical isolates. The antibacterial activity further indicates the enhancement of antimicrobial effect of the as

prepared nanocomposites than the annealed nanocomposites against the *E. Coli*, *M. Luterus* and *S. Aureus*. The biosynthesis of nanoparticles is used in biomedical and food packing fields. This is an inexpensive procedure and eco-friendly process to produce ternary nanocomposites.

References

- [1] Sandra Andrea Mayen-Hernandez, David Santos-Cruz, Francisco de Moure-Flores et al., *Inter. Journal of Photoenergy*. Volume (2014), Article ID 158782, 8 pages.
- [2] D. Patidar, N. Saxena, Kananbala Sharma, T.P. Sharma. *Optoelectronics and Advanced Materials – Rapid Communications* Vol. 1. No. 7, July (2007), pp. 329-332.
- [3] A. AbdolazadehZiabari, F.E. Ghodsi. *Mat. Science in Semiconductor Processing* 16 (2013) 1629-1636.
- [4] A. Sakly, N. Safta, A. Mejri, H. Mejri, A. Ben Lamine. *Journal of Nanomaterials*. Vol. 2010, Article ID 746520, 4 pages.
- [5] SomayehAzizi, Hamid RezagholipourDizaji, Mohammad HosseinEhsani, Syed FeyzolahGhavamiMirmahalle. *Surface Review and Letters*, Vol. 21, No. 5 (2014) 1450073, 7 pages.
- [6] Jamal. F. Mohammad and Hameed. S. Al-Jumaili. *Int. Journal of Application or Innovation in Engineering & Management (IJAIEM)*. Vol. 3, No. 5, May (2014), pp. 204-210.
- [7] Jin Mu, DanyingGu, XiaofangGu. *Journal of Dispersion Science and Technology*, 26:2, 193-195.
- [8] H. Harikrishnan, K. Shine, K. Ponmurugan, I.G. Moorthy. *Journal of Optoelectronics and Biomedical Materials*. Vol. 6 Issue 1, Jan – Mar (2014) pp. 1-7.
- [9] K. Nagamani, M.V. Reddy, Y. Lingappa, K.T. Ramakrishna Reddy, R.W. Miles. *Int. journal of Optoelectronic Engineering* 2012, 2(2): 1-4.

- [10] Yi-Feng Chai, Ling-Ling Wang, Gui-Fang Huang, Wei-Qing Huang, Yan-Hua Zhu. *Journal of Nanomaterials*. Volume (2014), Article ID 307687, 6 pages.
- [11] LenyYuliaty, Melody Kimi, MustaffaShamsuddin. *Beilstein Journal of Nanotechnology* (2014), 5, 587-595.
- [12] Jun Young Chol, Kang-Jin Kim, Ji- BeomYoo, Donghwan Kim. *Solar Energy* Vol. 64, Nos 1-3, (1998), pp. 41-47.
- [13] ChelladuraiMalarkodi, GurusamyAnnadurai. *Appl. Nanosci.* (2013) 3: 389-395.
- [14] Chen-I Wang, Zusing Yang, Arun Prakash Periasamy, Huan-Tsung Chang. *Journal of Materials*. Vol. (2013), Article ID 703985, 7 pages.
- [15] K. Ashwini, C. Pandurangappa, B.M. Nagabhushana. *PhysicaScripta* 85 (2012) 065706, pp. 5.
- [16] NeslihanUzar, M. Cetin Arikan. *Bull. Mater. Sci.*, Vol. 34, No. 2, April (2011), pp. 287- 292.
- [17] M. Salavati – Niasari, M.R. Loghman – Estarki, F. Davar. *Inorg. Chim. Acta* 362 (2009) 3677-3683.
- [18] Senapati U.S, Jha D.K, Sarkar D. *Research Journal of Chemical Sciences*. Vol. 5(1), 33-40, January (2015).
- [19] S. Rajeshkumar, M. Ponnanikajamaideen, C. Malarkodi, M. Malini, G. Annadurai. *J NanostructChem* (2014) 4: 96.

Table 1. Sample composition of Cd_xZn_{1-x}S nanocomposites

Reducing agent	Sample code	CdCl ₂ (M)	ZnCl ₂ (M)	CH ₄ N ₂ S (M)	Sample code for annealed at 500°C, 2h
Ammonia	A1	0.1M	0.9M	0.1M	—
	A2	0.15M	0.85M	0.15M	—
	A3	0.2M	0.8M	0.2M	S1
Aloe Barbadensis	B1	0.1M	0.9M	0.1M	—
	B2	0.15M	0.85M	0.15M	—
	B3	0.2M	0.8M	0.2M	S2
CynodonDactylon	C1	0.1M	0.9M	0.1M	—
	C2	0.15M	0.85M	0.15M	—
	C3	0.2M	0.8M	0.2M	S3
Ajwain	D1	0.1M	0.9M	0.1M	—
	D2	0.15M	0.85M	0.15M	—
	D3	0.2M	0.8M	0.2M	S4

Table 2. Structural parameters of nanocrystallineCd_xZn_{1-x}S nanocomposites

Reducing agent	Sample code	Crystalline size (nm)	Dislocation Density (δ) (x 10 ¹⁴ lines/m ²)	Micro Strain (ε)
Ammonia	A1	47.33	4.464	0.0007
	A2	33.60	8.857	0.0011
	A3	20.42	23.98	0.0016
Aloe Barbadensis	B1	40.90	5.977	0.0008
	B2	28.09	12.67	0.0016
	B3	12.54	63.59	0.0027
Cynodon Dactylon	C1	77.36	1.670	0.0005
	C2	46.94	4.538	0.0009
	C3	8.36	142.9	0.0041
Ajwain	D1	37.40	7.149	0.0018
	D2	26.44	14.30	0.0019
	D3	16.70	35.85	0.0020

Table 3. Structural parameters of Cd_xZn_{1-x}S nanocomposites annealed at 500° C for 2h

Reducing agent	Sample code	Crystalline size (nm)	Dislocation Density (δ) (x 10 ¹⁴ lines/m ²)	Micro Strain (ε)
Ammonia	S1	41.30	5.861	0.0025
Aloe Barbadensis	S2	82.00	1.487	0.0050
Cynodon Dactylon	S3	60.50	2.732	0.0060
Ajwain	S4	50.90	3.859	0.0070

Table 4. Antibacterial Activity data for the Cd_xZn_{1-x}S nanocomposites

Type of Bacteria	Bacterial Name	Zone Inhibition			
		A3		C3	
Gram Negative	<i>Escherchia Coli</i>	0.1 mm		0.4 mm	
Gram Positive	<i>Micrococcus Luterus</i>	0.1	mm	0.3	mm
	<i>StapylococcusAureus</i>	0.2	mm	0.2	mm

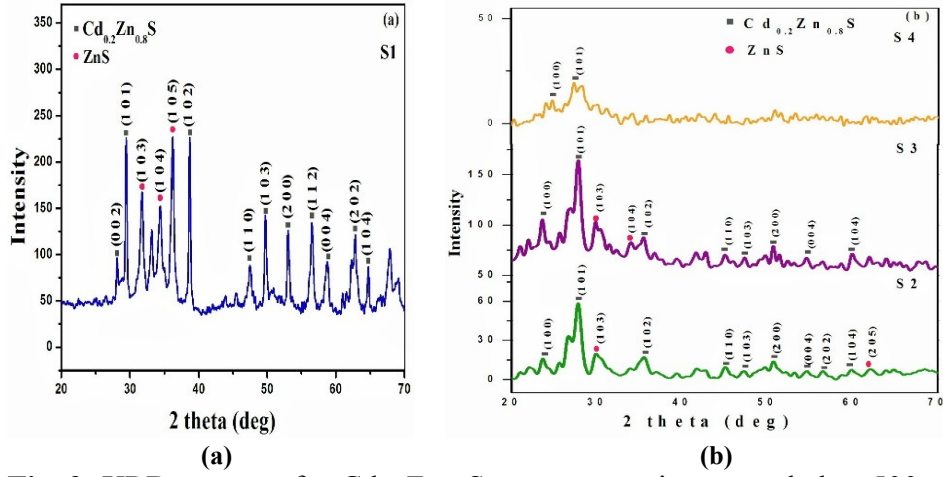


Fig. 2 XRD patterns for Cd_{0.2}Zn_{0.8}S nanocomposites annealed at 500° C for 2h (a) chemical synthesis (b) bio synthesis

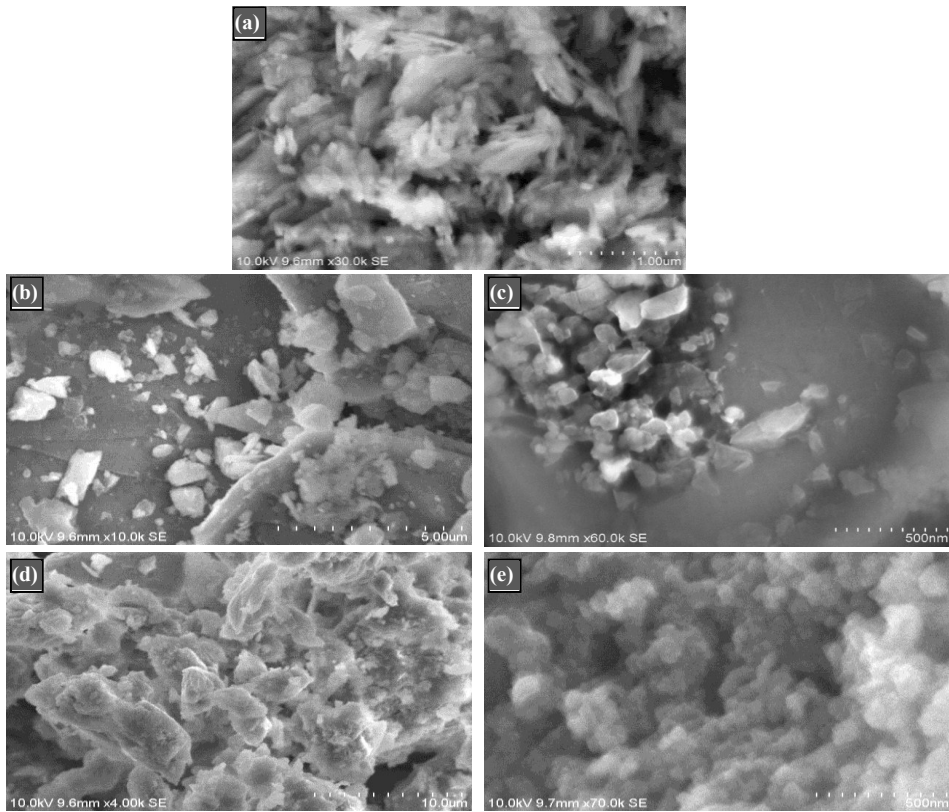


Fig. 3 FESEM micrograph of (a) sample (A3), (b) sample (B3), (c) sample (S2), (d) sample (C3) and (e) sample (S3)

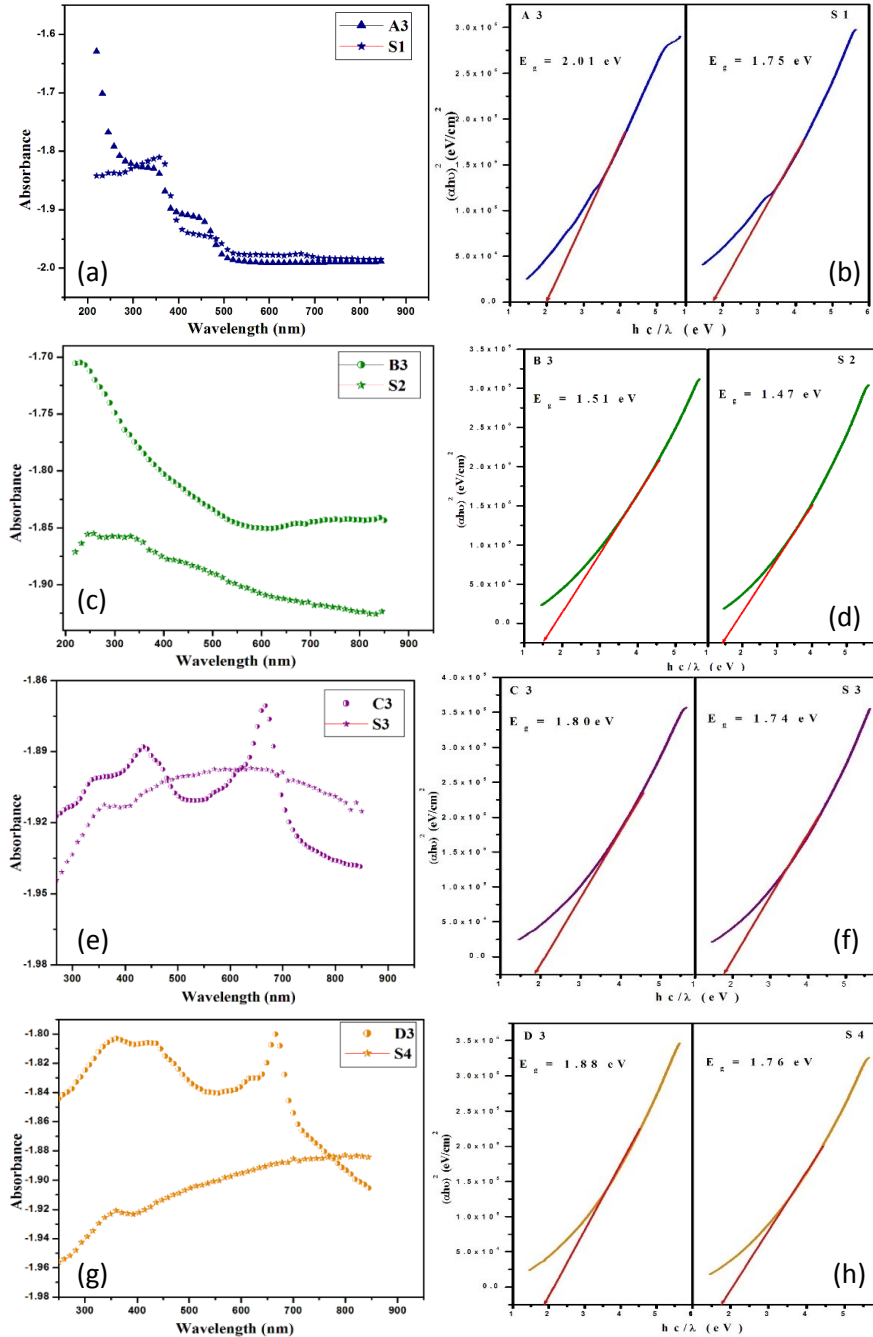


Fig. 4 (a, c, e, g) Absorbance spectra, (b, d, f, h) Energy band gap of as prepared A3, B3, C3, D3 and annealed $Cd_{0.2}Zn_{0.8}S$ nanocomposites S1, S2, S3, S4

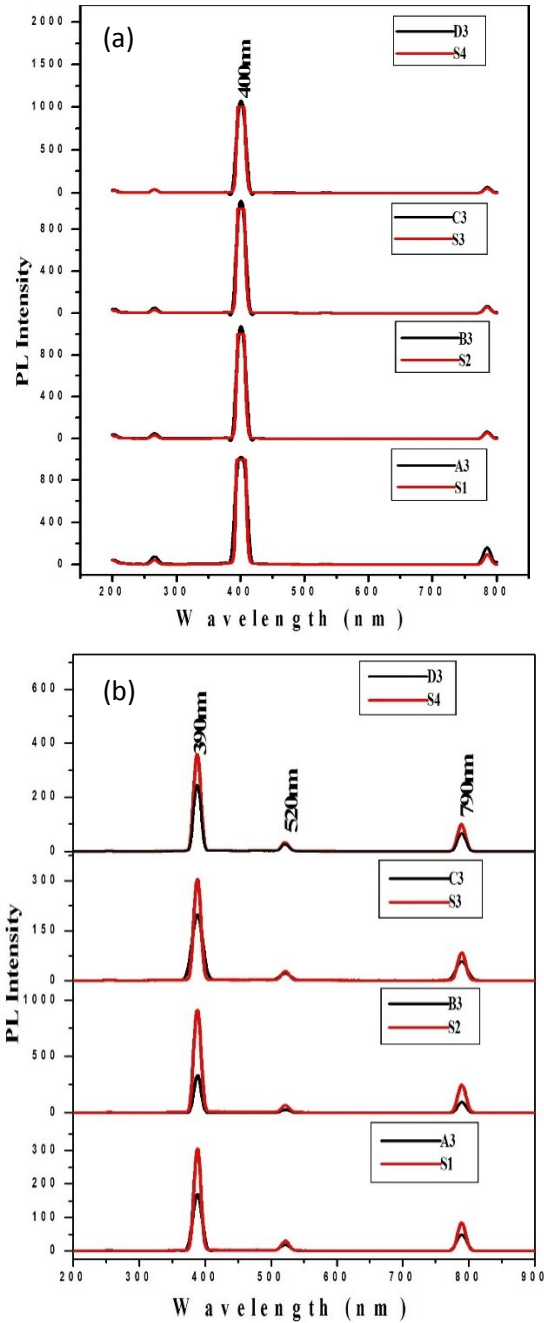
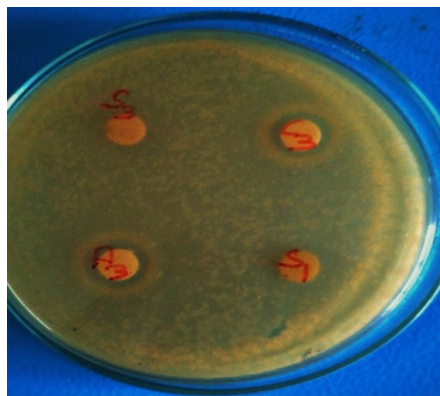
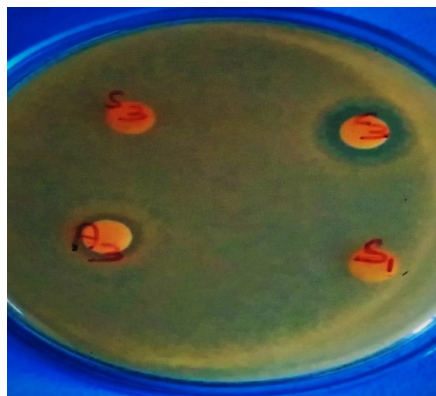


Fig. 5 (a) Excitation, (b) Emission spectra of as prepared and annealed Cd_{0.2}Zn_{0.8}S nanocomposites



(a) *Micrococcus luteus*



(b) *Escherichia coli*



(c) *Staphylococcus Aureus*

Fig. 6 (a, b & c) shows the antibacterial activity against the $Cd_xZn_{1-x}S$ nanocomposites

SEAWEEDS AND THEIR IMPORTANT BIOACTIVE PHYTO-CONSTITUENTS

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Abstract

Seaweeds are one of the most important living resources of the ocean and form the largest producers of biomass in the marine environment. They produce a wide variety of chemically active metabolites in their surroundings, potentially as an aid to protect themselves against the other settling organisms. These biogenic molecules render the uniqueness of chemical diversity in them compared to other plants. These distinctive compounds owe them a multitude of medicinal properties.

Keywords: *Seaweeds, chemical diversity, phyco-colloids, pigments, poly phenols, medicinal properties*

Introduction

Seaweeds or marine macro algae are non-flowering plants occurring in the sea, estuaries and backwaters and most of them are attached to rocks by holdfast and also grow on other plants as epiphytes. Seaweeds are really not weeds but form one of the important living resources of the ocean, having economical and commercial importance. They are the crucial primary producers in oceanic food web and hence are considered as a highly productive and dynamic ecosystem. Seaweed vegetation provides an ideal habitat, shelter to various marine animals and act as breeding, nursery and feeding grounds for many epiphytic faunas.

Moreover, the hapteron or holdfast of marine algae binds the sediments together and prevents coastal erosion.

Seaweeds have been known to produce compounds with interesting biological and pharmaceutical properties. For centuries, many of the seaweed secondary metabolites (SSM) have been used for traditional medicines due to their therapeutic potentials (Fitton *et al.*, 2006). Seaweeds are among the first marine organisms chemically analyzed, with more than 3,600 articles published describing 3,300 secondary metabolites, and they still remain an almost endless source of new bioactive compounds. Among macro algae, brown and red algae are significantly richer in secondary metabolites, with the latter being the top producers of halogenated metabolites. Biological compounds extracted from seaweed families namely Phaeophyceae, Rhodophyceae and Chlorophyceae were proven to have potential medicinal activities such as antioxidant, anti-inflammatory, antibacterial, antiviral, anticoagulant and apoptotic activity (Chathurvedi *et al.*, 2011).

Chemical diversity of seaweeds

Seaweeds produce a wide variety of chemically active metabolites in their surroundings, potentially as an aid to protect themselves against the other settling organisms. These active metabolites also known as biogenic compounds, such as halogenated compounds, alkaloids, pigments, aldehydes and terpenoids are produced by several species of marine macroalgae which were reported to have so many biological activities. As such, edible seaweeds may be the only relevant dietary source of some of these factors. Production of these secondary metabolites can vary in a

number of forms: seasonal, within species, within populations, within thallus or even geographically.

Phycocolloids

Seaweeds are known for synthesizing some phycocolloids and they form the only source for the production of phytochemicals like agar, carrageenan and algin. Agar is extracted from red algae such as *Gelidiella*, *Gracilaria*, and *Pterocladia*. Some other red algae viz. *Eucheuma*, *Chondrus*, *Hypnea* and *Gigartina* are used for the manufacture of carrageenan. Algin is extracted from species of *Sargassum*, *Turbinaria*, *Laminaria*, *Undaria*, *Macrocystis* and *Ascophyllum*. These phycocolloids are used as gelling, stabilizing and thickening agents in food, confectionary, pharmaceutical, dairy, textiles, paper, paint, varnish industries etc.

Agar is widely used in paper manufacturing, culture media, packaging material, photography, leather industry, plywood manufacturing, preservation of foodstuffs, dairy industry, cosmetics industry and pharmaceutical industry. Carrageenan is employed in food industry. Its value in the manufacture of sausages, corned beef, meat balls, ham, preparations of poultry and fish, chocolates, dessert gels, ice creams, juice concentrates, marmalade, sardine sauces is well known. It is also used in the manufacturing of non-food items like beer, air fresheners, textiles, toothpastes, hair shampoos, tissues, culture media, fungicides, etc. The applications of alginate find place in frozen foods, pastry fillings, syrups, bakery icings, dry mixes, meringues, frozen desserts, instant puddings, cooked puddings, chiffons, pie and pastry fillings, dessert gels, fabricated foods, salad dressings, meat and flavour sauces.

Polysaccharides

During the last decade, numerous bioactive polysaccharides with interesting functional properties have been discovered from seaweeds. Several algal species belonging to phaeophyta, rhodophyta and chlorophyta divisions have been recognized as crucial sources of sulfated polysaccharides. Seaweeds contain many different polysaccharides and their chemical structure is related to the corresponding taxonomic classification of algae and their cell structure. The contents of polysaccharides show seasonal variations and the total amount of these compounds in seaweeds is about 76% of dry weight (Holdt and Kraan, 2011).

Among many different algal polysaccharides, the most important are galactans, fucoidan, laminarin and alginates (Ferreira *et al.*, 2012). Fucoidan is a sulfated polysaccharide found in brown seaweeds. The macromolecule contains α -1,3-linked sulphated L-fucose as main sugar unit and sulfate ester groups (Song *et al.*, 2012; Synytsya *et al.*, 2010). The amount of fucoidan in algae is about 10% of dry mass. It has anti-inflammatory, antiviral, anti-tumor and antioxidative activities (Song *et al.*, 2012; Synytsya *et al.*, 2010). Antiviral properties of fucoidan participate in the inhibition of viral-induced syncytium formation.

Laminarin is another major polysaccharides found in brown algae. It has a chemical structure consisting of β -(1 \rightarrow 3)-linked glucose in the main chain and random β -(1 \rightarrow 6)-linked side-chains. The content of laminarin in seaweeds is about 10% of dry weight, but seasonally it can reach up to 32% (Holdt and Kraan, 2011). Laminarin is a dietary fibre and

can act as a prebiotic, it also has antiviral and antibacterial properties (O'Doherty *et al.*, 2010). Alginates are seen in plenty in brown seaweeds and constitute up to 47% of dry biomass whereas they are absent in terrestrial plants. Alginates extracted from seaweeds have shown strong antibacterial and anti-inflammatory activities.

Ulvan is the major water soluble, sulfated polysaccharide, extracted from the cell wall of green algae, viz. *Ulva*, *Enteromorpha*, *Monostroma*, *Caulerpa*, *Codium* and *Gayralia*. Ulvans are composed of disaccharide repetition moieties made up of sulfated rhamnose linked to either glucuronic acid, iduronic acid, or xylose and represent about 8–29 % of the algal dry weight (Lahaye, 1991; Robic *et al.*, 2009).

Pigments

Seaweed pigments can be divided into three major groups: chlorophylls, carotenoids and phycobiliproteins. Carotenoids are organic pigments present in chloroplasts and chromoplasts (Wijesinghe and Jeon, 2012). Different species of algae contain different kinds of carotenoids, which are very strong antioxidants. The most important carotenoids are β -carotene, fucoxanthin and tocopherol. The content of β -carotene in algal dry mass ranges from 36 to 4500 mg/kg.

Polyphenols

Seaweed extracts contain appreciable amounts of polyphenols, but its quantity is strongly dependent on the extraction method. *Ascophyllum* sp. has significantly more polyphenols than other seaweeds, whereas *Ulva* sp. has the lowest content of (Keyrouz *et al.*, 2011; Craige, 2011).

Phlorotannins are a group of tannin compounds, which belong to the polyphenolic compounds found in marine algae. Although tannins are widespread among terrestrial and marine plants, phlorotannins like eckol or dieckol, have been found only in brown seaweeds (Antonisamy and Raj, 2011; Gupta and Abu-Ghannam, 2011). Phlorotannins are formed by the polymerization of phloroglucinol through the acetate-malonate pathway.

Phlorotannin content varies from 1 to 10% of the total algal dry mass (Swanson and Druehl, 2002). The molecular skeleton of phlorotannins consists of 8 phenol rings, while tannins from terrestrial plants have only 3 to 4 rings. Phenol rings act as electron traps for free radicals and this unique structure accounts for their high antioxidant activity. Phlorotannins isolated from *Eisenia bicyclis* have shown even 10 times higher antioxidant activity in comparison with ascorbic acid and α -tocopherol (Gupta and Abu-Ghannam, 2011). Apart from this phlorotannins can also attack microbiological proteins, which result in the inhibition of bacteria (Gupta, and Abu-Ghannam, 2011).

Hormones

Growth hormones found in seaweed extracts are mainly responsible for the growth stimulation and the increase in the intensity of photosynthesis. Cytokinins (plant growth regulators) protect plants from the consequences of temperature changes. They are synthesized by biochemical modification of adenine. Within this group of hormones, zetaine and indole-3-propionic acid (IPA) are the main compounds identified in seaweed extracts (Stirk and Van Staden, 1997). Other plant

hormones present in seaweed extracts are auxins synthesized from tryptophan or indole. They are shown to initiate root formation and inhibit its elongation. The concentrations of auxins in seaweed extracts are different and strongly depended on the species. Some authors reported their presence in the extract of *Ascophyllum nodosum* at a concentration of 50 mg IAA /g of dry mass (IAA - indole-3-acetic acid) (Khan, *et al.*, 2009). Other researchers have also shown the presence of IAA in the extracts of *Porphyra perforata*, *Botryocladia* spp and *Enteromorpha* sp. (Khan *et al.*, 2009).

Among plant hormones, gibberellins were also isolated from seaweed extracts. They are produced in developing seeds from glyceraldehydes-3-phosphate. Gibberellins were identified in extracts from *Fucus vesiculosus* and *Fucus spiralis* (Tarakhovskaya, 2007). Trace quantities of these compounds were also detected in extract from *Ascophyllum nodosum* (Craige, 2011). The main role of gibberellins is to initiate seeds germination. Abscisic acid (ABA) synthesized from carotenoids by more than 60 species of algae (e.g. *Chlorella* spp., *Haemato-coccus pluvialis*) is another plant growth regulator. ABA is mostly responsible for the synthesis of proteins required for response to drought (Craige, 2011). Betaines, which are not conventional plant hormones, were also found in algal extracts (Mac Kinnon, 2010). Their minor function is to protect plants from drought and frost. Besides they can act as a source of nitrogen for plants. Extracts from brown algae *Ascophyllum nodosum* are also proved to be rich in betaines (Khan, *et al.*, 2009; Craige, 2011).

Conclusion

Seaweeds are a rich source of structurally novel and biologically active metabolites. These secondary or primary metabolites produced by these macro algae may be potential bioactive compounds of interest in the pharmaceutical industry and medicinal compounds. Bioactive compounds found in seaweeds await a major breakthrough for their potential application as natural antioxidants and drugs in different food and pharmaceutical products.

References

- [1] Antonisamy, M.J. & Raj, E.D.S. (2011) UV–VIS and HPLC studies on *Amphiroa anceps* (Lamarck) Decaisne. *Arabian J. Chem.* [E Pub ahead of Print]
- [2] Chathurvedi, M., Singh, M., Kumar, R., & Chugh, M. R. (2011). Seaweeds: A diet with nutritional, medicinal and industrial value. *Res.J.med. Plants*, 5, 153-157.
- [3] Craige, J.S. (2011). Seaweed extract stimuli in plant science and agriculture. *J. Appl. Phycol*, 23, 371-393.
- [4] Fitton, J.H., Irhimeh, M and Falk, N. (2007). Macro algal fucoidan extracts: a new opportunity for marine cosmetics. *Cosm. Toiletr. Mag*, 122: 55-64.
- [5] Gupta, S., Abu-Ghannam, N. (2011). Recent developments in the application of seaweeds or seaweed extracts as a means for enhancing the safety and quality attributes of foods. *Innov. Food Sci. Emerg. Technol*,12, 600-609.
- [6] Holdt, S.L. and Kraan, S. (2011). Bioactive compounds in seaweed: functional food applications and legislation. *J. Appl. Phycol*, 23, 543-597.

- [7] Keyrouz, R., Abasq, M.L., Le Bourvellec, C. (2011). Total phenolic contents, radical scavenging and cyclic voltammetry of seaweeds from Brittany. *Food Chem*, 126, 831-836.
- [8] Khan, W., Rayirath, U.P., Subramanian, S. (2009). Seaweed Extracts as Biostimulants of Plant Growth and Development. *J. Plant Growth Regul*, 28, 386-399.
- [9] Lahaye, M. (1991). Marine algae as sources of fibres: Determination of soluble and insoluble dietary fibre contents in some 'sea vegetables'. *J. Sci. Food. Agri*. 54, 587-594.
- [10] MacKinnon, S.A.; Craft, C.A.; Hiltz, D.; Ugarte, R. (2010). Improved methods of analysis for betaines in *Ascophyllum nodosum* and its commercial seaweed extracts. *J. Appl. Phycol*, 22, 489-494.
- [11] O'Doherty, J.V., Dillon, S., Figat, S., Callan, J.J., Sweeney, T. (2010), The effects of lactose inclusion and seaweed extract derived from *Laminaria* spp. on performance, digestibility of diet components and microbial populations in newly weaned pigs. *Anim. Feed Sci. Technol*, 157, 173-180.
- [12] Robic, A., Gaillard, J., Sassi, J.F., Lerat, Y and Lahaye, M.(2009). Ultrastructure of Ulvan: A polysaccharide from Green Seaweeds. *Biopolymers*, 91, 652-664.
- [13] Song, M.Y., Ku, S.K., Han, J.S. (2012). Genotoxicity testing of low molecular weight fucoidan from brown seaweeds. *Food Chem. Toxicol*, 50 (3-4), 790-796.
- [14] Stirk, W.A. and Van Staden, J. (1997). Isolation and identification of cyto-kinins in a new commercial seaweed product made from *Fucus serratus* L. *J. App. Phycol*, 9, 327-330.
- [15] Swanson, A.K. and Druehl, L.D. (2002). Induction, exudation and the UV protective role of kelp phlorotannins. *Aquat. Bot*, 73, 241-253.
- [16] Synytsya, A., Kim, W.J., and Kim, S.M. (2010). Structure and antitumor activity of fucoidan isolated from sporophyll of Korean brown seaweed *Undaria pinnatifida*. *Carbohydr. Polym*, 81, 41-48.

- [17] Tarakhovskaya, E.R., Maslov, Y.I. and Shishova, M.F. (2007). Phytohormones in Algae. *Russ. J. Plant Physiol*, 54, 163-170.
- [18] Wijesinghe, W.A. and J.P. and Jeon, Y.J. (2012). Enzyme-assistant extraction (EAE) of bioactive components: A useful approach for recovery of industrially important metabolites from seaweeds: A review. *Fitoterapia*, 83, 6-12.

STUDY OF WORK LIFE BALANCE OF WOMEN EMPLOYEES @ NEST INFORMATION TECHNOLOGIES (PVT) LTD. KOCHI

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Abstract

Large number of organisations have started realising the importance of work life balance in the sustenance of its workforce. Job seekers also now consider work life balance as the most important factor while taking up a job (Times jobs survey 2017). Too much of emphasis on work or home creates imbalance which leads to conflict in the work and family domains resulting in emotional and physical stress. Past researches have shown that those organizations with well-defined policies concerning work-life balance have a committed workforce, elevated levels of job satisfaction and greater pride in their organization. This study is focussed on the employees of NeST Information Technologies Pvt. Ltd, Kochi, Kerala. It aims to explore the women employees' perception about WLB and their agreeableness with it. Work Interference with Personal Life (WIPL or WFC), Personal Life Interference with Work (PLIW or FWC) and Satisfaction with work life balance(SWLB) are taken as the predictors of work life balance. The reliability of the instruments was tested against the collected data.

Key words: *Work Life Balance (WLB), Work family conflict (WFC), Family work conflict (FWC), Work Interference with Personal Life (WIPL)and Personal Life Interference with Work (PLIW)Satisfaction with work life balance (SWLB) NeST Information Technologies Pvt. Ltd.*

I. Introduction

People around the globe are on the lookout for jobs that match their talents as well as contributing towards improved satisfaction in their personal front also. As such, one of the greatest challenges faced by the HR departments of any organisation is to create an atmosphere wherein workers are able to strike a perfect balance between their professional and personal commitments. Work–life balance is defined as an employee’s perception that multiple domains of personal time, family care, and work are maintained and integrated with a minimum of role conflict (Clark, 2000; Ungerson & Yeandle, 2005). It reflects an individual’s orientation across different life roles, an inter-role phenomenon (Marks and MacDermid, 1996). The expression was first used in the UK in late 1970 to describe the balance between an individual’s work and personal life. Work life balance has important consequences for employee attitudes towards their organizations as well as for the lives of employees. A balance between work and life is supposed to exist when there is proper functioning at work and also at home. (Santhi and Sundar, 2012).

The IT sector is the major contributor to the present status of economic growth of India in terms of employment, exports and increase in GDP. The number of working women is on the rise which can be attributed to the IT industry that employs 21 per cent of the six per cent of the working women population of India (Nasscom survey 2012). The survey has also revealed that women friendly policies such as flexible work hours, transportation and healthcare programmes are the major reasons for the increase in the female workforce in the sector. The advent of Information and Communication Technology together with increasing

number of women taking up jobs in the sector has resulted in increased standard of living in urban as well as rural areas but at the same time it has also led to severe complexities while balancing paid work and personal life. Hence, it is crucial that the workforce of India have to be given work-life balancing programs to balance their paid work and their personal life.

II. NeST Technologies

NeST Technologies is a member of The NeST Group, a global organization comprised of companies in a multitude of technology and service areas, including Software Development, Fiber Optics, Networking, RF & Microwave, and Electronic Manufacturing Services. With over 4,000 employees in 25 companies worldwide, The NeST Group has business offices in virtually every major market, supported by Research and Development and Product Fulfillment centers in India. The company has its main development centers in India, though it also maintains onsite presence in the USA, Middle East, Europe, Australia and Japan to support its local clients. NeST Information Technologies Pvt. Ltd., the premier software arm of US \$200M NeST group, delivers solutions – IT, Process, People or Turnkey NeST IT's divisions specializing in Aerospace, Banking and Financial Services, Healthcare IT, Insurance spaces The NeST Group is a fast-growing industrial conglomerate based in Kerala spearheading the industrial revival of the State.

III. Literature Review

To respond to the massive changes witnessed in the economic conditions during the last two decades, with a substantial intensification

of work caused by economic uncertainty, organisational restructuring, and increase in business competition., organisations demand higher performance and commitment from their employees, which is translated into expectations for working longer and for prioritising work over personal life (Perrons, 2003, pp. 68-72; Simpson, 2000; White et al., 2003). Recent empirical research in the United Kingdom (Hyman et al., 2003) indicated that intrusion of work demands into personal life (e.g. working during the week-end) was related with reports of heightened stress and emotional exhaustion for employees. Furthermore, employees perceived that intrusion of work obligations into their personal lives negatively affected their health (Hyman et al., 2003).

Literatures on organizational psychology examine the effect of job demands on work-family conflict, which is identified in the role theory. Family demands as well as job demands significantly contribute towards work family conflict has been proven by many research studies. Recent definitions of work-life balance, in contrast to earlier ones, approach work life balance as referring to the ability of individuals, regardless of age or gender, to find a rhythm that will allow them to combine their work with their non-work responsibilities, activities and aspirations (Felstead et al., 2002).

Work-life balance is a matter of prime concern for both genders. Wesley and Muthuswamy (2005) did not find any gender differences in the experience of work to family or family to work conflict and argued that it was because the financial resources were now being used to pay for the household activities which earlier women had to do and moreover,

men had also started to share some work at home, whereas Aryee et al(1999) and Rajadhyaksha and Velgach (2009) found that gender was negatively related to family work conflict, suggesting that men did not experience as much family work conflict as women. They also found that women experienced significantly higher family interference with work as compared to men.

IV. Objectives of the study

The primary objective of the study is to understand whether the women employees of NeST Technologies enjoy a healthy work life balance. The specific objectives are:

- 1) To study the demographic profile of the women employees at NeST
- 2) To examine the levels of conflict and satisfaction with work life balance.
- 3) To test whether there is significant difference with respect to the socio-economic variables and constructs of work life balance

V. Methodology

The study is mainly descriptive in nature. The city of Kochi being one of the most favoured IT destinations was chosen as the area of study. The sample size chosen for the study is 100 which is approximately fifty percent of the total women employed in the organisation. Primary data was collected using a structured questionnaire having closed ended multiple-choice questions from the women employees of NeST

Information Technologies Pvt Ltd Kerala. 20 statements relating to work life balance were selected so as to identify the levels of WLB by adopting scaling technique. Secondary data was collected from websites and various journals. Collected data were analysed with the help of descriptive statistics like percentages, standard deviation, chi square as well as reliability analysis with the help of software package SPSS version 16.

VI. Results and Discussion

1. Profile of the respondents

Table 1.1 shows the demographic profile of the women employees of NeST Information Technology Ltd, Kochi. As per the table, out of 100 women employees 68% of the respondents were in the age bracket of 25 to 35 years while only 18% of respondents were above 30 years of age. With regard to the level of education, maximum respondents (36%) had B. Tech degree, 19% had postgraduate degree and 41% had bachelors degree in either science or commerce or diploma. Majority of the women (36%) had below 2 years of experience in the organisation followed by 27% with 2 to 5 years of experience whereas only 14% had an experience of working for more than 8 years in the organisation. At NeST 58 % of women are married while 42 % are single.

For applying Likert type scales in research, it is necessary to calculate the cronbach alpha coefficient for reliability and consistency. The constructs were checked for reliability and the coefficients obtained for the dimensions of Work family conflict, Family work conflict and Satisfaction with work life balance are 0.910, 0.888, 0.953 respectively.

The cronbach alpha for the dimensions are above 0.70 which indicates high level of internal consistency for the scale.

Table 1.1 Demographic profile of women employees

Sl.No	Characteristics	Number of respondents	Percentage
1	Age Group		
	Below 25	24	24
	25-30	33	33
	30-35	25	25
	Above 35	18	18
2	Educational Qualification		
	B Tech	36	36
	M Tech	9	9
	MCA	10	10
	BCA	4	4
	Others*	41	41
3	Designation		
	Programmer	29	29
	Analyst	13	13
	Web Designer	5	5
	Supervisor	2	2
	Others**	45	45
4	Educational Qualification		
	Upto 2 years	36	36
	2 to 5 yrs	27	27
	5-8 yrs	22	22
	Above 8 yrs	14	14
5	Designation		
	Married	42	42
	Unmarried	58	58

Note: 1. *denote respondents who are undergraduates in science/ commerce/arts/as well as diploma holders

2. ** denote personnel who perform data entry/technical support /sub staff

2. Work to Family Conflict and Family to Work Conflict

Imbalance in work and family domains is the cause for conflict between the domains and consequent physical and emotional stress. The spill over from work to family and family to work has real consequences and negatively affects the quality of family and career attainment of both men and women. Over the years, there is a growing perception that the quality of an employee's personal life and family life impacts work quality and that it makes business sense to promote work and family integration (Lockwood, 2003). The scale to measure Work Interference with Personal Life(WIPL) consists of six statements and that of Personal Life Interference with Work(PLIW) consist of seven statements.

The levels of work family conflict and family work conflict of women employees of NeST software solutions calculated with the help of mean and standard deviation is presented in table 2.1.

Table 2.1: Level of Work to Family and Family to Work Conflict

Levels of Work Family Conflict	Number	Mean & (SD)	Levels of Family Work conflict	Number	Mean & (SD)
Low	27	19.14 (5.05)	Low	32	18.72 (6.35)
Moderate	49		Moderate	44	
High	25		High	24	
Total	100		Total	100	

As per table 2.1 it can be inferred that maximum number of women employees (49% and 44%) at NeST experience moderate level of FWC and WFC respectively.

3. Satisfaction With Work Life Balance (SWLB)

SWLB is a construct defined as an overall level of contentment resulting from assessment of one's degree of success at meeting work and non-work role demands and it is most suitable construct in evaluating an employee's work-life balance. The instrument developed by Rashida Banu and Duraipandian to assess the work life balance of employees in the city of Chennai has been adopted in the study with minor changes. The scale used to measure SWLB consisted of seven statements.

For analytical purposes the levels of work life balance are classified into three categories namely low level, medium level and high level.

The score values mean + standard deviation and score values mean – standard deviation are classified as high level and low level of work life balance respectively. The score values between (+S. D) and (-S. D) are classified as medium level of work life balance.

Table 3.1: Levels of Satisfaction with work life balance of women employees of NeST Technologies

Sl.No	Levels of Work life Balance	Number	Mean	SD
1	Low	29	25.93	4.93
2	Moderate	50		
3	High	21		
	Total	100		

Table 3.1 reveals that 50% of women employees of NeST are having moderate level of work life balance, followed by 29% with low level of WLB and 21% with high level of WLB.

4. Socio-Economic Profile And Work Life Balance

In order to understand the relationship between socio economic variables and dimensions of work life balance Independent sample t- test and ANOVA is performed.

Hypothesis: The socio-economic variables such as marital status, age, experience and designation do not influence the women employees' perception regarding the constructs of work life balance.

Table 4.1: t test for significant difference between married and unmarried women employees with respect to constructs of work life balance.

Dimensions	Marital Status				t-value	P value
	Unmarried		Married			
	Mean	SD	Mean	SD		
Work Family Conflict	18.42	4.89	19.65	5.11	2.734	0.006**
Family Work Conflict	17.59	5.36	19.50	6.85	3.384	0.001**
Satisfaction with Work Life Balance	25.45	5.22	26.26	4.70	1.849	0.065

Note ** indicates highly significant at 1% level,

Since P value is less than 0.01, the null hypothesis is rejected at 1% level with regard to Work Family Conflict and Family Work Conflict. Hence there is significant difference between married and unmarried women employees with respect to spillover from work to family and family to work. Since the P value is greater than 0.05, the null hypothesis is accepted with respect to Satisfaction with work life balance ie., there is no significant difference regarding marital status on SWLB of women

employees which indicates that the perception of work life balance does not vary significantly between married and unmarried women employees at NeST . Based on mean score, it can be inferred that married women employees have better perception of work life balance than unmarried employees.

Table 4.2: ANOVA for significant difference among Age group of women employees with respect to dimensions of work life balance

Dimensions	Age Group in years				F value	P value
	Below 25yrs	25-30yrs	30-35yrs	Above 35yrs		
Work Family Conflict	18.99 ^a (4.83)	18.67 ^a (4.97)	18.93 ^a (5.25)	20.46 ^b (5.07)	2.798	0.040*
Family Work Conflict	16.43 ^a (4.98)	18.71 ^b (5.89)	18.86 ^b (7.07)	21.46 ^c (6.64)	11.928	<0.001**
Satisfaction with Work Life Balance	24.82 ^a (5.29)	26.88 ^c (4.99)	25.46 ^{ab} (5.35)	26.26 ^{bc} (3.15)	4.779	0.003**

Note: 1. The value within bracket refers to SD

2. ** denotes significant at 1% level

3. * denotes significant at 5% level

4. Different alphabet among age group denotes significant at 5% level using Duncan Multiple Range Test.(DMRT)

As per table 4.2, there is significance difference among Age group of women employees with regard to the dimension of Family Work Conflict and Satisfaction with Work life balance at 1% level and with respect to Work family conflict the difference is significant at 5% level. . Based on Duncan Multiple Range Test (DMRT), it is inferred that only

the age group “Above 35 years” significantly differs with other groups with respect to work family conflict, whereas the perception of Family work conflict and Satisfaction with work life balance significantly differs among every age group.

Table 4.3: ANOVA for significant difference among Educational Qualification of women employees with respect to constructs of work life balance

Constructs of WLB	Educational Qualification					F value	P value
	B Tech	M Tech	MCA	BCA	Others		
Work Family Conflict	18.18 (4.81)	22.91 (3.02)	20.08 (5.44)	22.64 (1.87)	18.60 (5.21)	12.511	<0.001**
Family Work Conflict	18.13 (6.05)	23.45 (6.90)	21.15 (7.23)	22.23 (4.57)	17.25 (5.64)	14.295	<0.001**
Work Life Balance	26.51 (4.70)	25.91 (3.50)	26.38 (3.50)	25.27 (3.53)	25.37 (5.72)	1.525	0.193

Note: 1. The value within bracket refers to SD
 2. ** denotes significant at 1% level

It is inferred from table 4.3 that there is no significant difference in the perception ‘Satisfaction with work life balance’ with respect to educational qualification of women employees but the perception of WFC and FWC is highly significant among the different groups.

Table 4.4: ANOVA for significant difference among Designation of women employees with respect to constructs of work life balance

Constructs	Designation						F value	P value
	Programmer	Analyst	Web Designer	Manager	Supervisor	Others		
Work Family Conflict	18.53 (5.14)	18.61 (5.48)	23.44 (1.05)	17.50 (5.40)	21.17 (3.11)	18.92 (5.11)	6.201	<0.001**
Family Work Conflict	19.39 (6.68)	17.09 (6.18)	27.52 (1.48)	18.13 (6.73)	21.25 (5.65)	17.33 (5.59)	17.296	<0.001**
Work Life Balance	27.16 (4.06)	25.36 (4.92)	27.22 (1.78)	27.13 (1.81)	26.39 (3.88)	25.02 (5.67)	4.238	0.001**

Note: ** denotes significant at 1% level

Table 4.4 shows that there is significant difference in the perception of WLB with respect to all its constructs among the women employees occupying different cadres.

VI. Conclusion and Implications

Based on the issue response percentage of the variables pertaining to work life balance it is divulged that women employees of NeST Information Technologies are in the moderate level of work life balance. Satisfaction with work life balance does not differ with marital status but the married employees have a better perception of work life balance. Tests performed indicate that the perception of work life balance is different for women employees belonging to different age groups,

designation and experience. When the general agreeableness of WLB practices at NeST were probed, 54% respondents are positive about it, 31% disagree to it while 15% are neutral about it. General work environment of the organization is good and service conditions and other work-related policies are pro-employees. Most of the women employees there are satisfied with their organization and intend to spend many years of their life working for NeST which indicates that human resource policies are very employee oriented and good. Overall, it can be deduced that the work life balance practices at NeST are between moderate to good

Among the companies in the information technology sector the HR practice of flexible schedules and family friendly policies are a matter of survival than retaining talented women employees. The study identified that good quality of work life exists among the women employees at NeST. The moderate level of WLB of women employees is a strong indicator of the fact that the organisation considers human resources as its most valuable asset and believes in employee centric policies to ensure higher levels of productivity.

References

- [1] Aryee, S., Luk, V., Leung, A. & Lo, S. (1999). Role stressors, inter-role conflict and well-being: the moderating influence of spousal support and coping behaviors among employed parents in Hong Kong. *Journal of Vocational Behavior*, 54, 259-278.
- [2] Clark SC (2000). Work /Family Border Theory: A New Theory of Work/Family Balance. *Human Relations* 53(6): 747–770.

- [3] Felstead, A., Jewson, N., Phizacklea, A. and Walter, S. (2002), “Opportunities to work at home in the context of work-life balance”, *Human Resource Management Journal*, Vol. 12, pp. 54-76
- [4] Hyman, J., Baldry, C., Scholarios, D. and Bunzel, D. (2003), “Work-life imbalance in the new service sector economy”, *British Journal of Industrial Relations*, Vol. 41, pp. 215-39
- [5] Marks Stephen R, Mac Dermid and Shelley M(1996) “Multiple Roles and Self: A theory of Role Balance ; *Journal of Marriage and Family*. Vol 58(2) <https://www.questia.com/read/1P3-9761263/multiple-roles-and-the-self-a-theory-of-role-balance> downloaded on 18/09/2017
- [6] Nancy R. Lockwood (2003) “Work/Life Balance Challenges and Solutions” *Nancy R. Lockwood SHRM Research Quarterly* (2003) <https://pdfs.semanticscholar.org/>
- [7] Parasuraman, S. and Simmers, C.A. (2001), “Type of employment, work-family conflict and well-being: a comparative study”, *Journal of Organizational Behavior*, Vol. 22, pp. 551-68.
- [8] Perrons, D. (2003), “The new economy and the work-life balance: conceptual explorations and a case study of new media”, *Gender, Work and Organization*, Vol. 10, pp. 65-93.
- [9] Rajadhyaksha, U. & Velgach, S. (2009). *Gender, gender role ideology and work-family conflict in India*. Academy of Management, Chicago, IL, USA.
- [10] Rashida Banu.A, Duraipandian.K.(2011) “Development of an Instrument to measure
- [11] Work life balance of it professionals in Chennai”*International Journal Of Management* Volume 5, Issue 11, November (2014), pp. 21-33
- [12] Santhi T.S, Sundar K(2012) “A study on the work life balance of women employees in information technology industry” *zenith International Journal of Business Economics & Management Research* Vol.2 Issue 1, January 2012

- [13] Narendranath. S (2007) "Work life balance -The Employer's Perspective" *Osmania Journal of Management Vol II Number 2, June 2007*
- [14] Simpson, R. (2000), "Presenteeism and the impact of long hours on managers", in Winstanley, D. and Woodall, J. (Eds), *Ethical Issues in Contemporary Human Resource Management*, Macmillan, London, pp. 156-71
- [15] Ungerson C, Yeandle, S (2005). *Care Workers and Work-Life Balance: The Example of Domiciliary Careworkers*. In: Hounston DM, ed. *Work-Life Balance in the 21st Century*, pp. 246–262. Hampshire, Palgrave Macmillan
- [16] Wesley, J.R. & Muthuswamy, P.R. (2005). "Work-family conflict in India- An empirical study". *SCMS Journal of Indian Management*, October-December, 95-102
- [17] http://en.wikipedia.org/wiki/Work-life_balance downloaded on 18-9-2017
- [18] [www.nesttech.com/about NeST Tech.html](http://www.nesttech.com/about_NeST_Tech.html).

आत्मनः द्रव्यान्यतमत्वम् ।

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वैशेषिकदर्शनानुसारेण पदार्थस्य तत्त्वज्ञानाद् एव मोक्षः। अत्र पथार्थाः द्रव्य, गुण, कर्म, सामान्य, विशेष, समवाय, अभावा इति सप्त । तत्र द्रव्याणि पृथिवी, आपः, तेजः, वायुः, आकाशः, कालः, दिक्, आत्मा, मन इति नव । आत्मा इति अष्टमं द्रव्यम् । न्यायदर्शनानुसारेण षोडश पदार्थानां तत्त्वज्ञानात् निःश्रेयसम् । प्रथमं प्रमाणं तदनन्तरं प्रमेयम्। प्रमेयानि द्वादश – आत्मा, शरीरम्, इन्द्रियम्, अर्थः, बुद्धिः, मनः, प्रवृत्तिः, दोषः, प्रेत्यभावः, फलम्, दुःखम्, अपवर्गः इति। प्रथमं प्रमेयं आत्मा इति। आत्मा इति अतिरिक्त पदार्थः नास्ति इति नास्तिकानां मतम्। न्यायमतरीत्या आत्मनो द्रव्यत्वं इदानीं निरूप्यते ।

वैशेषिकदर्शने आत्मा।

आत्मा द्रव्यम् इत्यत्र आत्मानुमानं प्रधानं प्रमाणम् । अस्माकम् इन्द्रियार्थानां रूपरसादीनां ज्ञानं भवति । तद्वत् ज्ञानमेव आत्मानुमाने लिङ्गम् । ज्ञानं किञ्चिद् द्रव्यवृत्तिः। ज्ञानमपि गुणः। स द्रव्यवृत्ती। ज्ञानस्य आश्रयद्रव्यमेव आत्मा इत्यनुमानम्।

ज्ञानस्य आश्रयभूतं न इन्द्रियं, न वा विषयः। इन्द्रियाणि ज्ञानकरणानि । विषयाः ज्ञानकर्मभूताः । आत्मा तु ज्ञानाश्रयः कर्ता । लोके यथा करणं अन्यत्, कर्म अन्यत्, कर्ता अन्यः तथा अत्रापि कारणात् इन्द्रियात्, कर्मभूतात् विषयात् च अन्यः कर्ता आत्मा ।

चार्वाकमतम् ।

जानाश्रयभूतं शरीरम् इत्यतः शरीरस्यैव आत्मत्वम् इति पूर्वपक्षः । चैतन्यं अथवा ज्ञानं शरीरस्य गुणः इति चार्वाकमतम् । समवायेन ज्ञानं प्रति शरीरं कारणमिति तन्मते कार्यकारणभावस्वीकारात् किञ्च ‘स्थूलो अहम्’ ‘कृशो अहम्’ इत्यादि प्रत्यक्षप्रतीतेः स्थूलत्वस्य कृशत्वस्य शरीरे एव प्रत्यक्षसिद्धत्वात् शरीरमेव आत्मा इति व्यवस्था ।

शरीरस्य न चैतन्यं , मृतेषु व्यभिचारतः । मृतशरीरे ज्ञानाभाव दर्शनेन अन्वयव्यभिचारः । किन्तु चार्वाकमते तु न अत्र दोषः। मृतशरीरे तु प्राणाभावादेव ज्ञानाभाव इति अत्र कार्यकारणभावस्य स्वीकारात् । ज्ञानं प्रति प्राणविशिष्टस्य शरीरस्य कारणत्वात् तदभावादेव मृतशरीरे ज्ञानाभाव इति चार्वाकमतम् । अतः शरीरमेव आत्मा इति ।

चार्वाकमतखण्डनम् ।

शरीरस्य आत्मत्वे बाल्ये विलोकितस्य स्थाविरे स्मरणानुपपत्तेः शरीरस्य च उपचय – अपचय दर्शनात् उत्पादविनाशशालित्वात् बाल्यशरीरस्य नष्टत्वेन वृद्धभावे बाल्यानुभूतस्य स्मरणम् न उपपद्यते । एवं स्मृतिः सम्भवति इति वाच्यम् । अनन्तसंस्कार कल्पने गौरवात् इति ।

किञ्च शरीरस्य आत्मत्वे तु बालकस्य स्तन्यापानदि प्रवृत्तिः न स्यात् । इष्टसाधनता ज्ञानस्य तत्र हेतुत्वात् । न्यायमते च पूर्वशरीरे अनुभूतस्य इष्टसाधनता ज्ञानस्य अस्मिन् जन्मनि नित्यो अयमात्मा एतत् शरीरनिष्ठः स्मरति इति वक्तुम् शक्यते । तस्य इष्टसाधनता ज्ञानस्य स्मरणादेव अस्मिन् शरीरे प्रवृत्तिः । न च तत्र आत्मा जन्मान्तरानुभूतम् सर्वमपि स्मरतु इति वाच्यम् । आत्मनः उद्बोधकाभावात् तत्

न संभवति । अदृष्टमेव अन्यत् कारणं बालकस्य स्तन्यपान प्रवृत्तयै इति । संसारस्य अनादितया आत्मनोऽपि नित्यत्वं सिध्यति ।

इन्द्रियातिरिक्तत्वम्

बधिरोऽहम् इत्यादि लोकगतानुभवात् इन्द्रियाणि एव आत्मेति केचित् चार्वाकाः । इन्द्रियं विना ज्ञानं न स्यात् इत्यतः । इन्द्रिय व्यतिरिक्तः आत्मा न स्यात् इति पूर्वपक्षः । करणत्व कर्तृत्वयोः सामानाधिकरण्यात् करणत्वं तु साधकतमत्वं, ज्ञानं प्रति साधकम् इन्द्रियमेव । तत्तु करणत्वेन गृह्यते । यदेव करणं स एव कर्ता इत्यतः इन्द्रियव्यतिरिक्तो न कश्चित् आत्मपदार्थः । चक्षुरादीनि कर्तृणि करणत्वात् इति अनुमानव्यवस्था।

तन्मतं निराकरोति सिद्धान्ती कर्तृकरणयोः पृथक्त्वसूचनेन । तेन कर्तृकरणव्यवस्था संभवति । तौ परस्पर विरुद्ध स्वभाववन्तौ च । अन्यथा उभयोः संज्ञयोः एव पृथक्त्वं निरर्थकं स्यात् इति ।

चार्वाकः तन्निराकरोति “ विरोधे साधकाभावात् “ इति । कर्तृकरणयोः पृथक्त्वे प्रमाणं नास्ति, साधकाभावात् । अतः कर्तृकरणयोः ऐक्यं स्वीकर्तव्यम् इति ।

नैयायिकानाम् इदं न संमतम् । कर्तृकरणयोः ऐक्यं तु असंभावि एव । कारणानां धर्मस्तु विषयेण सह संयुज्य तद् ग्रहणमात्राय एव इति प्रसिद्धम् । इन्द्रियाणां कर्तृत्वे सति तेषाम् एव अनुभवितृत्वम् इति न युक्तं अनुभवस्य पृथक् कर्मत्वात् । तथा च अनुभवस्मृत्योः सामानाधिकरण्यात् इन्द्रियाणां एव स्मृतिधर्मकत्वं संभवेत् । अनुभवति स्मरति इति नियमः । अन्यथा देवदत्तानुभवस्य यज्ञदत्तकृत स्मरण प्रसङ्गः । इन्द्रियाणां उपघाते तद् दृष्टसौन्दर्यस्य स्मरणं अनुपपन्नमेव स्यात् तदपि लोकविरुद्धमेव इति ।

अपरं च इन्द्रियाणां पृथक्त्वात् एकस्मिन् एव शरीरे अनेकात्म प्रसङ्गः । तत् तु अयुक्तमेव। अन्यथा इन्द्रियाणां परस्पर सम्बन्ध विरहापत्तिः । अपरे तु एकस्यैव आत्मनः पृथक् पृथक् इन्द्रियरूपेण व्यवस्थितिः चेत् नेत्रोपघाते कर्णाभ्यां दर्शनापत्तिः प्रसज्येत । अतः इन्द्रियातिरिक्तः आत्मा ।

मनोऽतिरिक्तः आत्मा ।

मनो नाम अन्तरिन्द्रियम् नित्यं च । तदेव सर्वज्ञानस्य आश्रयभूतं इति केषांचन मतम् । अस्य परिहारः न्यायदर्शने “ ज्ञातुर्ज्ञानसाधनोपपत्तेः संज्ञाभेदमात्रम्” इति सूत्रे दर्शितः। ज्ञानस्य आश्रयः ज्ञाता अन्यः, ज्ञान साधनं अन्यत् । यथा ‘चक्षुषा पश्यति’ , ‘श्रोत्रेण शृणोति’ इत्यादि ज्ञानसाधनानि चक्षुरादि इन्द्रियाणि, ज्ञानाश्रयः अन्यः । एवं मनसा विजानाति इति व्यवहारात् ज्ञानसाधनं मनः अन्यत् । ज्ञानाश्रयः अन्यः । अतः मनोऽतिरिक्तः आत्मा।

ननु मन एव ज्ञानाश्रयः अस्तु , ज्ञानसाधनं अन्यत् भवतु इति चेत् , नैवम् । इदं तु संज्ञा भेदमात्रम्। ज्ञानाश्रयस्य आत्मा इति संज्ञा ज्ञानसाधनस्य मनः इति संज्ञा। यदि विपरीतेन उच्यते , तथापि अर्थे न विरोधः। ज्ञानसाधनाद् अन्यत् ज्ञानाश्रयः आत्मा इति ।

सिद्धान्तमुक्तावल्यां “ मनोऽपि न तथा ज्ञानघनध्यक्षं तदा भवेत्” इत्युक्तम् । यदि मनः ज्ञानाश्रयभूतं तदा ज्ञानप्रत्यक्षमेव न स्यात् । मनः अणुरूपवत् प्रत्यक्षे च महत्वस्य कारणत्वात् । एवं मनसो गुणभूतं ज्ञानं अपि अप्रत्यक्षमेव स्यात्। परन्तु सर्वेषां स्वज्ञानं प्रत्यक्षमेव। तस्मात् न मनोगुणः ज्ञानम् । तेन आत्मा मनसः अतिरिक्तः इति सिध्यति। अतः आत्मा शरीरातिरिक्तः इन्द्रियातिरिक्तः मनोऽतिरिक्तः इति न्यायमतम् ।

पूर्वोक्तवादमुखेन देहेन्द्रियबुद्धिमनोऽतिरिक्तः कश्चित् चेतनः ज्ञानगुणाश्रयो द्रव्यम् अस्तीति सिद्धम्। यद्यपि विज्ञानम् आधुनिकम् आत्मनो निरूपणे अशक्तं तथापि आत्मनिराकरणमपि तैर्न कर्तुं शक्यते इति वस्तु अस्मच्छास्त्राणां दाथात्म्यशक्तिम् अवश्यम् निरूपयत्येव ।

References

- Nyayadarsanam- The sutras of Gotama and Bhasya of Vatsyayana, Ed. by Nyayacarya Sri Padmaprasada Sastri, Nyayacarya Harirama Sukla, Varanasi – 1990.
- Ganganath Jha – The Nyayasutra of Gautama Vol – IV, Delhi, R print – 1999
- Debasish Cakrabarthi – Vaisesika Sutra of Kanada, NewDelhi- 2003