Spiritus Scientiae

STUDENTS' JOURNAL

Contents

Editorial

It gives me immense pleasure to bring out the first issue of *Spiritus Scientiae*, a compilation of the research work of the students at their post graduate and graduate levels. Man is on the quest for knowledge since the dawn of humanity. From the early civilization to the present we see this process of evolution, emancipation and empowerment. From the invention of the wheel to the current developments in nano technology we see this evolution. From barter to bit coins this evolution continues. We owe a great deal to the men and women who thought differently, interacted differently and made concerted efforts differently. In this modern world, it is this difference that should continue to guide our destiny.

Educational institutions are the nerve centre for research and development. No education is complete unless it is able to ignite the minds of the learner. *Spiritus Scientiae* is an initiative to provide a platform for students to publish their research work at the college level itself. It aims to inculcate a genuine interest and aptitude for students in research. Research is a cohesive force that can bridge the gap between the rich and poor, developed and developing nations and knowledge producers and consumers - a catalyst to help reduce the knowledge divide.

The first issue of *Spiritus Scientiae* is set apart exclusively for the students of our college. We intend to invite research papers from other colleges from the next issue onwards. I would like to place on record my sincere thanks to the Manager, Principal, IQAC Coordinator and the Editorial Board for their support and co-operation in bringing out this issue. Let the *Spiritus Scientiae* become a platform where the students are able to break their inter-departmental barriers through the common language of research.

Prof. Linchu Elizabeth Samuel

Routing the Coloniser:
Mahesh Dattani's Thirty Days in September

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Abstract

The article deals with the problem of incest where readers/viewers are introduced to a man who sexually molests his own sister and her daughter. The study is an attempt to relate sexual molestation with the process of colonisation and the molester with the colonizer. It also deals with the measures adopted by the two victims, Shanta and mala, to free themselves of the evil influence of the molester, Vinay, and his detestable memories. This could possibly be equated with the process of decolonization.

Introduction

Indian English Literature, in the last few decades, has emerged as a vital force to uphold the sensibility of postmodern era at global level and dramatic art has always been a part of the rich tradition of India. Indian English drama and dramatists have gained acceptance throughout the world due to the realistic portrayal of social evils that prevail. One among the notable Indian English dramatists is Mahesh Dattani, who can be rightly called the "Indian Bernard Shaw." Dattani's plays have their politics. They attack and try to wipe out the false notions and practises prevalent in society.

Mahesh Dattani has to his credit about fifteen plays that introduce sensitive issues like homosexuality, child sexual abuse, sufferings of AIDS victims, etc. Asha Kuthari Choudhuri personally feels that, "most of his plays are constructed around social issues, not only on any specific message. Dattani maintains the stance of a non- judgemental observer and never intrude into the plays he writes nor attempts to sermonize" (26). What makes Dattani a tenor singer among those who strike a lower key is that he always tries to make his audience realize that drama is not a mechanical representation of human experience, but it is a lively representation of the new concepts of social relationship. He writes: "I am certain that my plays are a true reflection of my time, place and socio- economic background." (xv). While conversing with Bijay Kumar Das, he gives information as to how he started writing plays. He says:

I began with a need for original writing in English for my amateur theatre group. . . . It was in my mid- twenties, I realized that I wanted to do something closer to my own culture rather than European plays, so it came from a need. I never saw myself as a writer but

a theatre person. *(Form and Meaning 176)*

Thirty Days *in September*, a play in volume two of his *Collected Plays*, deals with the problem of incest where we are introduced to a man who sexually molests his own sister and her daughter; and its aftermath on the victims. Dattani believes that all his plays deal with the struggle that happens within an individual when he is placed in a society. Lillete Dubey, a well known theatre personality and stage director, in her "A Note on the Play", states how Dattani has striven to ensure authenticity to his work by interviewing a dozen survivors and moulding their stories to provide a framework of truthfulness! In her own words, "every survivor and psychologist who has seen the play [was] amazed by its veracity" (3). This play maintains a sort of balance between the different events with the shift of memory between the past and the present. On the superficial level, it is the story of a mother, Shanta, who is anxious to get her daughter, Mala, married to a man named Deepak. Beyond it, the play is about the complex relationship that exists between Shanta, Mala and Shanta's brother, Vinay. They are all struggling to cope up with their haunting, traumatic past memories in the present. Dubey, who has played the role of Shanta on stage, has felt that the theme chosen by Dattani is "[s]ensitive and powerful without ever offending sensibilities . . . manages to bring home the horror and the pain within the frame work of a very identifiable mother-daughter relationship" (4). The play is more concerned with the individual's psyche that gets intensified by the passage of time, than on the issue of child abuse.

Colonising the Mind

Women play a crucial role in building up a family. They also function like retention walls preventing the erosion of values that lead to the toppling of the edifice. This could be one of the possible reasons why society always shows the tendency to idealise women as selfless creatures and patient sufferers. Indian mythical women like Sita, Savitri and Ahalya exemplify the ideal Indian woman hood that excels in selfless love, uncomplaining suffering, sacrificial mentality, and devotion to spouse. The notion of ideal womanhood that restricts the freedom of a woman is more rigid in a society where men decide the moral code for their own carefree living. The condition is not much different in many of the Indian societies, which are ruled by the patriarchal code of conduct. They insist that a woman should remain domestic oriented and her life should be solely set apart for bringing up children, looking after the elders and satisfying the needs of her spouse. While performing these roles, she has to satisfy as close as possible the requisites of ideal woman hood. The patriarchal society expects a woman to bear all setbacks in her personal and familial life uncomplainingly, that too with a smiling face. She is always expected to act like a shock absorber to her family. Even when problems are surging in her mind, she has to stay calm and quiet like a sea sans billows. According to Foucault,

> moral rules were called upon [by males] to exercise their rights, their power, their authority, and their liberty: . . . in a marital life . . . no rule or custom prevented the husband from having extra marital sexual relations. . . These themes of sexual austerity should be understood . . . as the elaboration and stylization of an activity in the exercise of its power and the practice of its liberty. (23)

As the play *Thirty Days in September* opens, we are introduced to Mala who

is opening up her mind to an imaginary counselor. Mala believes that her mother is responsible for all the bad things happened in her life.

The life of the Khatri family is a tragic one. Shanta was a great devotee of Krishna, but she hardly spends time with her husband. So her husband disappears leaving back her and their young daughter, Mala. Mala accuses her mother for the indifference she had shown to her father. Mala has a lover, Deepak, with whom she spends most of her time. But when he discusses with her his intention of marrying her, she tries to run away from the proposal. Later on, we come to understand that she is unable to stick on to one person. There is "something" within her that asks her to go around and have sensual love with everyone she meets in the society.

Shanta is happy with Deepak's proposal, but Mala turns it down in a rude manner. Mala's decision keeps Shanta quite defenseless. Shanta is not able to say anything. Deepak tells Shanta what has actually happened between them. He says: "Last week, I told her that she was the most intelligent, sensitive and dynamic woman I had met. She just stared at me and said, 'I have something to tell you. It is over. I don't want to continue with our relationship.' She doesn't want to see me again (CP II 14)." Shanta consoles Deepak promising that everything will be all right. But in reality Mala has gone astray and Shanta is not in a position to control her daughter.

Mala is not interested in marriage. She moves around with many men to satisfy her desires. In Act I Mala is seen in a party where she has an issue with a man named Ravi who comes there with his fiancé, Radhika. Mala, as usual, is dressed provocatively, which attracts Ravi. Mala

encourages the man to take liberty with her. They start dancing together and at last she requests him to take her with him, that is, she wants to spend the night with that man. She says, "Do whatever you want with me, but take me with you now." (CP II 18) However, he is not in a position to take her away with him as he had already promised his fiancé, Radhika that he would spend the night with her. Mala goes to the extent of becoming frivolous. Still, Ravi leaves her and goes with Radhika, humiliating Mala.

Even after such a horrible happening, Mala goes back to her house as if nothing has happened. When her mother urges Mala to marry Deepak, she puts down her suggestion. Shanta demands of Mala the reason for showing indifference to her. Mala reveals her past with anger and hatred for her mother.

Dr. Pillai, a famous transcultural psychiatrist, considers lack of free communication between parents and children as the primary cause why many girls are sexually victimized. A girl needs to have the freedom to talk to her parents, especially her mother (39). He also suggests: "While communication between parents and children is necessary for mutual understanding and growth, the parents should learn to deal with children with parental feelings. . ." (28). Instead of patiently listening to her daughter and believing what she continuously kept on saying, Shanta prefers harbouring the impression that either Mala is simply cooking up stories or she is forcing her uncle to molest her. She tells Mala it is the reason why she has remained silent all these years. This is quite evident when they talk to each other. In a flood of anger, Mala takes the portrait of Lord Krishna, which her mother finds solace in, and flings it out of the door without listening to

the words of her mother who tries to keep the portrait safe.

Colonisation has always been reckoned as molestation and also vice versa. Dr. Beena Agarwal, in her book *Mahesh Dattani's Plays, says:* "In dealing with the dynamics of human relationship within the range of theatre, Dattani expresses his concern for the taboo relationship, discrimination of values on the basis of gender prejudices, uncertain liaisons and the disgust for sexual colonialism" (127). Political colonisation has disappeared from our world, but several of its consequences still remain with us. The most prominent among these is the "colonization of the mind." Being the most damaging aspect of colonialism, it is taking possession and control of its victims' minds. According to Marcelo Dascal, the metaphor "colonization of the mind" highlights the intervention of an external source – the 'colonizer' – in the mental sphere of a subject or group of subjects – the 'colonized'. This intervention affects central aspects of the mind's structure, mode of operation, and contents; and its effects are long-lasting and not easily removable. There is a marked asymmetry of power between the colonizer and the colonized though they can be aware or unaware of their role of; and both can participate in the process voluntarily or involuntarily ("Colonizing" 2).

During the process of colonisation, the coloniser robs the colonised of their many valuables like culture, self esteem, beliefs, relations and they become physically as well as spiritually molested. Uncle Vinay, the coloniser of Mala's self has always been aided by her mother in carrying out his sexual feats heartlessly. Mala feels that she has lost her soul to this coloniser and she harbours hard feelings against her mother for facilitating the process of colonialisation within herself:

Where were you when he locked the door to your bedroom while I was napping in there? Where were you during those fifteen minutes when he was destroying my soul? Fifteen minutes every day of my summer holidays, add them up. Fifteen minutes multiplied by thirty or thirty- one or whatever. That's how long or how little it took for you to send me to hell for the rest of my life! Surely you must have known, Ma. (CP II 53)

The colonised self of Mala goes to the extent of believing that if her mother had treated her father more lovely, he would have never left them.

Dattani's play is not just the story of Mala, it is also the story of Shanta. Shanta, Mala's mother, is a great devotee of Lord Krishna. There is a big portrait of Lord Krishna hanging on the wall of the living room of Khatri family. The picture has great significance. Even at the end of the play, this picture plays a crucial role by untangling the questions that are in the mind of Deepak. Shanta always tries to escape from the interrogation of Mala by looking at the picture of Lord Krishna. In Indian culture, a husband should be a lord - like figure to a wife. However, Shanta proclaims that she cannot consider her husband as her lord. That leaves us wonder whether Shanta too is colonised by some external forces!

Shanta comes before us as a picture of holiness. She is happy to realise that Deepak is interested in her daughter and he wants to marry her. She is happier on realising that he is the son of Colonel Bhatia. But this happiness is short lived. When her daughter tells her not to entertain Deepak or let him inside the house if ever he comes there, Shanta is upset. She tries to send Deepak back, but he wants to stay there and to talk to Shanta about some

issues regarding the relation between him and Mala. While they are having the conversation, Mala's call comes and she accuses her mother for letting Deepak inside and also for talking to him.

The exchange of words that takes place between the mother and the daughter sheds light on the married life of Shanta, which was not successful. Shanta always spends time in the Pooja room or in the kitchen. She also refuses to sleep with her husband at night. Mala believes that it is because of the indifference shown by Shanta that her father had left them. She says:

> He left because of you. You didn't love him. The only reason you shared my room was because you didn't want to sleep with him. . . He said to me 'I married a frozen woman'. A frozen woman. So don't try to tell me that you were concerned about me by hiding the truth. The only truth you want to hide is your failure as a wife and a mother. *(CP II 35- 36)*

Shanta is moved by her daughter's arguments. After admitting the cause of emotional numbness, Shanta picks up pieces of broken glass of the picture of Krishna, destroyed by her daughter, to kill herself. Shanta admits to her daughter that she was also molested by her own brother in her childhood. The trauma of what has happened to her when she was six, leaves her sexually frozen.

At a metaphorical level, sexual molestation can be equated with colonisation. Colonisers always make sure about the physical as well as the mental and spiritual subjectivity of the colonised. The natives of the colonies are thus brought under the control of the colonial power. The natives of colonies are never encouraged to think and decide what

is good for them. Those in power win the natives to their side by making them believe that they care for them, they act on their behalf, and everything they do is for their good. Slowly, the natives develop a mindset that refuses to think of having an independent existence. The natives would not be even happy of parting with their colonisers. The psyche of the colonised is always under the control of their rulers.

Vinay and society are cast in this play in the role of colonisers. Vinay exercises his power over his sister and niece through sexual molestation. He shows the magnanimity to pay for the rent of Shanta and Mala, who are prey to his machinations. Society too plays the role of a coloniser. In a society that practises and insists incest taboo very strongly, Mala and Shanta have no other option, but to remain silent. Bijay Kumar Das in his book *Form and Meaning in Mahesh Dattani's Plays says,* "If family exists in heterosexual relationship in the society, it is the family which gives rise to incest causing mental harassment to youngsters as well as to the elders alike." (65).

The sexual harassment takes away the trust of Mala and Shanta in the institution of marriage itself. According to Karen Horney, a member of the new Freudian school, the discontent for civilization shown by an individual is an aftermath of "basic anxiety" (41). This is a situation where a child feels isolated and helpless in the hostile world. As a result of the childhood insecurity and lack of warmth of love, the child is forced to leave his/her own self and it becomes completely hostile to this world. So Dr. Agarwal says: "An individual's hostility to cultural context prepares a neurotic order and makes natural responses impossible. There seems to be a consistency in advocacy that psychic disorders are results of unhealthy

social and familial disorders" (127).

As a result of the violence inflicted, the sexually and emotionally frigid Shanta refuses a meaningful family life with her husband, and Mala starts getting involved in sexual relationship with many men, including her colleagues and cousins. Mala even goes to the extent of putting down the marriage proposal of Deepak, the angel-figure in the play, who is capable of de-colonising her mind. Psychological studies done on victims of Pedophilia show that,

> females who have undergone incestuous relationships show long range psychological problems, including feelings of guilt and sin, especially if religious. In some cases, extreme behavioural traits, such as promiscuity or frigidity have been noted in their adult life. . . There evolves in her a dysfunctional attitude towards males as a whole. In short, a female's ability to have healthy emotional experiences in life becomes wrecked. A girl may not know the implications and consequences to herself . . . until she grows up. This makes her situation both pathetic and dangerous. (Pillai 28)

Deepak gropes in the dark unable to understand why Mala has dropped his proposal. Mala reveals that she cannot escape from the mental power thrust upon her by her Coloniser - Uncle, Vinay. It is a fact that when a person is sexually molested, the physical, mental and the spiritual selves are equally afflicted. Mala's afflicted mind drains away her confidence that she could love Deepak truly. She is doubtful whether she can love anyone else. Mala admits to Deepak that she cannot be free of her molester-Uncle. She doubts whether there is a part within her that refuses to part with him.

Routing the Coloniser

The oppressor- oppressed, or coloniser-colonised relationship is not a long lasting one. No power that oppresses/ suppresses can ever exist unchallenged. Wherever there is power, there is resistance. As people become slaves to memories, ideas, luxuries and persons, their minds are colonized by them. These colonizers (memories, ideas, luxuries etc.) dictate the terms for the existence of the colonized people and it is difficult to escape from them. But unless and until they are free from them, they will not have a peaceful existence. Both Mala and Shanta bear the pain of humiliation because their family and society do not permit them to reveal the heinous crime that has been done to them. The assumption that underlies the arguments and rhetoric of decolonization is that a person or a nation or sometimes even a state has, prior to colonization, a recognizable and stable "identity". One of decolonization's tasks is the rescuing of this identity from the threat of "mind colonization" and restore it to its position of authority in the person's, nation's or state's life.

Mala knows that she is wronged, but the full implication of what has really happened to her is known to Mala only when she becomes an adolescent. As she reaches her adolescence, she is shocked to see that "the world is hostile and human relationship is a betrayal" (Agarwal 118). She tries to overcome and defeat the power her uncle had exerted on her. She is unable to rout the thoughts of her uncle and the evil influence of what has happened to her in her childhood, which has already colonised her mind. She makes several attempts to unleash all the unpleasant, oppressing memories that have been haunting her, to her mother. A normal life is impossible for her unless she decolonises

her mind. She wishes that her mother could give her a patient listening and offer some solution to unburden her troubled mind. If Shanta has been willing to join her daughter in her fight to overpower her colonised mind, Mala could have bounced back to normalcy. The indifference shown by Shanta forces her to resort to her own methods of decolonizing her mind. In order to escape from the betrayal of her uncle, Mala becomes sexually promiscuous. The hyper sexuality and flirtatious nature of Mala is her immature step to get rid of the unpleasant memories of the sexual violence and violator.

Her efforts to overcome the painful memories do not prove successful at the beginning, because they are very unscientific. In order to free herself, she goes around making physical relationship with others. Her sexual promiscuousness is visible in the first as well as in the third act. Her lack of interest in finding a life partner for herself could possibly be attributed to the fact that she no longer believes in the institution of marriage.

Mala who blames herself at the beginning, saying, "This is what I am meant for. It's not anybody's fault, except my own" (CP II 9), slowly, realises that what has happened to her is not a result of her own fault. Towards the end of the play we see a changed Mala who openly says to the haunting memories of her uncle that she knows now that he is dead and also that his memories won't haunt her anymore. She says, "You are dead! You deserve to be dead! Die!" (CP II 57) In the last part of the play she tells the imaginary counselor

that she will celebrate 29th February as her freedom day as it is on this date that her uncle died. Though she tells Deepak that she cannot get married because the memories of her uncle still haunts her, at the end of the play we see a married Mala who courageously declares that her uncle does not matter to her anymore. She succeeds in doing away with the evil spell laid on her by her molester.

Shanta knew that Vinay had been sexually molesting her. But she was unable to react against it. Instead, she cooked good food for her and stuffed her with it. Shanta cannot accept the truth that Mala is sexually molested by her own brother and her weak, already tarnished self does not give her the courage to resist it. To escape from her dilemma, she relies on Lord Krishna and spends her time in her pooja room to defend her mind from the haunting memories of the past. Her prayers and supplications to Lord Krishna tells that she adored HIM like Mira Bhai. Being too much religious is more dangerous that being irreligious. Shanta seeks the help of Lord Krishna to divert her from the realities of the world. Mala, in her rage, destroys the picture of Lord Krishna, which she feels, is the reason why her mother is running away from the harsh realities of life to live in a fool's paradise. The God's picture is like a bubble within which Shanta keeps herself safe with the hope that it would forever protect her. The mind of Shanta, just like her daughter, is colonized from her childhood itself. She is also badly in need of undergoing the decolonization process.

As Shanta realises that her prayers to Lord Krishna alone cannot aid her in freeing her mind, she confesses to her daughter what Vinay has done to her. Shanta cannot believe that she has opened up her mind to her daughter. And in a moment of panic she tries to stop herself from saying more, by putting the broken glass pieces of the portrait of Lord Krishna into her mouth. With her mouth bleeding, Shanta looks at Mala with folded hands and falls on knees. Mala too kneels down holding her mother's hands. Both the mother and the daughter realise that they are in this suffering together and they should shoulder each other while resisting the evil that has colonised their selves in the form of Vinay. Mala knows that Shanta has forgiven her. It is a reality that, no mother can withhold forgiveness from her child for ever. Mala, who used to accuse her mother for all that has happened to her, forgives her, because she understands that her mother has suffered more than what she has suffered. The moment they try to understand and stand by each other rather than blaming each other, they succeed in decolonising their minds of their sexual coloniser. The decolonising process of Mala is complete when she regains the maturity to forgive her mother.

Vinay sexually colonises Shanta and Mala and he challenges the social norm that detested and decried incestuous relationships. The strangest part of his dealings is that he pays the rent of their house. The financial support given by him is the colonial tactic that keeps the colonised selves of the two women under

his thumb. Mala fights with her mother over this issue, but Shanta remains silent because her husband had already left them and there was no one to help them. This feeling of helplessness and indebtedness keeps his victims continuously under the oppressing yoke of his power. Though political colonialism has come to an end, people like Vinay exercise their power over others by employing colonial tactics.

Conclusion

Dattani's plays do not end by presenting the problems, but they offer solutions to deal with those social evils. His Shanta and Mala are not left as such at the mercy of society and its people with vulture like disposition. The dramatist tells how such colonised selves could be decolonised and brought back to the main stream of society. So many people, who consider incest as a social evil from which women have to be saved, have joined hands together to fight for this social cause. Their unity was visible in New Delhi when the 23 year old girl was brutally raped by six men, including one juvenile, in a moving bus. All those who protested against this issue, despite their caste, religion, gender and race, were trying to make sure that such atrocities are not be repeated again in India. It is in this context, as we consider the services rendered by writers like Mahesh Dattani, we ought to stand up and salute them with our hats off!

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Exploring the Uncharted Territories of Human Psyche as Represented in Darren Aronofsky's Film Black Swan

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Abstract

The ballet film, Black Swan, is a horrifying psychic journey of a girl named Nina. It keeps a perfect balance between the realistic world and the mysterious world of human psyche. Nina lives on the borderline of sanity and insanity. The movie explores the human psyche which is very much complex with its entangled feelings and powerful emotional upsurges. The mother daughter relationship is analysed using Queer theory,which is designated as a radical thinking of the relationship between subjectivity, sexuality and representation.

Introduction

Film is a visual language. While language consists of alphabets, words, sentences, paragraphs, film consists of elements like frames, shots, scenes and sequences. Each frame adds up to form a shot, which in turn forms up scenes, which gives rise to sequence; just like alphabets become words, which becomes sentences, and later they form to become paragraphs, which in turn gives rise to texts. Thus films can also be considered as texts.

Black Swan: Analysing the Problem

Black Swan is an American psychological thriller directed by Darren Aronofsky and distributed by Fox Searchlight Pictures. The film was released on September 1, 2010 in Venice and on December 3, 2010 in the U.S. The film gathered several awards including five Academy Award nominations and won the Best Actress Award for the film. The film Black Swan is interesting for many reasons. Aronofsky's direction skills need much appreciation because he makes every viewer feel the pain which the character, Nina experiences. As the film progresses we see Nina slowly steeping into madness, losing control over her mind.

The story begins when the company announces that it needs a Swan Queen for their new ballet, which was a re-working of PyotrIlyich Tchaikovsky's famous ballet Swan Lake. The production needs a ballerina to play both the parts of

white and black swans. Nina is a perfect fit for the fragile white swan. But the part of black swan seems too though for her. Thomas, the director of Swan Lake was not impressed by Nina's performance. Despite her flawless performance as the white swan she failed to capture the sexuality of blackswan. Nina goes home in tears and practices until she breaks her big toe nail. The next day Nina convinces Thomas that she can afford the black swan. She finds out later that she got the role of Swan Queen and was overjoyed.

One night Nina's mother suspects that Nina has scratches on her back and assumes, Nina has been hurting herself again like she used to when she was young. The next day Nina wakes up late and desperately goes out. She arrives at the ballet studio and finds that Thomas has appointed another ballerina, Lily as her substitute for the performance. This enrages Nina and questions Lily. Nina became frustrated that she could not make out what is real and unreal. She believed that what all things has happened are real and complains to Thomas that Lily is trying to snatch her role. Thomas consoles Nina and tells her that the only person trying to sabotage Nina is Nina herself.

Nina's hallucinations became stronger and stronger. She practiced continuously for hours day and night. She wakes up in the next morning and prepares to go out but she finds that she was locked in the house. All these violent scenes happen hours prior to the premiere of Swan Lake. Nina hits her mother and takes the knob of the door and goes out. Nina arrives at the studio and finds that Lily preparing to take the role of Swan Queen. Nina tells Thomas that she has no problem and she will perform the Swan Queen.

The first act goes well, until Nina is distracted by a hallucination during a lift, causing her partner, playing the Prince, to drop her. Nina returns to her dressing room and finds Lily there. Nina shoves Lily into a mirror violently. Nina then grabs a shard of glass and stabs Lily in the stomach. Nina hides the body in the bathroom. She returns to the stage to dance with passion. Nina then completely loses herself and metamorphoses into the evil twin, the black swan, with sprouting black feathers. Nina dances perfectly and receives a standing ovation.

Everyone congratulated Nina including Lily, showing that their fight was just a hallucination. She became confused and went back to the dressing room. She checked the room and finds out the mirror is still shattered. Painfully she realises that she had stabbed herself and removes a shard from her own body. Even after realizing her tragedy, she courageously danced the last act, in which the white swan throws herself off a cliff. She leaps from the constructed hill as the white swan does to kill herself and lands on the hidden mattress. Thomas and the cast run to congratulate Nina, only to find that she is severely bleeding. Thomas frantically asks her what she has done, Nina whispers, "I felt it. Perfect. It was perfect" (Scene 116C). The applause grows more and more faint. Her eyes glaze over and everything goes completely silent. Nina

lies there motionless, a smile frozen on her face.

The film explicitly portrays the complex nature of Nina. But it does not show the reason for the complexity of Nina's mind. The director leave the film open ended and the audience can interpret it in many ways. If we probe deep into the film, definitely we will get a handful of get clues to identify the actual problem of Nina. The behaviour of Nina is different from a normal person. When we analyse her behaviour closely we can see the picture of a paranoid schizoid overlapping Nina's image. The mental illness in Nina is the reason for her tragic life and death. But after watching the movie, a question will remain unanswered in the mind of every viewer. What is going on between Nina and her mother Erica?

Let us assume for the moment that Erica knew that Nina was a mentally unstable paranoid schizoid, since the time when Nina was quite young. Sometimes in these situations, where a mother is caring for a mentally ill child, the child needs to be strictly regimented and controlled in order to maintain stability. This could be the reason why Erica feels the need to restrict Nina's movement and social interactions. It also explains why Erica is protective over Nina and peppers stuffed animals and other infantilizing elements in Nina's room. This is only a possibility as there are several other cracks in their relationship that are still unsettled. There is a possibility of Erica molesting Nina. In the film we never see Erica in the sex scenes. But the film gives us immense clues for this possibility. We can attribute a sort of 'queerness' in the relationship between Erica and Nina in the film.

The decayed mother-daughter relationship in the film makes us aware about the inadequacy of laws which supports heterosexuality. "Queer theory argues that heterosexuality bestows certain privileges and a hierarchy of sexual values that is constructed through discourses. This constructionist view of sexuality suggests that sexual identity is always socially determined. It is never static and is constantly in need of reiteration".

The mother in the film is homosexual. She molests her own daughter. This seems to be an offence and unacceptable in the social context. It is undoubtedly a serious offence from the part of the mother. In the movie we never come across sexual activity between the mother and the daughter. But the film gives us a handful of clues to substantiate this argument. We see Erica, forcefully undresses Nina. This situation reflects the ugly truth behind lives of the two ballerinas. But why Erica molests Nina? It is simply because the social constrains of the society prevented Erica from having a woman partner. This led her to an utter confusion and mental conflict. Erica slowly diverted her sexual feelings towards her daughter. She might have been molesting Nina from a very young age. Gradually, Erica might have gained full control over Nina.

The Trauma and its Effects

The various aspects of trauma theory are applied to explain the inner conflict of Nina. The relationship between trauma

and mental illness is analysed here. Human psyche is very complex. It is an area of entanled feelings and mixed emotions.

We see Nina barricading her room so that her mother would not enter into her room. But a willing submission is always there in Nina, before her mother. Nina is supposed to be in her twenties, but she acts like a little girl in her mother's presence. Nina's bedroom looks like a little girl's room with lots of stuffed animals. Nina's mother undresses her forcefully and treats her like a little girl. The effect of this sexual abuse by her mother on Nina is great. It completely steeps Nina into a psychological trauma. There are several other reasons for her trauma. The unbearable stress that she had to suffer as a ballerina is one reason. Lily, the fellow dancer of the company tries to befriend Nina. Lily's presence and her evil sexual behaviour made Nina identify Lily with her mother. Her delusions became stronger and she believes that Lily has seduced her. Seduction is followed by betrayal in Nina's head, which causes Nina to view Lily as a rival trying to take away her role as the Swan Queen.

She also had to suffer the sexual abuse by the director of the ballet company. She silently suffers his attempts to seduce her. The same kind of submission is shown by Nina before her mother. Her father's name is not mentioned in the film. It is proved that a child who has only one parent is likely to develop mental illness. The absence will also create an inexplicable trauma in children, especially in girls. The willing submission might be an outcome of her dependency towards her mother. This strange dependency points us to another mental illness; the Stockholm syndrome.

Stockholm syndrome is more complex than any other mental illness. It is a psychological condition that the captors develop an emotional bonding with the abusers. At times we see Nina developing such a liking toward her abusers, Erica (her mother), Thomas (the ballet director) and Lilly (her rival). The willing submission before her mother, viewing Thomas as a fatherly figure and responding positively to the evil acts of Lily etc. can be seen as the symptoms of Stockholm syndrome.

Nina has undergone a train of trauma throughout her life. This trauma stayed in her for a long time. A kind of coping mechanism is being activated in Nina's unconscious. She adopted self-mutilation as a coping mechanism to resist the trauma. Later this self-mutilation became inadequate so that she has to adopt other ways to resist her trauma. She completely concentrates on ballet. But the immense pressure and sexual abuse from the part of Thomas Leroy made her a Schizoid. Her hallucinations and imaginations are also a part of resistance taken by her inner mind to escape from the painful reality. Her passion to become the Swan Queen and the trauma she experiences contradicts each other and pushes her from the borderline of sanity into the depths of insanity.

Nina can only become the black swan by killing Lily, which by extension is a symbolic killing of her mother. Only then

can she be the black swan. As a final act of resistance she kills Lily in her hallucination but unfortunately in reality, she kills herself. This proves that her trauma is irresistible and inescapable. When she tries to resist trauma it becomes more and more complex.

It is difficult to explore the uncharted territories of human psyche. Trauma has sometimes been defined in reference to circumstances that are "outside the realm of normal human experience". Unfortunately, this definition is not always true. For some group of people, trauma can occur frequently and become part of the common human experience. Traumatic events are extraordinary, not because they occur rarely, but rather because they overwhelm the ordinary human adaptation to life.Trauma is indeed an emotional retort to a dreadful event in one's life. Terrible events may include accidents, rape or natural disaster. Trauma cannot be treated as a sudden reaction to an incident rather it is developed during a course of time. Trauma can be man-made or natural.

Nina develops trauma from the very young age and it stays on her for a long period of time. Traumatic experiences follow her like a shadow over her life. New painful experiences add onto her past trauma. The queerness in the mother-daughter relationship, exploitation and abuse at the workplace etc. are the root causes of Nina's trauma and madness. An escape from trauma is not at all possible, the only thing we can do for the people who experiences trauma, is to reduce its effect by supporting them, caring them and providing them a secure life.

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An Ecocritical Approach to James Cameron's Avatar

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Abstract

Every theory is born in the lap of time parented by social, cultural and political revolutions. Theories have their say on the social stage when the age demands it. Literature has been this social stage for centuries. James Francis Cameron's epic science fiction *Avatar*, conjures audiences into the fascinating world of Pandora. The article tries to examine the ecocritical aspects of the film *Avatar*, using the basic principles of cinematic ecocrticism. Avatar abounds in themes of deep ecology and a criticism from the theoretical point of view leads us to new and sometimes, ambivalent conclusions. But as far as films like *Avatar* which have within them themes of deep ecology and environmentalism are concerned, their success also depends on the impact of the message they give out to the society.

Introduction

Philosophy and theory travel alongside human civilization. They are re-born in varied forms from time to time. What one generation holds high as the ultimate truth, the next generation proves wrong. The journey of humanity has been one of constant learning and unlearning. With the advent of cinema in the late 19th century, as a prominent "moving" medium, literature has been forced to share space with it. Today, both literature and cinema are part of popular mass culture.

Literature has evolved via different stages, beginning from poetry, through drama and prose to the latest forms of fiction. There is no doubt that cinema too will trace and pursue similar stages of development in later centuries, as it already has come a long way with the aid of science and technology.

Adrian .J. Ivakhiv's notion of ecocinema presented in her book *Ecologies of the Moving Image says,*

> For the traditional environmental melodrama, the (environmentalist's) hope may be that audience members will identify with the individual hero who takes on an environmental challenge and acts to change the world

for the better. (191)

Kaleidoscope of Pandora

Avatar, however, goes beyond mere identification with the hero. Like the rich world of Pandora portrayed in Avatar, dense with rainforests, the film itself is a 'complex, dense specimen' for ecocritics; the breaking down of which is a time and energy consuming activity.

The basic structure of the film can be classified as formalistic; Pandoran ecology can be seen as an exaggerated version of our own Earth's ecological system. It is a result of the formalist ornamenting technique whereby a kind of defamiliarization is achieved in order to produce visual effect. Few things which may be noted include the navi queues, the floating mountains and the mystical unobtanium.

Avatar creates a hyperbolised version of the Earth. The visual imagery projected by 3D animated stereoscopic filming tends to entrap the viewers in a world, largely displaced from the real. Hence Pandora which is more attractive takes an upper hand in the minds of the viewers. The film, in some ways fails to achieve the ends of eco-consciousness. Rather, succeeding as an aesthetic medium in its various aspects, the film 'catches' and 'traps' the audience within itself. Indeed, this kind of an entrapment does assert the quality of the film and filmmakers do aim at such a process to take place, especially when they produce 3D films. A viewer who steps out of the movie hall after a 178 minute 'experience' of *Avatar* would only mourn

his/her fate of returning to a less attractive world, where there is less blue and green, hardly any bioluminescence, and no floating mountains. Therefore rather than becoming aware of one's ecological responsibilities, *Avatar* seems to confine the viewer in its illusory, unreal world, always making the person yearn for more of *Avatar*.

There is a significant play of colours in the film which serves like a visual treat. The navi are blue-skinned with wonderful bioluminescent dots that glow in the dark. Blue is a colour with universal appeal. It also produces beautiful contrast with the natural colour green. Shades of blue are extensively used in Avatar in strong contrast to the refreshing green rainforests. Scenes that make this play of colours very much evident are those in which Jake and Neytiri fly their mountain banshees, whose wings are of the different shades of teal and violet. Therefore *Avatar* rather than holding a mirror to the reality of life, provides the viewer with an attractive movie experience.

Two extremes are presented in Avatar- the primitive and the post- modern. There is a juxtaposition of images from the primitive world along with that of the fragmentary post-modern world. In this sense, the world of Pandora achieves a sense of completeness and perfection. It seems 'ideally utopian'. The human population and their technology are portrayed as essentially of a dystopian nature. Obviously, the audience would empathize and feel one with what seems to them the ideal or the image of perfection.

Post Pandoran Depression is a term given to a phenomenon observed among the viewers of *Avatar* who expressed an earnest longing to physically exist in the world of Pandora. Viewers of Avatar showed an abnormal curiosity in exploring the depth of reality within *Avatar*. This can be considered the peak of success of the film medium but it has a negative impact in ecocritical terms. *Avatar* seems to have an "inverse reaction" on the audience. The film does deal with themes like 'deep ecology' in detail. But at the end of the day all that its viewers wish for is to get transported to the world of Pandora leaving the Earth's real situation behind. Scott Macdonald, in his book *The Eco-cinema Experience* remarks:

> Recent decades have seen the development of a tradition of filmmaking that uses technology to provide cinematic experiences of being immersed within the natural world. While even the most interesting of these emulsion-based films and digital videos are prey to the material limitations I've described, the experiences they provide transcend these limitations at least for the durations of these particular works and, like other forms of cinema, in memory (19).

Avatar succeeds in achieving a complete "detachment process" among its audience. Post Pandoran Depression is proof of it. It entangles the audience within the world of Pandora, detaching them from the real situation of the Earth. The impact Avatar makes upon its viewers is long- lasting. It is determined that the level of control a movie has on its viewers is highly dependent upon the cinematic devices used. Tightly edited films exert more control on brain activity. *Avatar* is a tightly edited 3D movie in widescreen. This exerts more control over the audience, "immersing" them in Pandora.

Ecological Foundations: Human vs Navi

Avatar proclaims that nature has all the answers. The Navi find refuge in times of trouble at the heart of Eywa. The Great Leonopteryx is nature's way of guarding the navi. Human instruments fail to work in the magnetic fields of unobtanium. The very name "unobtanium" that Cameron gives to the superconductor points to his knowledge in the powers of nature. In *Avatar* Cameron explores nature's behaviour; its response to stimulus. Nature has its own way of handling and countering matters.

Humanity's belief in the power of technology fails in the war with Pandora. Jake actually foresees this before he prepares for the war. Pandoran ecology works as a single unit to resist destruction. The fiercest of predators, the thanator and the Leonopteryx take active part in this. Avatar then, posits an anti-technological viewpoint. In a way it might also be saying that technology is the root cause behind humanity's pride. But taking into account the production side of the film, the argument becomes baseless since a lot of technology has been exclusively designed and used for the making of Avatar.

Empathizing with the navi imposes

upon the audience a consequential lack of feeling for the human. Of course, it brings to the surface the flaws of contemporary humanity but it places humans so deep in their flaws that redemption becomes almost impossible. The question of whether the anti-human stance of *Avatar* would encourage or discourage concern for humanity is ambivalent, when the inundating influence of the 3D animated film is taken into consideration.

Conclusion

The recurring statement by Jake, "Sooner or later though, you always have to wake up" is evocative of the situation in which the audience find themselves after a 178 minute watch of *Avatar*. The beauty of Pandora is absorbing and all-consuming. The end of the movie is a waking up to reality. The last shot of the film is a close-up of Jake's navi eyes opening up to Pandora. The end is abrupt and shocks the audience back into reality. *Avatar*, as for the film critic, is dense and complex for the audience too. Within the 178 minute watch, the audience go through a range of emotions and feelings, trying to digest the film into their systems. But certain complex structures remain, to haunt the viewers' minds, which is a James Cameronian signature.

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An Economic Valuation of the Benefits of Varattar Using Contingent Valuation Method

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Abstract

The primary objective of this study is to understand the direct and indirect benefits provided by the Varattar river and to estimate prople's willingness to pay to rejuvenate the river. For this purpose, both primary and secondary data have been collected. To estimate people's willingness to pay to rejuvenate the Varattar, primary data was randomly collected from 500 respondents using a contingent valuation survey. It was executed among respondents of Kuttoor and Eraviperoor panchayats. The study throwns light on the value perceptions of the local population.

1. Introduction

Varattar River, a distributary of the Pampa River is a 9.5 km long water channel that in the past connected and linked the Pampa to the Manimala River. Varattar provides many direct and indirect benefits to the local community in the area. Sharply diminished instream flow have severely affected the size and robustness of Varattar. Today, Varattar is a river with no water. There are grasses, bushes, trees and other encroachments along the banks. A sand bank with overgrown grass blocks the entrance. Unscientifically constructed bridges and roads are the major cause for the decrease in the water flow of the Varattar. Other causes were encroachments and excessive sand mining. Sand mining has deepened the river bed level at the originating point near Arattupuzha. Moreover, encroachments are rampant on either side of the river.

Last year, based on public request, the State Human Rights Commission directed the Water Resource Department, the Mining and Geology Department and the State Pollution Control Board to conduct a joint scientific study on the factors that resulted in reduced water flow in the Varattar. The legislative Committee (Environment) inspected the Varattar river bed in 2002 to verify the large –scale encroachment. The panel observed that almost two-thirds of the Varattar was encroached upon by the local population for cultivating tapioca, rice, vegetables fodder grass, etc. Concrete residential

building too had come up on the river bed at certain points. In recent times, the Irrigation Departments submitted a proposal to deepen the river.

The rejuvenation of Varattar River faced another dead-lock as the second phase got stalled due to financial constraints. The government directed the district authorities in the state to clear all encroachments on public property on a war footing. There has been demands for action against large scale encroachments on the river bed of Varattar, Pampa and Manimala over the past several years. In this context, the present study aims to evaluate the benefits provides by the Varattar and people's willingness to pay to revive the Varattar and its services.

2. Objectives

The following objectives have been selected for the study.

1. To study the direct and indirect benefits provided by Varattar.

2. Estimation of people's willingness to pay to rejuvenate the Varattar.

3. Methodology

The primary objective of this study was to understand the direct and indirect benefits provided by the Varattar. For this purpose, both primary and secondary data has been collected. To estimate people's willingness to pay to rejuvenate the Varattar, primary data was randomly collected from 500 respondents using a contingent valuation survey. It was executed among respondents of Kuttoor and Eraviperoor panchayats. Secondary data was also used for the study.

Contingent Valuation (CVM) is a stated preference method in which due to unavailability of any direct means of measurements, a hypothetical market scenario is constructed and presented to the respondents and an interview schedule is used to elicit willingness to pay values from the respondents. The amount stated by the respondents in response to the scenario question, according to economic theory, would be equal to what people would be actually willing to pay to avoid a specified environmental damage, to achieve a stated improvement in environmental quality or to receive a specified supply of a public good. This value stated by the respondents would be representative of the value the respondents had for the environmental resource (Varattar). The contingent valuation questionnaire was randomly executed on 500 heads of households/housewives whose age ranged between 25 and 65. 250 questionnaires were employed in Kuttoor Grama Panchayat and 250 in Eraviperoor Grama Panchayat. The statistical package limpdep was used to analyze the data. The survey was conducted during the period from February to May, 2014. The primary objective of this study was to understand the direct and indirect benefits provided by the Varattar and an estimation of people's willingness to pay to rejuvenate the Varattar.

The study area comprised the two panchayats of Kuttoor and Eaviperoor in Central Kerala through which the Varattar passes.
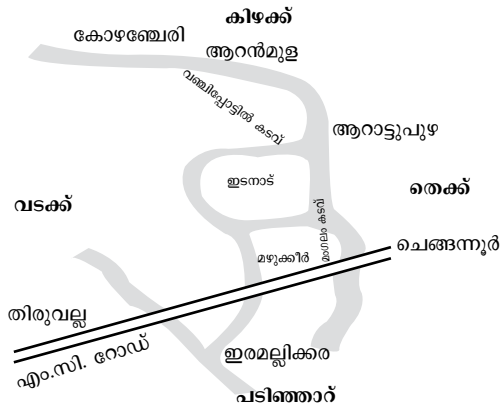
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ഇരമല്ലിക്കര
പടിഞ്ഞാറ്

Fig 1.1

4. Limitations of the Study

The study attempted an analysis of direct and indirect benefits provided by Varattar riverine system. For the analysis to be precise, a huge sample size is required. Due to the shortage of time and financial constraints, the sample size selected was small. Another limitation of this study was that only two panchayats was surveyed to elicit direct values.

5. The Survey

To estimate people's willingness to pay for the rejuvenation of the Varattar River so that its direct and indirect benefits can be enjoyed by the local population, the environmental economic tool of contingent valuation was employed. For this, a hypothetical market was envisaged that would ensure a better Varattar river system management programme and improved water quality for people living in the study area. Using this method, respondents were provided with two scenarios, one in which the Varattar would be allowed to continue in its current state and the loss of these benefits that were once enjoyed by respondents free of cost would no longer be available in this scenario. the second

scenario in which it would be rejuvenated so that the local community would continue to enjoy its benefits.

Given these two scenarios, respondents were given the option to choose one. If they chose the first option, they were told that the rejuvenation process would involve a cost. They were asked whether they would be willing to bear part of that cost. They were asked their willingness to pay for a period of one year either in lump sum or as a monthly instalment. In case the response was positive, respondents were taken step by step through a series of payment options to arrive at a final payment amount. According to contingent valuation methodology, this amount which denotes the actual willingness to pay of the respondent is an estimate of the value of the Varattar and its benefits to that particular individual. If the response was negative, the respondent was probed with attitudinal question to find the reason for lack of interest in the scenario. A series of attitudinal questions were also asked to ensure that the stated amount was a true reflection of respondent's willingness to pay.

i. Survey of Attitudes

Attitudinal questions were also asked to check whether the wiliness to pay estimates stated by respondents were genuine or not. When asked about the state of the Varattar, the unanimous response was that it was degrading.

When the respondents were asked if they believed that the Varattar had provided valuable direct benefits to the

local community in the past, nearly 62 per cent of the respondents strongly agreed while only 0.6 per cent disagreed. Table 3.1 gives the details.

Table 1.1
Response on the Direct Benefit Provided by the Varattar

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
No.	314	152	16	15	3	500
Percentage	62.8	30.4	3.2	3	0.6	100

Source: Primary Data, 2014

On questions on the specific indirect benefits provided by the Varattar, nearly 42 per cent of the respondents strongly agreed while 4.6 per cent disagreed stating that the Varattar was of no particular benefit to them. Table 1.2 gives the details.

Table 1.2
Response on the Indirect Benefit Provided by the Varattar

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
No.	209	196	57	15	23	500
Percentage	41.8	39.2	11.4	3	4.6	100

Source: Primary Data, 2014

When the respondents were asked if they believed that the measures taken by the Government for the rejuvenation of the Varattar had been effective, nearly 61 per cent of the respondents stated that they belived the government intervention had been ineffective. Only 2.6 per cent agreed that government measures had been effective. Table 1.3 gives the details.

Table 5.3
Response on the Effectiveness of Measures Adopted by the Government for the Rejuvenation of the Varattar

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
No.	13	103	287	36	61	500
Percentage	2.6	20.6	57.4	7.2	12.2	100

Source: Primary Data, 2014

When respondents were asked their willingness to pay for the rejuvenation of the Varattar, 71.6 per cent expressed their willingness to pay. Only 19.2 per cent

expressed unwillingness to pay. However, when the scenario was presented to them and the benefits of rejuvenation explained in details, all of them expressed willingness to participate in the project. Table 1.4 gives the details

Table 1.4
Response on the Willingness to Pay for the Rejuvenation of the Varatar

	Interested	Uninterested	Ready to Give if Necessary	Total
No.	358	96	46	500
(%)	71.6	19.2	9.2	100

Source: Primary Data, 2014

ii. Estimation Results

Regression was fitted to the CVM data using a Multinomial Logit Model with marginal effects. The statistical package limdep was used to run the regression and estimate values. Goodness of fit of the model was explained using pseudo R^2. A lognormal distribution with a spike falling at zero was fitted to the probability distribution. Table 1.5 gives the details.

Table 1.5
Regression Results for WTP Amounts

Multinomial Logit Model	
Maximum Likelihood Estimates	
Dependent variable	WTPDUMMY
Weighting variable	ONE
Number of observations	500
Log likelihood function	- 448.51
Restricted log likelihood	- 511.8
Chi-squared	103.5
Degrees of freedom	11
Significance level	.0000000

Source: Primary Data, 2014

iii. Analysis of Socio Economic Variables

From table 1.6, it can be seen that education was not significant (as the probability column shows). All the respondents were aware of the true value of the Varattar and were willing to pay for its rejuvenation irrespective of educational qualification. Gender was also insignificant. Age had very little impact on WTP and was negatively related to probability of WTP. As age increased by 1 unit, the probability of WTP decreases by 0.27 percent. Coefficients of all income dummies were significant at 1 percent level. All the coefficients explained above are based on the marginal effects coefficients obtained in the last column. Table 1.6 gives the details.

Table 1.6

Regression Results of Estimated WTP on Selected Environmental and Socio- Economic Variables

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z Signifi- cance	Mean of X	Marginal Effect
EDUDUM1	0.139621	0.25655623	0.544	0.5863	.3000977	- 0.018602
EDUDUM2	0.212156	0.23883074	0.888	0.3744	.5474095	0.0274788
INCOME1	1.242759	0.35401273	3.510	0.0004	.1153470	0.1609643
INCOME2	1.175632	0.29874700	3.935	0.0001	.3255132	0.1522699
INCOME3	1.138167	0.29576514	3.781	0.0002	.3607038	0.1448269
INCOME4	1.111132	0.27424754	3.912	0.0002	0.301013	0.1377761
INCOME5	4.126324	0.76378746	5.402	0.0000	.1339198	0. 5344486
GENDER	- 0.19160	0.19961879	- 0 .96	0.3371	.7438905	- 0.024817
AGE	- 0.02217	0.00700515	- 3.17	0.0015	39.35679	- 0.002872
OCCUDUM	0.565269	0.25741512	2.196	0.0281	.1378299	0.0732147

Source: Primary Data, 2014

The study estimated a mean monthly Willingness to Pay (WTP) of Rs.66.70. As a final exercise, the sample values were expanded to the population of the two panchayats in order to obtain an estimate for how much the residents of the two panchayats valued the indirect benefits provided by the paddy wetlands. The amount estimated was Rs.25.725 lakhs. Table 1.7 gives the details.

Table 1.7
Willingness to Pay Estimates

Annual Income (Rs.)	Percentage of Respondents (%)	Mean WTP (Rs.)	Total WTP (Rs.)
< 5,000	29.7	52.7	1026470
5,000 - 10,000	34.0	42.4	308543.3
10,000 – 50,000	19.3	59.3	845286.3
50,000 – 1,00,000	7.8	88.0	275906
> 1,00,000	9.1	91.1	116654.6
Total	**100**	**66.7**	**25,72,860**

Source: Primary Data, 2014

The study estimated the total willingness to pay for the rejuvenation of the Varattar as Rs.25.72 lakhs and a mean Willingness to Pay (WTP) of Rs.66.7 per month.

6. Major Finding and Conclusion

The study observed that the direct benefits provided by the Varattar were manifold. The major direct benefits include water for Household Use, fertile soil on the banks of the Varattar, means of transporting goods and passengers, irrigating agricultural lands in the two panchayats. The Varattar was a major corridor for transportation of snake boats which came from far and wide to participate in the Aranmula Snake boat race. In addition to the direct benefits, the Varattar provides many indirect benefits to the local community. Regulating services provide people with benefits, such as flood regulation and detoxification, from the regulation of ecosystem processes. Information services include functions that contribute to human health, such as recreation, education and aesthetic experiences. Habitat refers to those functions that provide reproduction, habitat and refuge to wild animals and plants.

The second objective of the study was to estimate People's willingness to pay to rejuvenate the Varattar. For this, the Contingent Valuation Method was used.

Attitudinal questions were also asked to check whether the wiliness to pay estimates stated by respondents were genuine or

not. When the respondents were asked if they believed that the Varattar had provided valuable direct benefits to the local community in the past, nearly 62 per cent of the respondents strongly agreed while only 0.6 per cent disagreed. On questions on the specific indirect benefits provided by the Varattar, nearly 42 per cent of the respondents strongly agreed while 4.6 per cent disagreed stating that the Varattar of no particular benefit to them. When the respondents were asked if they believed that the measures taken by the Government for the rejuvenation of the Varattar had been effective, nearly 61 per cent of the respondents stated that they believed the government intervention had been ineffective. When respondents were asked their willingness to pay for the rejuvenation of the Varattar, 71.6 per cent expressed their willingness to pay. Only 19.2 per cent expressed unwillingness to pay. However, when the scenario was presented to them and the benefits of rejuvenation explained in details, all of them expressed willingness to contribute.

The survey also showed that education was not significant. All the respondents were aware of the true value of the Varattar and were willing to pay for its rejuvenation irrespective of educational qualification. Gender was also insignificant. Age had very little impact on WTP and was negatively related to probability of WTP.

The study estimated the total willingness to pay for the rejuvenation of the Varattar as Rs.25.72 lakhs and a mean Willingness to Pay (WTP) of Rs.66.7 per month. In a region where average daily wages centre around Rs.500, this is very low. Although people acknowledge the need for rejuvenating the Varattar, they are unwilling to pay greater amounts for the protection and continued provision of these benefits. Such value perceptions can only contribute to accelerated speed in the pace at which rivers are lost or converted to other land forms uses. Yet, scientific evidence shows that if market mechanisms were to be implemented to replace the provision of functions provided by rivers, the cost involved in their provision would run into crores.

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A Study on the Influence of River Pampa in Central Travancore

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Abstract

Each river is a culture that flows into the harbour of immortal time. The story of each civilization is also the story of a river. Civilizations blossomed on the banks of rivers, dark ages swept away and closed hearts opened up. Great rivers like the Nile, Indus, Euphrates *etc.* are not just sources of water, but breeding grounds of human civilization. The Pampa River in Kerala too had played a vital role in the life of the state, as it provided abundant water resource. The study focuses on River Pampa, how it influenced the culture and people in Central Travancore and the present condition of it.

Introduction

Kerala is a state bestowed with the bounty of nature's beauties, festooned with placid rivers, fresh lakes and lagoons, lush green forests and shimmering blue sea water. River is that mass of water which, while flowing on a slope along a definite course makes fragments flow along with it.Kerala is rich in rivers, west flowing and east flowing. Kerala has a total of forty four rivers of which forty one are west world flowing and three are east flowing. Comparatively the rivers of Kerala are of short length. The longest river is Periyar while the shortest is Mancheswaram. The River Pampa is the lifeline of Central Travancore and is also known as *"Dhak shina Ganga"*. It originates at Pulachimalai hill in Peerumadu in the Western Ghats and flows through Ranni, Kozhencherry, Chengannur, Thiruvulla and Ambalappuzha Taluks and finally empties in to the Vembanad Lake. The Pampa is the third longest river in Kerala with a length of l76 km, and a catchment area of 2235 Sq.km which flows through the most densely populated regions of the state. The River Manimala joins the Pampa at Valanjavattom (Eramallikara) near Thiruvalla and the Achankovil River at Veeyapuram near Haripad. The Pampa spreads itself as an arterial network in Kuttanadu, Kerala's rice bowl. Around 30 lakh people in the districts of Kottayam, Pathanamthitta and Alappuzha depend on this river for their daily water use (Hunt, 2005).

The Vembanadu wetland system is the largest brackish, tropical wetland eco-system on the south-west coast of India. The wetland system along with its rivers and minted drainage basins covers an area of about 15769 sq.km. Main rivers draining into the Vembanadu wetland system are the Pampa, Achankovil, Manimala and Meenachil. The Pampa is the largest river in the Vembanadu wetland system. It mixes with the Vembanadu Lake after a long journey of l29 km. Pampa is also the largest water contributor to the Vembanadu wetland system (Bijoy, 2004).

Sabarimala is one of the important religious centers closely minted to the river Pampa. Even more the history of the River Pampa can be extracted from the records of Sabarimala temple. Another important religious festival conducted in the Basin of the Pampa River is the Maramon Convention held annually by the Mar Thoma Evangelistic Association (MTEA), the Missionary wing of the Mar Thoma Church. Ayiroor Cherukolpuzha Religious convention is another important festival on the river bed of Pampa.

The River Pampa has been venerated as *Dakshina Ganga* and devotees of Lord Ayyappa believe that immersing oneself in the Pampa is equivalent to bathing in the Holy Ganges River. Bathing in the river, believed to absolve one's sins, is a requirement before commencing the trek though the forest to the Ayyappa Temple atop Sabarirmala. The Pampa water purifies one from curse and evil.

The River Pampa is the life line of Central Travancore and the Snake Boats *(Chundan valloms)* are one of the cultural gifts to the Keralites by the River Pampa. The Major snake boat races are conducted in the Pampa waters at various localities namely Ayroor, Malakkara, Chengannur, Mannar, Neeretupurarm, Payipadu, Pulinkunnu and Aranrnula. The snake boat race *(Chundan Vallom kali)* is one of the important 'traditional sports in Kerala. One of the most important boat races is being held at Aranmula in the river Pampa. Aranmula Boat Race is connected with the Onam Festival of Kerala. About 50 Snake Boats otherwise called *'Palliyodams'* participate in the Aranmula *'Uthruttathy Jalolswom'*. The Aranmula Jalolsawam is steadily and fast growing into a great international event. The Annual Boat Race is one of the biggest domestic tourist attractions every year.

The third longest river of the state is formed by the confluence of Kakki Aar, Arudai Aar, Kakkad Aar, Azhutha Aar, Perunthenaruvi, Madatharuvi, Varattar, Kuttemperoor Aar, Thanungattilthodu, Kozhithodu, and Kall Aar. The River Pampa is formed by several streams having their origin in the Pulnchimalai, Nagamalai, Sundaranmalai in the Peerumadu. Pampa has been contributing immensely to the communal harmony as it has become a cosmopolitan social event.

The Perunthenaruvi waterfall of the Pampa River is a favourite picnic spot for both domestic and foreign tourists. Kakki reservoir, set in sylvan background, is a tourists' delight. The splendid artificial lake offers exhilarating boating experience. The surrounding forest abounds with tigers, elephants, deers and monkeys.

Scope of the study

The study is relevant and unique because no systematic study about the topic was held till date. Pampa River provides transportation facility, cultural and religious activities, and the presence of a major Hydro-Electric Project. Thus it has been playing a significant role in the social and cultural history of Kerala. The contribution of the river Pampa to the development of Kerala is thus unique in every sense.

The major hypothesis put forward through the study is the influence of Pampa River on the social and cultural life of Kerala. It enriches our cultural uniqueness and flows as the embodiment of secularism. But this river is dying day by day due to unscientific and unauthorized sand mining and immense pollution. The need to protect the river without any further delay is inevitable.

Objectives

There are five major objectives of the study:

- ❖ to understand the origin and course of Pampa River in the river map of Kerala;

- ❖ to understand the religious and cultural significance of the river;

- ❖ to understand the present condition of the river, including the level of pollution and

- ❖ to assess the urgent need for its protection.

- ❖ to evaluate the role of the Pampa Parikrakshana Samithi in rejuvenating the River Pampa.

Influence of The River Pampa

Sabarimala Temple, Aranmula Temple, Chemkolpuzha Convention, Maramon Convention, Parumala Church, Edathuva Church and Aranmula Boat Race are the different religious-cultural entities that effect as a melting pot of varied cultural characteristics on the banks of the river Pampa. The relation between these cultural entities and the Pampa River is a matter of interest for academics and all those who try to preserve the ecological balance of Kerala for a long time.

Sabarimala is located about 72 km from Pathanamthitta town. The famous Temple dedicated to Lord Ayyappa where thousands of ardent devotees assemble between the months of November and January is located here. The devotees undertake penance for about 41 days during which period they follow austerity measures before taking on the pilgrimage. The Temple is situated in the picturesque mountain ranges of Sabarimala at about 9l4 meters above sea level. It can be reached only on foot, traversing about 4 km from the banks of Pampa, The Temple is closed on all other days of the year except during the festive season between November and January and the first five days of every Malayalam month and also during Malayalam New Year, Vishu. The temple welcomes people of all cult and creeds, except women between 10 and 50 years of age.

Aranmula is a beautiful village located further inla nd from Chengannur. It is from here that the sacred jewels of Ayyappa are taken in processions to Sabarimala every year. Aranmula is also known for

the water sports involving a spectacular procession of snake boats. It is also linked with legends from the *Mahabharata*. Among the Krishna Temples of Kerala, the most important ones are at Guruvayur Trichambaram, Tiruvarpu, Ambalapuzha and Aranmula. Aranmula is one of the five ancient Shrines in the Chengannur area of Kerala, mentioned in the Mahabharatha. It has been glorified by the Tamil hymn of *Namalvar* of the first millennium A.D. A great many legends is associated with the establishment of the Aranmula Temple. This temple is located on the banks of river Pampa. It is associated with water carnivals – boat race during the Onam season.

The snake boat race is a traditional water sport of Central Travancore especially in Pathanamthitta and Alappuzha Districts, which attracts thousands of tourists from all over the world. People of all ages, castes and creeds gather to enjoy the skillful rhythmic action of peddling and rowing. Boat races have made very valuable contribution to Indian wood craft. It has given rise to a section of expert craftsmen who have perfected the skill of snake boat making. The extraordinary skill, intelligence and imagination applied by the craftsmen of Kerala in the construction of beautifull Chundan Valloms receive admiration from artists and tourists alike.

Palliyodams are given sanctity of a temple due to the belief in the presence of the Diety, *Parthasarthy* of the Holy Shrine of the Aranmula Temple. This legendary festival is a great annual event in Central Travancore. It has religious, artistic and social overtones. Nowhere else in the world would there be such an event with as many as thousands of people forming one *eenam and thalam*. It has no parallel as it is a commemoration of an ancient tradition rooted in 600 years of history. Aranmula boat race has manifold significance; it has contributed intensely to communal harmony and it has become a cosmopolitan social event, participated by the people of all religions, ages and creeds. It attracts thousands of domestic and foreign tourists (Menon, 1967).

Aranlmula Kannadi is a special type of mirror produced at Aranmula. This unique metal mirrors are the result of Kerala's rich cultural and metallurgical traditions. The British Museum in London has a 45 cm tall Aranmula Metal Mirror in its collection. The origin or the Aranmula Kannadi is linked with the Aranmula Panhasarathy Temple. As per legend, eight families of experts in temple arts and crafts were brought by the royal chiefs of Aranmula from Thirunelveli District to work in the Parathasarathy Temple centuries ago. Some undisclosed metals were alloyed with copper and tin to cast the mirrors. The procedure and metallurgy are now known only to a single family in Aranmula.

Edathua church is picturesquely located on the bank of the River Pampa and has an ancient church dedicated to St. George which attracts large number of pilgrims. Along with the Kalloorkad Church, it is one of the oldest churches, with the image of St. George installed in it. It is believed to have been brought from the ancient Edapalli Church. The annual festival in April and May attracts thousands of pilgrims especially from Tamil Nadu.

Cherukolpuzha Hindu Matha Parishat is an annual Hindu convention held on the sandy stretches of Pampa River. The place where this convention is held is named Vidyathiraja Nagar after the great Guru Sri. Vidyadhiraja Chattampi Swamikal.

Present Status of the River Pampa

The banks of Pampa were once rich in paddy, vegetables and fruits. It is believed that Pampa encounters rare medicinal plants and hence bathing in it used to cure illness. One of the prime causes of the degradation of this river system is due to extensive deforestation in the catchment area. This has resulted in the drying up of almost all of its 28 tributaries and the loss of its regular flow.

While deforestation is a gradual process of deterioration, unscientific and uncontrolled sand mining invariably leads to rivers dying without preamble. When sand is removed from the river bed, the hydraulic gradient will be increased dangerously. This reduces the capacity of the river in recharging ground water. Twenty lakh people living along the banks of Pampa are anxious at the inevitable consequences of rampant large scale sand mining. Due to unscrupulous sand removal, the river bed has lowered about 5 mts during the period from 1986 to 1998. The water level in the wells near the banks of the river is getting lowered and as a result people are forced to deepen their wells every year. Drinking water scarcity is being experienced even in very close areas of the river and crops are destroyed due to the lowering of water tables (Unnithan, 2000).

The pollution and disposal of waste materials directly into the river Pampa have caused severe threat to ecology and to public health. The level of pollution in the river Pampa during Sabarimala pilgrimage season has been alarmingly high. The total coliforms have reached the level of 95000 MPN per l00 Ml against the permissible limit of 500/100 Ml. Similarly the dissolved oxygen level in the river water is reduced to one milligram/litre against the maximum permissible limit of 3 mg/litre. The quality of water deteriorates considerably during the festival season. By the end of the season the river become a sewer to drain out the sewage.

People residing in the Pamps river basin up to Kuttanad are exposed to grave health risks during the *'Mandalam Makaravilakku'* pilgrimage season since the river gets increasingly polluted and several water-born diseases and multi-drug—resistant diseases are on the rise in the Kuttanad region. The only solution to this serious problem is setting up of required infrastructure such as high capacity sewage treatment plants at Pampa and Sannidhanam, keeping in mind the increasing number of pilgrims every year, so as to arrest the discharge of fecal contamination and other hazardous wastes into the river. Many water born diseases have become common throughout the year by drinking water from Pampa. Hepatitis and Typhoid are the main water-borne disease affecting among the people.

The callous neglect of the Devaswam Board and massive pollution creates the worst kind of environmental sacrilege with far reaching and even irrevocable

consequences. The pollution of Pampa water, in turn, has adversely affected the growth of fauna and flora which is an environmentally undesirable phenomenon for the ecosystem.

Remedial Measures:
The Role of PPS

The Pampa Parakshana Samathy (PPS) is a voluntary Non-Governmental Organization working relentlessly since I993 to protect the River Pampa and to save it from degradation and destruction. The PPS was formally inaugurated at a large public gathering at Kozhenchery on l4 May I994 and it has been working to study the problems faced by the river and seeking solutions to those problems. It works along with other organizations like Center for Earth Sciences Studies (CESS), Center for Water Resources Development and Management (CWRDM) and the Kerala State Pollution Control Board.

Early efforts of the PPS to curb the illegal and unscientific removal of sand from the river bed prompted the then Pathanamthitta District Collector, Smti. Valsala Kumari to intervene. As a result of the deliberations that followed, removal of sand from the Pampa in the stretch extending from Cherukolpuzha to Kizhavarakadavu was banned in April, I995. There were path breaking developments which led ultimately to the regulation of sand removal from all Kerala's rivers by the State Government. Fifty percent of revenues generated by sale of river sand by local self governments are to be deposited in a "River Protection Fund". The Kerala River Bank Protection and Sand Removal Regulation Act, 2001 were posted on 6th

December 2001 in the Kerala Legislative Assembly and implemented from 27th April 2002. The Hon'bl Kerala High Court directed the Pollution Control Board to monitor the pollution levels in Pampa at Sabarimala basin during the pilgrimage season. A sewage treatment plant and two incinerators were put in place in 2002 (Kurup, 2010).

The PPS studied the problems created by the ever-growing crowds at Sabarimala and ways to manage the situation effectively. It submitted an Action Plan to the High Court and the State Government. As a result of endless representations, the Legislative Assembly Environment Committee headed by Prof. A. V. Thamarakshan visited Sabarimala and initiated a sub-committee with the District Collector as Chairman to prepare a master plan for Sabarimala. The report of the sub-committee was presented in the Legislative Assembly on 6th August, 1988. However, as a result of strong opposition from the Devaswom Board, the Government was not able to execute the master plan. The PPS has approached the High Court praying for the Court's intervention to have the master plan executed(Kurup, 2010).

The PPS supports and encourages the efforts of Varattar Samrakshana Samithy (Edanadu) to revive Varattar, which is a branch of Pampa. The Manimala and Achankovil rivers, tributaries of the Pampa, also face serious problems. PPS has played a useful role in the ongoing campaigns to save those rivers too. The PPS took the initiative and brought together activists of various river protection organizations

in Kerala under the umbrella of the All Kerala Rivers Protection Council with head quarters at Aluva.

The cleaning up of the River Pampa has been one of the prime concerns of the PPS. The pollution created by the pilgrimage to Sabarimala, the convention held on the river bed and the direct discharge of untreated hospital wastes cause untold damage to the river and seriously affect the quality of life of the people who depend on Pampa's water. In 1997 the PPS prepared an Action Plan for the conservation and protection of Pampa and presented it to the Public for debate and discussion. The plan was favorably received and was widely covered in the news media. Since 1995, the PPS has been campaigning against the proposed Pampa, Achancovil, Vaipar link project formulated by the National Water Development Agency. The PPS is also engaged in activating NGOs and Nature Clubs in educational institutions along with the river basin to popularize the need for conserving the river eco systems in Kerala especially the river Pampa as part of environmental education and awareness campaigns (Kurup, 2010).

The Pampa Parirakshana Samithy has completed the following projects satisfactorily:

1. Environmental Education and Awareness Campaigns as part of Pampa Action Plan supported by the National River Conservation Directorate.

2. Establishment of Environmental Resource Centre as part of the Govt. of India.

3. Science popularization programme, Creation of Environmental Resource on River Pampa supported by the Kerala State Council for Science, Technology and Environment (KSCSTE), Thiruvananthapurnam.

River Pampa being included in the National River Conservation Plan (NRCP), the Ministry of Environment and Forest (MoEF) has approved the first phase of the Pampa Action Plan (PAP) estimated to cost Rs. 18.45 crore and set apart Rs. 12.9 crore as its share. The National River Conservation Directorate (NRCD) is the body under the MoEF that administer the National River Conservation Plan. The Govt. of Kerala had issued an order on November 2003 for implementing the first phase of Pampa Action Plan and appointed the Kerala Water Authority (KWA) as the Nodal Agency to implement the PAP. The river Pampa is the only river from Kerala being included in the National River Conservation Plan (NRCP). The objective of the River Action Plan is to improve the water quality of major rivers which are the major fresh water sources in the country through the implementation of various pollution abatement schemes. The important works being taken up under NRCP include:

❖ Interception and diversion of works to capture the raw sewage flowing into the river through open drains and divert them for treatment.

❖ Sewage Treatment Plants (STP) for treating the diverted sewage.

❖ Low cost sanitation works to

prevent open defecation on river banks.

❖ River front development works such as improvement of bathing Ghats etc.

The Ministry of Environment & Forest has sanctioned Rs. 18.45 crore for Pampa River Action Plan in Kerala. The amount has been sanctioned under the National River Conservation Plan on 70:30 cost sharing bases between the Central Government and the State Government of Kerala where the Central Government's share in the project will be Rs. 12.92 crore and the State Government's share will be Rs. 5.53 crore. Under the project, 12 components of works have been approved. It has been interlinked with the Sabarimala master plan. The project envisages the establishment of an environmental resource centre for the collection of locally available information of rich cultural heritage along the river basin and popularize science and technology for the uplift of poor people.

Conclusion

Rivers are sacred for the people of Kerala and the cultural diversity along the river bank has been immense. There is an urgent need for conserving the rich heritage and culture associated with the riverside ecosystems in Kerala, particularly those associated with river Pampa and the sustainable development of the State Kerala. To mitigate the degradation of our inherited wisdom and care for nature, a wholehearted initiative from the grass root level is essential. In this scenario, the relevance of an institution dedicated exclusively to documenting the rich river heritage of Kerala and an action program

networking conservation and environment education activities is significant. Now the stage is set for a severe socio economic and environmental disaster along the banks of the river Pampa. Pampa is not alone in its plight. Almost all major rivers of Kerala face days of danger due to over exploitation. The rain fed river systems need to be conserved and their resources utilized with moderation.**References**

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DPPH Radical Scavenging Activity of Different Extracts of *Pajanelia Longifolia* (Willd) K. Schum flower

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Abstract

The present study was to determine the DPPH radical scavenging activity of different extracts of *Pajanalia longifolia* flower. The results were expressed in their IC_{50} values and the extract with low IC_{50} values were considered as good antioxidant. From the results methanol extract showed more DPPH radical inhibition with an IC_{50} value of 15.25 μg/ml, followed by petroleum ether extract with 18.5 μg/ml, chloroform extract with an IC_{50} value of 25.25 μg/ml, acetone extract with an IC_{50} value of 41 μg/ml and the water extract showed least inhibition with an IC_{50} value of 113 μg/ml.

Introduction

Free radicals can cause cellular damage and can oxidize critical cellular components such as membrane lipids, proteins, and DNA. This damage has been associated with diverse patho-physiological events, including cancer, atherosclerosis, diabetics, renal disease, and neuro-degeneration (Seitz and Stickel, 2006). Various plants extracts and plant derived compounds are known to reduce the deleterious effect of free radicals. Medicinal plants are a valuable source of natural products for maintaining human health. According to world health organization medicinal plants would be the best source to obtain a variety of drugs (Santos *et al*, 1995). The medicinal properties of the plants are due to the phytochemicals produced by them. *Pajanelia longifolia* (Willd) K. Schum, is a large deciduous tree belonging to the family Bignoniaceae. From the ethnobotanical information available, the

root, leaves, stem bark, inflorescence, fruit and seeds were used as medicine against fever, oedema, diarrhoea, dysentery and rheumatism, urinary bladder disorders, cough and also as antiseptic. Screening of various plant parts for biological activities showed its hepatoprotective, immunomodulatory (Shwetha *et al*, 2012), antibacterial activities (Choudary *et al*, 2010) and also can be used against obesity (Akhila *et al*, 2013).

The present study was undertaken to evaluate the antioxidant activity of different extracts of Pajanelia longifolia flowers.

Materials and methods
Collection and peroration of extract

Pajanelia longifolia flowers were collected from Chengannur, Alappuzha, Kerala, India. The collected flowers were washed with dechlorinated water, shade dried under room temperature and powdered. 25 gram of powdered flowers was extracted successively with different solvents based on increasing order of their polarity. With each solvent, extraction was continued till no more colour has formed with respective solvents. After each extraction the residue was dried in oven and been used for next extraction. The filtrate were taken and evaporated until solvents were completely evaporated to get the solidified extracts. The extracts thus obtained were stored in clean vials and maintained at 4oCin a refrigerator.

In vitro Antioxidant activity by DPPH radical scavenging activity

The free radical scavenging activities were determined by 1, 1-diphenyl-2-picrylhydrazyl (DPPH) method with some modifications of the method proposed by Coruh *et al* (2007). DPPH solution (0.005 mg/ml) in methanol was prepared and a series of extract solutions with varying concentrations were prepared by dissolving the dried extracts in methanol and 0.1 ml of solutions from each extract was added to 1.4 ml of DPPH solution. The absorbance at 517 nm was recorded after 5 min of incubation at room temperature. Radical scavenging capacity of each extract has been calculated as the percent DPPH radical scavenging affect which is:

$$\% \text{ of inhibition} = \frac{(\text{Absorbance of control} - \text{Absorbance of extract})}{\text{Absorbance of control}} \times 100$$

Result and Discussion

The present study evaluates the antioxidant activity of different extracts of *P. longifolia* flowers. The beneficial effects of the plant extracts and natural products as antioxidant agents, based on reaction with free radicals and other reactive species, has become the focus of interest. In addition, it has been demonstrated that herbal plants play a protective role in the pathogenesis of various diseases (Halliwell, 1990). For the present study successive extraction was performed using five solvents based on their polarity. The solvents used were petroleum ether, chloroform, acetone, methanol and water.

The antioxidant activities are studied by performing DPPH radical scavenging assay. The results were expressed in their IC_{50} values (Table 1). The extracts showed their antioxidant ability in scavenging the DPPH free radicals. DPPH is a stable free radical and accepts an electron or

hydrogen radical to become a stable diamagnetic molecule (Yamaguchi et al, 1990). The reduction capability of DPPH radicals was determined by the decrease in its absorbance at 517 nm induced by antioxidants. In this method the commercially available and stable free radical DPPH (2, 2- diphenyl -1 -picryl hydrazyl) soluble in methanol was used, which may be disappeared or reduced by the antioxidant compounds.

The methanol extract showed more DPPH radical inhibition with an IC_{50} value of 15.25 μg/ml (Table 2), followed by petroleum ether extract with 18.5 μg/ml (Table 2) chloroform extract with an IC_{50} value of 25.25 μg/ml (Table 2), acetone extract with an IC_{50} value of 41 μg/ml (Table 3) and the water extract showed least inhibition with an IC_{50} value of 113 μg/ml (Table 4).

The results revealed different levels of DPPH inhibition by different extracts. This may be due to the solubility of phytochemicals in different solvents that varies in their polarity. The petroleum ether being the non polar solvent can be used to extract non polar or less polar compounds like terpenes. The chloroform extract contain steroids, terpenoids and alklaoids. The acetone extract contain few alkaloids, glycosides, flavonoids, phenolics and saponoins. The methanolic extract contains glycosides, flavonoids, phenolics, and saponoins. The water extract being the most polar and contain the more polar glycosides, flavonoids and phenolics.

The result obtained thus indicates that Pajanelia longifolia extracts has

potent antioxidant activity by scavenging abilities against DPPH radical. This plant is considered medicinal in using the root, leaves, stem bark, inflorescence, fruit and seeds against fever, oedema, diarrhea, dysentery and rheumatism, urinary bladder disorders, cough and also as antiseptic. The successive solvent extraction caused the dissolution of different phytochemicals in them. These include terpenoids, alkaloid, steroid, polyphenols, flavonoids, flavones, tannins etc. The above proposed antioxidant activity of different extracts of P. longifolia flower may be due to the presence of these phytochemicals. And the variation in their activity may be due to the difference in concentration of phytochemicals, nature of compounds present in each extract or due to the interaction between different phytohemicals present in each extract.

In conclusion, P. longifolia extracts are found to posse's antioxidant activity. The present results demonstrate that P. longifolia is a potential source of natural antioxidants can be used in treatment and prevention of diseases caused by free radicals. Indeed there is a need for detailed investigation for molecule that are responsible for the proposed activity.

Extracts	*IC50 value
Petroleum ether extract	18.5 μg/ml
Chloroform extract	25.25 μg/ml
Acetone extract	41 μg/ml
Methanol extract	15.25 μg/ml
Water extract	113 μg/ml

IC50 value is the concentration of extract needed to inhibit 50% of the radicals produced in the reaction mixture

Table 2. Percentage of inhibition of DPPH radical by petroleum ether, chloroform and methanol extracts of Pajanelia longifolia flowers

Concentration of drug (in μg/ml)	Petroleum ether extract (in %)	Chloroform extract (in %)	Methanol extract (in %)
5	12.05	1.78	28.57
10	25.35	16.60	32.58
15	30.69	23.75	49.37
20	59.28	37.76	69.46
25	71.33	49.64	84.10
30	91.07	64.73	93.21
35	91.85	73.21	95.05

Table 3. Percentage of inhibition of DPPH radical by acetone extract of Pajanelia longifolia flowers

Concentration of drug (in μg/ml)	Acetone extract (in %)
10	1.33
20	12.76
30	29.55
40	48.39
50	59.36
60	64.28
70	66.51

Table 4. Percentage of inhibition of DPPH radical by water extract of Pajanelia longifolia flowers

Concentration of drug (in μg/ml)	Water extract (in %)
20	1.78
40	11.87
60	22.76
80	34.55
100	43.39
120	53.92
140	54.46

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A Comparative Study on the Radula of Five Species of Octopods

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Abstract

Octopods are arguably one of the most charismatic cephalopods, because of their importance as fisheries resources, reported intelligence and behavioural complexity, vertebrate-like eyes and well developed capabilities for rapid change in appearance. Radula is the unique feeding organ of neocoleoid cephalopods consists of a maximum of nine elements. The radula morphology is different in different species. Scanning electron microscopy is the most powerful tool used in radular study. In the present study, we compared the radular morphology of five species of Octopods; *Amphioctopus marginatus, Callistoctopus luteus, Cistopus indicus, Octopus vulgaris* and *Pteroctopus keralensis*. Radular studies on these five octopods molluscs showed significant interspecific morphological differences on the rachidian, lateral and marginal teeths.

Key words: Octopus, radula, rachidian teeth, lateral teeth, marginal teeth.

Introduction

Octopods, popularly known as 'devil fishes', are marine benthic animals found in coastal waters to 1000 m depth of the oceans. The largest groups of octopods are the benthic octopuses of the family Octopodidae containing over 300 species (Norman *et al.*, 2014). Thus far, 38 nominal species of octopods, representing the families Octopodidae, Tremoctopodidae and Argonautidae, have been recorded from Indian waters and the Andaman and Nicobar and Lakshadweep islands (Silas *et al.*, 1985). In cephalopods, species descriptions are widely based on a set of variables published over 20 years ago (Roper and Voss, 1983) and the set of

recommended variables differs among octopuses, cuttlefishes, and squids. These variables have become important in cephalopod systematics because of the lack of hard structures for taxonomic and systematic analysis.

Radula is a unique feeding organ in mollusc specifically to gastropods and cephalopods. It is a minutely toothed, chitinous ribbon, which is typically used for scraping or cutting food particles from a surface. The morphology of radula is different in different species. A typical radula comprises a number of bilaterally-symmetrical self-similar rows of teeth rooted in a radular membrane. Some species have teeth that bend with the membrane as it moves over the odontophore, whereas in other species, the teeth are firmly rooted in place, and the entire radular structure moves as one entity. The odontophore is the tongue of flesh underlying the radular membrane, and controls the organ's protrusion and return. It can be likened to a pulley wheel over which the radular 'string' is pulled. The radula comprises multiple, identical rows of teeth; often, each tooth in a row (along with its symmetric partner) will have a unique morphology. Each tooth can be divided into three sections: a base, a shaft, and a cusp. The teeth often tesselate with their neighbours, and this interlocking serves to make it more difficult to remove them from the radular ribbon. The radular teeth can generally bend in a sideways direction.

The number, shape, and specialized arrangement of teeth in each transverse row is consistent on a radula, and the different patterns can be used as a diagnostic characteristic to identify the species in many cases. Each row of radula teeth consists of one central or median tooth (or rachidian tooth, rachis tooth); followed by the laterals and marginals. Many octopods have a peculiar type of heterodont radula in which the cusps of rhachidian tooth vary from one tooth to the next in a sequential manner. This arrangement is called seriation and results in a serial repetition along the radula. The number of teeth representing a series varies with the species but commonly the fifth tooth will resemble the first. The seriation can involve either asymmetrical or symmetrical rhachidian teeth. The usual radular formula for Coleoid cephalopods is written as MP+MT+L2+L1+R, where MP is the marginal plate, MT is Marginal tooth, L2 is second lateral, L1 is the first lateral and R is rhachidian tooth (Samuel and Patterson, 2003). One of the most peculiar is the "ctenoglossan" radula of bolitaenid octopods in which all lateral teeth are multicuspid (Naef, 1923; Nixon, 1995).
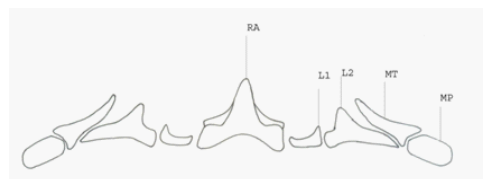
Taxonomy within the family Octopodidae continues to be a source of considerable confusion and controversy, despite extensive revisions in recent decades. Diversity of octopods is high in

the coastal waters of Kerala. As taxonomy is the basis for animal identification and classification of radula becomes an important key in describing a specific species. This prompted the present study.

Materials and methods

Study Period: November 2013-February 2014

Study Sites: Sakthikulangara and Neendakara

Sakthikulangara (08⁰ 55' N., 76o 32' E.) - Neendakara (08⁰ 56' N., 76o 32' E.) twin fishing harbours are situated at the mouth of Ashtamudi backwaters and about 9 km north of Kollam city. These harbours were selected as regular sampling sites for the study as majority of the trawlers in Kerala are operated from this area.

Collection and Preservation

Octopods for the radular study were collected from Sakthikulangara and Neendakara (Kollam) fishing harbours of Kerala. Collected specimens were washed thoroughly, kept in ice boxes and brought to the lab. In the lab, the fresh specimens were cleaned, washed and photographed using Nikkon D90 digital camera. The beaks and radulae of the octopus species were removed from the buccal mass and preserved in 70 per cent ethanol for the taxonomic studies. Specimens were preserved in 10% formaldehyde solution after noting the colouration.

SEM Studies

The radulae were removed from the proboscis and preserved in 70% alcohol. Scanning Electron Microscope (SEM)

photographs were taken to study the radula in detail. SEM micrographs were recorded using JEOL-Scanning Electron Microscope (model JSM-5600 Lv) available at National Institute for Interdisciplinary Science and Technology (NIIST), Council of Scientific and Industrial Research, Govt of India, Thiruvananthapuram. Line drawings on the structural pattern of radula (left and right transverse row) were undertaken. A comparison was also attempted on the earlier described species.

Results and discussion

Going through this study five species of Octopods, *Amphioctopus marginatus, Callistoctopus luteus, Cistopus indicus, Octopus vulgaris* and *Pteroctopus keralensis* were collected. Radular studies on these five octopods molluscs showed considerable variations on the rachidian, lateral and marginal teeths.

Morphological description of radula of five species of octopods as follows,

1. Amphioctopus marginatus Taki (1964)

Materials examined: 2 males and 3 females.

A. marginatus, radula with 7 teeth plus 2 marginal plates in each transverse row. Rhachidian tooth symmetrical, unicuspidate with broad, robust medial cone. Lateral cusps in symmetrical seriation migrating from medial to lateral position over 2–3 transverse rows. First lateral teeth unicuspidate, cusp towards the lateral edge, second lateral teeth unicuspidate, long with curved base, cusp on medial end. First marginal teeth long,

51

slender and tusk shaped, marginal plates rectangular in shape.
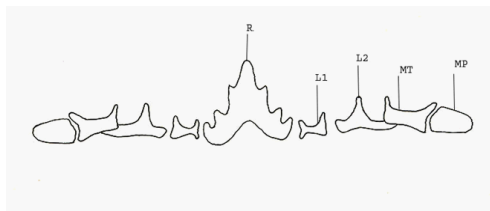
3. Cistopus indicus (Rapp, 1835)

Materials examined: 5 males and 5 females.

C. indicus, radula with nine elements, 7 transverse rows of teeth and two rows of marginal plates. Rachidian tooth big, leaf shaped with one or two lateral cusps on each side of the medial cone. Lateral cusps in asymmetrical seriation migrating from lateral to medial position over 2 transverse rows. First lateral teeth small with one medial cusp; second lateral teeth with wide heel, one dagger like cusp. Marginal teeth long with sabre like cusp, short base. Marginal plates oblong.
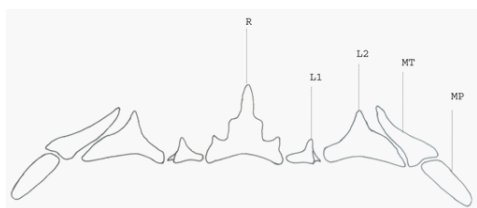
4. Octopus vulgaris Cuvier, 1797

Materials examined: 3 males and 2 females.

O. vulgaris, radula with 9 elements, 7 rows of teeth plus marginal plates. Rachidian tooth of radula with 2 lateral cusps on each side in asymmetrical seriation, migrating from medial to lateral position over 2 to 5 rows. First lateral teeth unicuspidate with strong, pointed cusp towards lateral edge. Second lateral teeth long, unicuspidate with cusp on medial end. Marginal teeth long, curved and marginal plates broad.
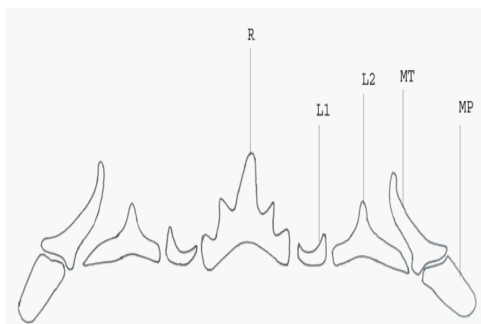
5. Pteroctopus keralensis (Oommen, 1966)

Materials examined: 5 males and 2 females.

P. keralensis, radula with 7 teeth plus 2 marginal plates per transverse row. Rachidian tooth bicuspid with moderately broad median cusp. First lateral teeth has a slightly arched base and small cusp. Second lateral teeth long and acutely pointed. First marginal tooth strong and curved. Marginal plates oval shaped.
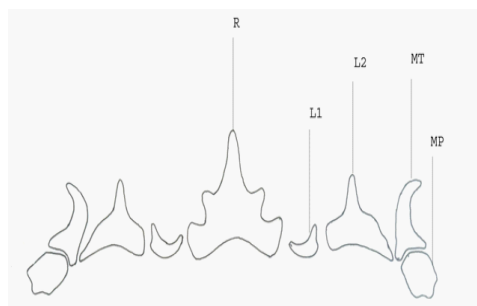
Table 1. Comparison of morphometric characters of radula of
A. marginatus, C. luteus, C. indicus, O. vulgaris and P. keralensis

Species	R	L1	L2	MT	MP
A. marginatus	Symmetrical, nicuspidate, medial cone broad	Unicuspidate, cusp towards the lateral edge	Unicuspidate, curved base, cusp on medial end.	Long, lender and tusk shaped	Rectangular
C. luteus	2–3 lateral cusps, robust medial cone; lateral cusps - symmetrical seriation	small, unicuspidate, cusp towards the lateral edge	Unicuspidate, cusp on medial end.	Small with curved base	Broad, bluntly rounded
C. indicus	Big, leaf shaped, one or two lateral cusps lateral cusps -asymmetrical seriation	Small with one medial cusp	Wide heel, one dagger like cusp.	Long with sabre like cusp, short base	Oblong
O. vulgaris	Bicuspid, asymmetrical seriation (migrating from medial to lateral position over 2 to 5 rows)	Unicuspidate, cusp towards lateral edge	Long, unicuspidate, cusp on medial end	Long, curved	Broad
P. keralensis	Bicuspid, moderately broad median cusp	Small, unicuspidate, slightly arched base	Long, pointed	Strong, curved	Oval

Morphometric studies of the radula should be carried out first on ontogenic series of one species to determine the degree of individual variation (Bradner and Kay, 1996). For this, repeated sampling and studies on radula of a single species could help us to arrive at new results and a clear radular structure for that particular species.

Radular difference between the five species is very distinct than their relatives of the same genus. These distinct findings serve as key identification characters for taxonomical references. It would be very useful to name individual radula types for species identification but till now the complexity has narrowed the chances to categorize the types of radula. The positive

result is that the different shapes of the individual tooth structures can be used for identification of different species with similar morphological characters coming under the same genus.

Conclusion

Radula, an organ of great systematic importance. It has also being recognized as an important morphological criterion for the taxonomic allocation of species. It shows general similarities at family and generic level with consistent differences at the species level. The different structures of the individual tooth in the radula of the octopods (A. marginatus, C. luteus, C. indicus, O. vulgaris and P. keralensis) will be a positive key and reliable one for the identification and confirmation of the species whenever there is difficult in identifying the species with morphological characters.

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Equation of time

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Abstract

Time as we all know, is very important in everyone's life. The project entitled 'Equation of time' is all about how to calculate the **Time** in ordinary use. The theories behind the calculation of time are *Rotation and Revolution of Earth, Kepler's laws* etc. By the use of this theory the equation of time can be calculated.

Introduction

Time is the concept that develops under the motion of earth, mainly the rotation and revolution. All the celestial bodies rotate on the celestial sphere as a consequence of the rotations of earth. Sun makes daily motion (diurnal) and annual motion on the celestial sphere apparently. On a systematic study on the motion satisfying all the constraints we established the concept of day, month, duration of time, seasons and different types of time calculation. The study on this subject is very interesting since eagerness of knowing the universe and the time calculation sprouted from childhood itself.

Celestial Sphere

The imaginary sphere surrounding the observer on which we may suppose that the celestial bodies are fixed is called celestial sphere. The observer's position (or the earth in a large sense) is taken as the center of the celestial sphere whose radius is indefinite.

Diurnal Motion, Celestial Axis and Equator

The earths rotate about a diameter (called its axis) from west to east in 23 hour 56 minutes 4seconds of apparent solar time. This period is called a sidereal day. As a consequence the celestial sphere with all the celestial bodies appears to rotate from east to west. The apparent daily rotation of celestial sphere is called diurnal rotation. Axis of diurnal rotation of celestial sphere is called celestial axis. The points where the axis meets the celestial sphere are called the celestial poles. The great circle of the celestial sphere perpendicular to the celestial axis is called celestial equator.

Annual Motion of Sun, Ecliptic, Obliquity

All celestial bodies take part simultaneously in the diurnal motion. Apart from taking part in the diurnal motion certain bodies like sun, moon, planet etc. have their own independent (actual or apparent) motion in space. The sun moves along a great circle of celestial sphere eastward describing about one degree per day relative to stars completing on around in one year. The annual motion of the sun is only apparent and is due to the earth's annual revolution around the sun. The path of the apartment annual motion of the sun is called ecliptic. The plane of the ecliptic is inclined at any angle of about 23°27' to the plane of the equator. The angle is called the obliquity of the ecliptic and is denoted by ω.

First point of Aries and first point of Libra

The ecliptic and the equator intersect at any two points

1.   First point of Aries (Y)
2.   First point of Libra (Ω)

Northern Hemisphere
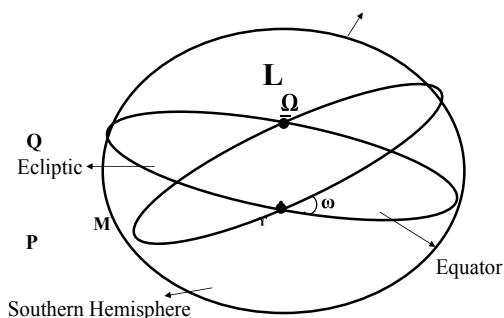
Equinoxes and Solstices

During the annual motion the sun comes to the first point of Aries Y on March 21st. The sun comes to first point of Libra Ω on September 23rd. The sun comes to the position midway between Y and Ω on ecliptic on June 21st. The sun comes to the portion midway between Ω and Y on the ecliptic on December 22nd.
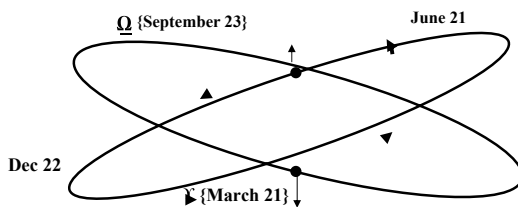
Sidereal Time

The period of one complete rotation of the celestial sphere about the celestial axis is called a sidereal day. It is also the period of one complete revolution of any celestial body in diurnal motion. Therefore sidereal time can be reckoned with reference to the revolution of any fixed star. Conventionally sidereal time is calculated by the revolution of the first point of Aries Y. The sidereal day is the interval between two successive transits (upper or lower) of the first point of Aries. When the first point of Aries Y is at its upper transits it is sidereal noon. It is the beginning of sidereal day. When it reaches the portion of the lower transits, it must sidereal midnight.

The duration of sidereal day is 23 hr. 56 min 4 sec of ordinary solar time. As in the case of ordinary solar time a sidereal day is divided into 24 sidereal hrs. A sidereal hour is divided into 60 sidereal seconds. The clock which keeps sidereal time is

called the sidereal clock or Astronomical clock.

Sidereal time is useful for some astronomical purposes it is not useful for civic purpose, as it has no direct bearing to the day and night phenomenon. Apparent solar time is reckoned by the motion of the apparent sun i.e. true sun. Due to the non-uniform motion of the sun, in R.A. during the year, the duration of the apparent solar day (interval between two successive transits of the same kind of the apparent sun) is not a constant and therefore the apparent solar time cannot be kept, by a clock working at a regular rate. To get over the defects of the sidereal time and apparent solar time, astronomers have introduced mean solar time which is called time indicated by the hour angle of an imaginary sun called the Astronomical mean sun or the mean sun. The mean sun is an imaginary point on the equator describing it in the same period as the sun that is a year. But changing its right ascension uniformly and such that at any instant the mean sun and apparent sun differ a little in right ascension.

Celestial Coordinate System

It is useful to impose on the celestial sphere a coordinate system that is analogous to the latitude-longitude system employed for the surface of the Earth.

Right Ascension and Declination: This coordinate system is illustrated in the following figure (for which you should imagine the earth to be a point at the center of the sphere).

In a celestial coordinate system the North and South Celestial Poles are determined by projecting the rotation axis of the earth to intersect the celestial sphere, which in turn defines a Celestial Equator. The celestial equivalent of latitude is called declination and is measured in degrees North (positive numbers) or South (negative numbers) of the Celestial Equator. The celestial equivalent of longitude is called right ascension (R.A.). Right ascension can be measured in degrees, but for historical reasons it is more common to measure it in time (hours, minutes, seconds): the sky turns 360 degrees in 24 hours and therefore it must turn 15 degrees every hour; thus, 1 hour of right ascension is equivalent to 15 degrees of (apparent) sky rotation.
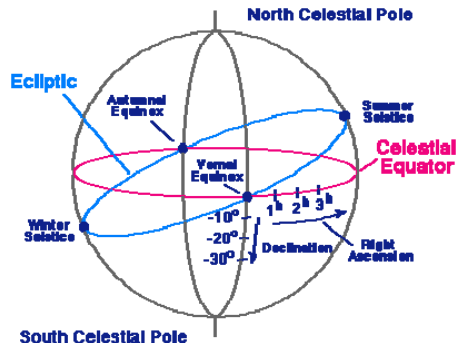
Kepler's Laws of Planetary Motion

Law 1: Every planet describes an elliptical orbit around the sun, the sun being situated at a focus.

Law 2: The motion everywhere in the orbit of a planet is such that the radius vector joining the sun and the planet describes equal areas in equal interval of

time i.e. the areal velocity of a planet is constant.

Law 3: The Square of periodic time of planets are proportional to the cube of their mean distance (semi-major axis of their orbits) from the sun.

The earth being a planet obeys the above laws. Therefore the actual orbit of the earth around the sun is an ellipse with the sun at the focus. It can be proved that the apparent orbit of the sun around the equal ellipse with earth at a focus.
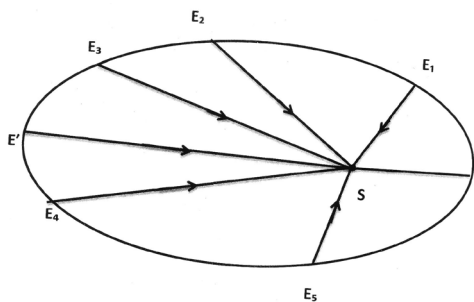
(1)
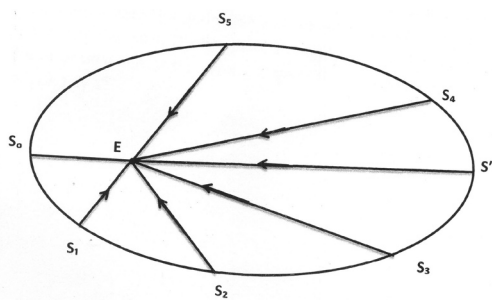
(2)

In (1) let E_1, E_2, E_3, E_4... be different positions of the earth in its actual orbit around the sun S, which is at a focus. In (2) ES_1, ES_2, ES_3, ES_4...are drawn parallel

and equal respectively to E_1S, E_2S, E_3S, E_4S... Now S_1, S_2, S_3, S_4... are the apparent position of the sun assuming the earth were at rest. Clearly the locus obtained by joining these points in an ellipse equal to the actual orbit of the earth around the sun. The earth is at a focus of this relative orbit of the sun.

The position E of the earth in its actual orbit around the sun when it is nearest to the sun is called perihelion and the position E' when the earth is farthest from the sun is called aphelion. If S_0 be the position of the sun in apparent orbit nearest to the earth and S' be the farthest position then S_0 and S' are respectively called perigee and apogee. In either case they are the extremities of the major axis of the elliptic orbit. Perigee and apogee (or perihelion and aphelion) are together called apses or asides of the orbit. The line joining them (major axis) is called the apse line or apsidal line of the orbit. Perigee falls on January 3rd and apogee falls on July 4th.

Dynamical Mean Sun

The dynamical mean sun is an imaginary object on the ecliptic describing its motion uniformly in the same period as the sun, that in one year. It coincides with the true sun at perigee and apogee.

At any instant the longitude of the dynamical mean sun is equal to the R.A. of mean sun.

Equation of Time

The west hour angle of the mean sun at any instant gives the mean solar time. As the mean sun is an imaginary object it cannot be observed to set time. Therefore

equation of time is introduced defining it as the interval to be subtracted from the apparent solar time to get the mean solar time.

The irregularity in the sun's motion in R.A. which makes the true sun unsuitable as a timekeeper arises out of two causes,

1) The relative orbit of the sun around the earth (i.e. eccentric) and as such the changes in longitude of the true sun is uniform. Therefore there is always difference between the longitude of the dynamical mean sun (l) and the longitude of the true sun ($\odot$) this difference is called the equation of time due to eccentricity or equation of centre and is denoted by E_2.

i.e. $E_2 = l - \alpha$

1) The sun moves along the ecliptic which is inclined at an angle ω to the equator. Therefore at any instant there is difference between the longitude ($\odot$) and R.A. (α) of the apparent sun. This difference is called the equation of time due to obliquity or reduction to the equator and is denoted by E_2.

i.e. $E_2 = \odot - \alpha$

$\therefore$ Equation of time $E = E_1 + E_2$

Note: (i) If the relative orbit of the sun where circular ($e=0$) then the longitudes of the true sun and dynamically mean sun are equal so that $E_2 = 0$. Hence E_2 is called equation of time due to eccentricity.

(ii) If the ecliptic coincides with the equator ($\omega=0$) the R.A. and longitude

of the true sun are equal so that $E_2=0$. Hence E_2 is called equation of time due to obliquity.

Analytical Expression for the Equation of Time

Equation of time has been defined as the amount of time to be subtracted from the apparent solar time to get the mean solar time.

Apparent solar time − E = Mean solar time

$\therefore$ *E = Apparent solar time − Mean solar time*

   = *Hour angle of the apparent sun − Hour angle of mean sun*

$= \left(\begin{array}{c} Sidereal\ time \\ -R.A.\ of\ the\ apparent\ sun \end{array} \right) - \left(\begin{array}{c} Sidereal\ time\ - \\ R.A.\ of\ the\ mean\ sun \end{array} \right)$

   = *R.A. of the mean sun − R.A. of the apparent sun*

= *longitude of dynamical mean sun − R.A. of the apparent sun*

i.e. $E = l - \alpha$

$= (l - \theta) + (\theta - \alpha)$

$= E_1 + E_2$

To find E_1
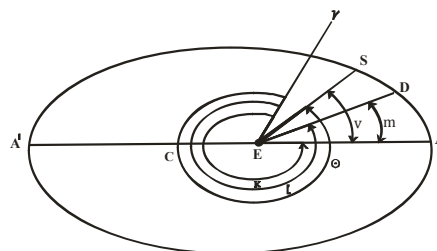
Let S be the position of the sun at any instant and D that of the dynamical mean sun. At this instant the angular distance of the dynamical mean sun from the perigee is the mean anomaly of the apparent sun.

$\therefore \angle AES = v$, True anomaly of sun

$\angle AED = m$, Mean anomaly of sun

We get,

$$\theta = K + v$$

$$l = K + m$$

$$l - \theta = m - v$$

Also $v = m + 2e \sin m + \frac{5}{4} e^2 \sin 2m + \cdots$

i.e. $v = m + 2e \sin m \ (nearly)$

$$m - v = -2e \sin m$$

$$= -2e \sin(l - K)$$

$$l - \varnothing = -2e \sin(l - K)$$

i.e. $E_1 = -2e \sin(l - K)$

To find E_2

We have, $\alpha = \varnothing - t \sin 2\varnothing + \frac{t^2}{2} \sin 4\varnothing$

Where $t = tan^2 \frac{\omega}{2}$

$$\alpha = \varnothing - tan^2 \frac{\omega}{2} \sin 2\varnothing \ (nearly)$$

$$\varnothing - \alpha = tan^2 \frac{\omega}{2} \sin 2\varnothing$$

$$= tan^2 \frac{\omega}{2} \sin 2[l + 2e \sin (l - K)]$$

$$= tan^2 \frac{\omega}{2} \sin 2l \ (nearly)$$

i.e. $E_2 = tan^2 \frac{\omega}{2} \sin 2l$

Equation of time,

$$E = E_1 + E_2$$

$$E = -2e \sin(l - K) + tan^2 \frac{\omega}{2} \sin 2l$$

$$E = \frac{12}{n} [-2e \sin(l - K) + tan^2 \frac{\omega}{2} \sin 2l]$$

hours of time

Taking $e = \frac{1}{60}$ and $\omega = 23°27''$

we get,

$E = -460 \sin(l - K) + 592 \sin 2l$ Seconds of time

Note: Equation of time at any instant can be either positive or negative.

Relation between Sidereal Time and Mean Time

We have already defined that a sidereal day is the interval between two successive transits of and the mean solar day is the interval between two successive transits of mean sun. A tropical year is $365\frac{1}{4}$ mean solar days nearly. In this period both the true and mean sun describe one complete revolution of 360^0 from the west to east relative to. During the period the mean sun performs $365\frac{1}{4}$ revolutions with respect to the meridian at any place. Therefore the first point of Aries performs $366\frac{1}{4}$ revolutions with respect to the meridian of the place.

$$\therefore 366\frac{1}{4} mean\ solar\ days = 366\frac{1}{4} sidereal\ days$$

Standard Times

Formally each country adopted its own meridian as the prime meridian. The method had many inconvenience, for the longitude of the same place were different on maps prepared by different countries. In 1884 a prime meridian conference was held in Washington. At the conference it was recommended that Greenwich meridian must be considered as zero meridian or prime meridian and the longitude of other places must be measured east or west of this prime meridian. It is also recommended that a particular country should follow a particular time throughout the country. This time is called standard time for the country. Standard time roughly corresponds to the central meridian of the country. It usually differs from the Greenwich Mean Time by an integral standard time followed in India is that given by the meridian of longitude 82˚30' E. That is the Indian Standard Time (I.S.T) is $5\frac{1}{2}$ hours in advance of Greenwich Mean Time (G.M.T)

I.S.T=G.M.T+5h.30m.

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Green synthesis of colloidal iron particles in nano dimensions using aqueous Adhatoda Vassica leaf extract and a study of their catalytic activities

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Abstract

Colloidal iron particles have been synthesized through a green strategy using the phytochemicals extracted from the leaves of the medicinally active plant, Adhatoda Vassica as reductant and capping agent. Amorphous iron particles were formed easily under ambient conditions and were characterized by UV-Vis spectroscopy and scanning electron microscopy. Reactivity of the colloidal iron particles were tested by (i) the H_2O_2-catalyzed degradation of bromothymol blue as a model organic contaminant and (ii) the electron transfer reaction between hexacyano ferrate (III) ions and thiosulfate. Both reactions indicated the as-synthesized iron particles to be catalytically active.

Introduction

The presence of nano and micro sized inorganic materials in nature have prompted researchers to design various processes mimicking nature and fortunately the efforts have succeeded to a great extent and has resulted in the development of relatively new and largely unexplored area of research based on the biosynthesis of nano materials. A bottom up approach in nano metal synthesis using microorganisms and plant extracts [1-5] are being used to synthesize metal nanoparticles where the main reaction occurring is reduction/oxidation. The microbial enzyme or the plant phytochemicals with antioxidant or reducing properties are usually responsible for reduction of metal compounds into their respective nanoparticles. While evaluating this approach from a green chemistry perspective it emerges itself as an ecofriendly method as the solvent used is mostly water and the enzyme/phytochemicals act as reducing and capping agents. Most synthetic methods on the other hand rely heavily on organic

solvents due to hydrophobicity of the capping agent used [6]

Iron has a great deal to offer at the nano scale, including very potent catalytic and magnetic properties. Recent work has begun to take advantage of iron's potential with efforts to stabilize it and work in this field appears to be gaining momentum [7]. Though much work has been done in the area of green synthesis of noble metal nanoparticles, very limited work has been done in the case of metals like Fe which are reactive species whose surface properties change rapidly and profoundly over time and solution chemistry and with environmental conditions. The biosynthesis of iron nanoparticles of various sizes and morphologies using sorghum bran extracts, aqueous coffee and tea extracts [8-10] have been reported. The size and crystallinity (hexagonal metallic iron, amorphous iron, and Fe2O3) of the synthesized iron nanoparticles were found to depend on the concentration of the extract in the reaction mixture and the synthesized iron nanoparticles were found to be nontoxic when compared with iron nanoparticles prepared using conventional NaBH4 reduction protocols [11]

Keeping this background in mind we have attempted the synthesis of iron nanoparticles with the leaf extract of the biologically active shrub AdhatodaVasica known in vernacular language as adalodakam. This plant belonging to the family of Acanthceae is grown in almost all households of Kerala and used in ayurvedic systems for treatments of coughs, asthma, and symptoms of common cold.

A secondary property of the herb is that it helps to stop bleeding. The roots, leaves and flowers of the plant are used for the extraction of volatile oils and alkaloids which have great medicinal importance.

Experimental

All chemicals were of analytical reagent grade, purchased from Merck (India) and used without further treatment. Double distilled water was used for preparation of solutions. Fresh leaves of adalodakam were collected from the college campus. It was thoroughly washed with double distilled water to remove any dirt present. The fresh leaves as well as dried leaves were used for preparation of the extracts.

Preparation of colloidal iron nanoparticles:

2g of dried ground leaves (or 10g of thinly cut fresh leaves) were extracted with 30ml of double distilled water at 30°C, 50°C and 80°C while being continuously shaken for 2 hours. After extraction, samples were filtered through a Whatmann No.1 filter paper and the filtrate centrifuged at 4000 rpm for 30 minutes. The resultant supernatant was collected and stored at -4°C till use. Iron nanoparticles were prepared by adding 0.1 M FeCl3 solution to the leaf extract (supernatant at ambient temperature) in a 2:1 volume ratio. The mixture was hand shaken for 1 min and allowed to stand at room temperature for 24 h for completion of the reaction. By the time the solution attains a dark brown colour and is subjected to high speed centrifugation to separate the colloidal iron nanoparticles.

Characterization of iron nanoparticles

UV –Vis spectra

The UV-VIS spectrum of the colloidal iron after completion of the reaction and centrifugation was recorded on a Shimadzu UV-2450 spectrophotometer.

SEM Analysis

Scanning Electron Microscopic (SEM) analysis was done using SEM JEOL MODEL JSM 6390L machine. Thin films of sample were prepared on a carbon copper grid by just dropping a very small amount of sample on the grid, extra solution was removed using a blotting paper and then the film on the SEM grid were allowed to dry by putting it under a mercury lamp for 5 minutes.

Catalytic Studies

Degradation of bromothymol blue

The performance of the synthesized iron containing nanoparticles in the degradation of organic contaminants was investigated using bromothymol blue (BTB) as a model organic contaminant.

Bromothymol blue solution (500 mg\L) was prepared by dissolving 50 mg of bromothymol blue in 100 ml of doubly distilled water. Blanks were prepared by adding 2 ml of BTB, 200μl ml of 30% H_2O_2 and 3ml water in a cuvette. The colloidal iron particles were added to double distilled water to make solutions with iron concentration of 3.33 μM, 6.66 μM, and 26.64 μM respectively. Sample was prepared by mixing 2 ml of 0.8 mM BTB and 200μl of 30% H_2O_2 in the cell. Cuvette was inserted into the spectrophotometer and the colloidal iron particles were added to the solution and quickly mixed with a pipette. Scans were started immediately after the addition of iron and the cuvette was left untouched until completion. Absorbance was monitored at the wave length of maximum absorption (431 nm).

Electron transfer reaction

For the electron transfer reaction between potassium ferricyanide and sodium thiosulphate 200μl of 0.01 potassium ferricyanide and 0.1 ml, 0.3 ml, 0.5 ml of iron nanoparticles solution containing 6.61μM, 19.98μM, 33.3μM of iron respectively were added to a cuvette and solution was kept at room temperature. The reaction was initiated by adding 0.2ml of 0.1 M $S_2O_3^{2-}$ solutions. The reaction was then monitored by measuring the absorbance at 420 nm.

Results

On adding the aqueous leaf extract to $FeCl_3.6H_2O$ (4ml) the solution instantaneously turned from pale yellow to dark brownish indicating the formation of iron nanoparticles. The pH value of iron nanoparticles prepared using leaf extract at 30°C, 50°C, and 80°C were 0.75, 0.80 and 1.15 respectively. These low pH values, suggested the formation of amorphous iron oxyhydroxide, known to form at low pH. However, sedimentation was not observed even after 2-3 weeks of storage which indicates that the synthesized iron nanoparticles are stabilized by the functional groups in the adalodakam leaf extracts.

UV-Vis Absorption

For the iron nanoparticles a continuous absorption is observed in the visible range. Similar UV- Vis spectra for amorphous iron nanoparticles synthesized using tea polyphenols [5,11,12] and aqueous sorghum bran extracts [13] have been reported.   It was also observed that colloidal samples prepared with dry leaf extract had more absorbance than those prepared with fresh leaf extract (Figure 1).
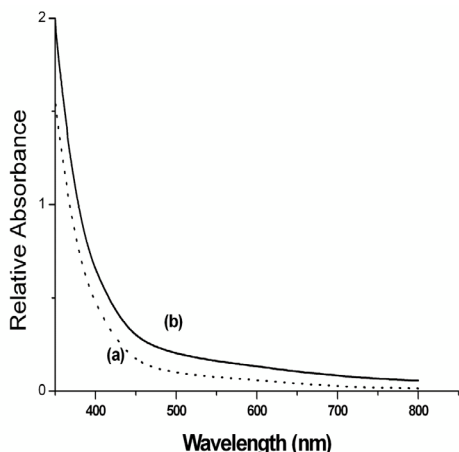

Figure 2. UV-Vis spectra of colloidal iron nano particles synthesized using aqueous adalodakam extracts at (a) 30°C (b) 50°C and (c) 80°C

Figure 3 shows the effect of concentration of iron salt solution on the absorbance, the absorbance being more for the nanoparticles prepared using 0.001N Fe than that prepared using 0.1 N $FeCl_3$.

Figure 1. UV-Vis spectra of colloidal iron nano particles prepared using extract of (a) fresh leaves (b) dried leaves

Further, the colloidal samples prepared with leaves extracted at 80° C had the maximum absorbance while that prepared with the leaves extracted at 30°C had the least absorbance (Fig 2).
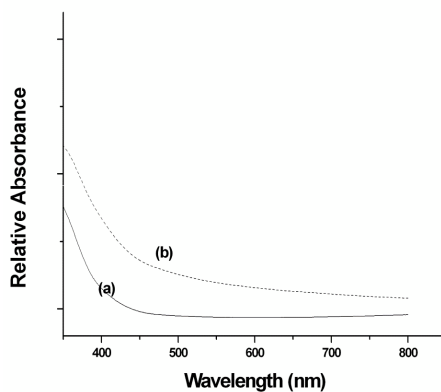
Figure 3 UV-Vis spectra of colloidal iron nano particles prepared using (a) 0.1 N FeCl3 and (b) 0.01N FeCl3

Sem analysis

The scanning electron micrographs of iron nanoparticles prepared using leaf extracts ADL 50 (leaves extracted at 50°C) and ADL 80 (leaves extracted at 80°C) are shown in figure 4. The particles clearly show differences in sizes of the nanoparticles. Those prepared with the extract ADL 80 have larger particle size than that prepared using ADL 50. Plant polyphenols and other hetero cycles are known to be extracted more at higher temperatures. As reported earlier by Nadagouda et al [5], the concentration

2% hydrogen peroxide and various concentrations of the synthesized iron nanoparticles. Degradation of bromothymol blue did not occur in the presence of only 2% H_2O_2. This indicates that there is no direct oxidation mechanisms by H_2O_2 alone. However, degradation of BTB occurred in the presence of 2% H_2O_2 and colloidal iron particles, suggesting degradation through a pathway catalyzed by the iron particles. The degradation of BTB was fastest in the presence of 2% H_2O_2 and 26.64 μM iron particles leading to an 80% reduction in the concentration
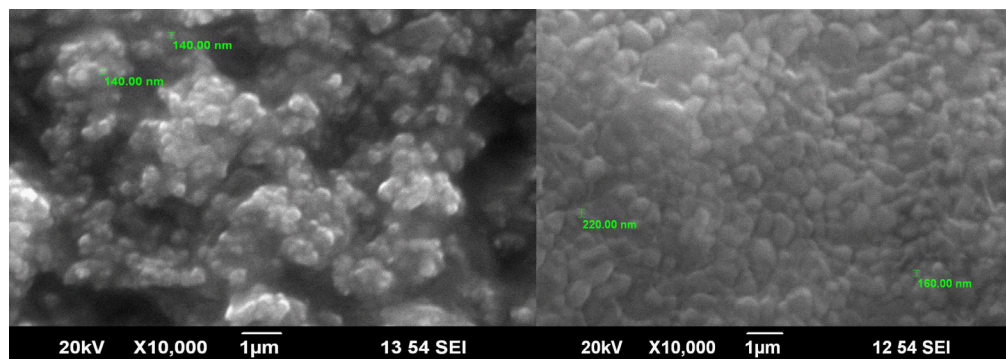
*Figure 4 Scanning electron micrograph of iron nanoparticles prepared
via the aqueous leaf extract ADL 50 and ADL 80*

of phenolic compounds is critical to the size and morphology of metallic nanoparticles. The iron nanoparticles prepared with leave extract ADL 50 shows particle of size 140 nm while that prepared using ADL 80 has particles with 220 nm and 160 nm sizes which is therefore in agreement with earlier reports.

Catalytic studies

Degradation of bromothymol blue

Figure 5 shows the degradation of bromothymol blue with   time using

of BTB within 60 minutes. In the presence of 2% H_2O_2 and 6.66 μM colloidal iron particles about 78% of BTB was degraded in 60 minutes. In the presence of 3.33μM colloidal iron particle the reaction was significantly slower and only about 11% of the BTB degraded in 60 minutes. This trend indicates a complex mechanism. In the case of 6.66μM iron particle the reaction seems to be better catalyzed. Though the results are indicative of an optimum concentration, this cannot be said with certainty as further studies need

to be conducted.

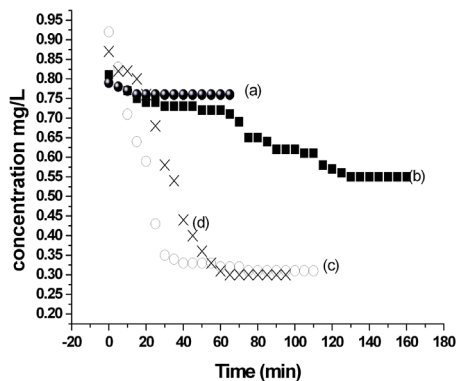Iron nanoparticles usually have a strong tendency aggregate resulting in rapid sedimentation and restricted movements.

Figure 5 : Degradation of BTB over time with with colloidal iron catalyzed peroxide (a)control (BTB with 2% H$_2$O$_2$ solution(b) BTB treated with 3.33μM (as Fe) iron particles and 2% H$_2$O$_2$(c) BTB treated with 6.66μM (as Fe) iron particles and 2% H$_2$O$_2$ (d) BTB treated with 26.64μM (as Fe) iron particles and 2% H$_2$O$_2$

This is particularly enhanced in aquatic environments. This is a block in the use of Fe nanoparticles in environmental remediation. In our case, since no flocculation or sedimentation was observed even after one week of storage it is to be inferred that the Fe nanoparticles   are stabilized by the polyphenols and water soluble heterocyclics. This stabilization is potentially useful for environmental and catalytic applications.

Electron transfer reaction

The electron transfer reaction between potassium ferricyanide and sodium thiosulphate was carried out in presence of the synthesized iron nanoparticles.

$$Fe(CN)_6{}^{3-} + S_2O_3{}^{2-} \rightarrow Fe(CN)_6{}^{4-} + S_4O_6{}^{2-}$$
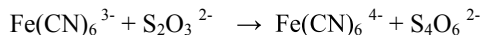
This particular reaction has been reported to be catalysed by Pt nanoparticles [14] where it is said the reaction proceed via electron transfer to and from the Pt particle surface such that the Pt nanoparticles act as highly dispersed electrodes.   In our case we monitored the decline of the absorbance of Fe(CN)6^{3-} at 420 nm with and without the leaf extract protected iron nanoparticles. The absorption was measured at intervals of 5 minutes for 110 minutes.   The reaction was also carried out in the absence of iron nanoparticles. It is seen from Figure 6 that the decline of Fe(CN)6^{3-} peaks were faster with increasing amount of iron nanoparticles (protected by leaf extract capping).   The reaction was also conducted in presence of iron nano particles (from which the capped agents were removed by repeated washing double distilled water).   Though the absorbance showed a decline it stopped within 5 minutes. Conclusion
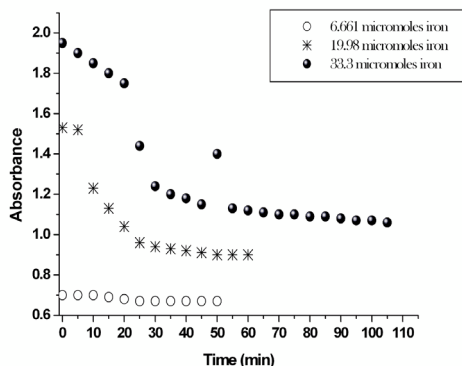

Figure 6: Electron transfer reaction between Fe(CN)63- and S2O32- catalyzed by capped Fe nanoparticles

Iron nanoparticles were biosynthesized through the use of plant extracts of the leaves of Adathodavasica via a green environmentally friendly and cost effective technique. The nanoparticles were characterized using UV-VIS spectroscopy and SEM analysis. Adalodakam leaves were extracted at different temperature and these extracts when used as green reductants gave nanoparticles with variation in particle size. This was evident from SEM analysis. It is to be inferred that the size of the nanoparticles is dependent on the concentration of the plant extracts. The catalytic activity of the synthesized iron nanoparticles were checked with the help of (i) H_2O_2 assisted degradation of bromothymol blue as a model organic contaminant and (ii) electron transfer reaction between $Fe(CN)_6^{3-}$ and $S_2O_3^{2-}$. Both the reactions were found to be catalyzed by the synthesized nanoparticles. Further, it was seen that increasing amount of Fe resulted in enhanced rate of the reaction and the phytochemicals present in the leaf extracts acted as capping agents for the nanoparticles.

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Coleus Aromaticus Plant Extract Mediated Green Synthesis of Silver Nano Particles and their Antibacterial Activity.

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Researchers have been fascinated by the concept of green synthesis of inorganic materials due to the advantages over conventional methods involving chemical agents associated with environmental toxicity. Synthesis of nanoparticles using plant extracts is particularly attractive and the use of plants with reported biological activity is being explored in the synthesis of metal nanoparticles towards medicinal applications. In this study we have synthesized silver nanoparticles at room temperature by reduction of silver ions with the extract of the leaves of Coleus Aromaticus (Navara). The synthesized particles have been characterized using UV-Vis spectroscopy and scanning electron microscopy. The antibacterial activity of the silver nanoparticles showed inhibitory activity against the pathogenic microorganisms viz., Escherichia Coli, Salmonella typhi, Staphylococcus aureus and Bacillus subtilis.

Key words: Coleus aromaticus, Ag NP's , antibacterial, Plasmon resonance, navara

1. Introduction

Silver preparations have been long used as antimicrobial agents against bacteria, viruses and fungi, although the mechanism and manner of action is not fully known [1]. Ag particles in nano dimensions possess unique and considerably changed physical, chemical and biological properties and find applications in numerous fields like photography, catalysis, pharmaceuticals, antibacterial water filters, cosmetics, photonics, optoelectronics and surface-enhanced Raman scattering (SERS)

detection [2]. Nowadays, eco-friendly methods employing various biological reductants like yeast, fungi, bacteria and plant extracts are used for the synthesis of nanoparticles since theprocesses using these systems occur close to ambient temperatures and pressures at about neutral pH's and avoid the use of toxic solvents and chemicals [3]. The use of plant parts for biosynthesis of nanoparticles is an exciting methodology that is relatively unexploited and unexplored.Plants possess a wide variety of bioactive constituents which could exert a synergetic influence on the properties of the nanoparticles like size, shape, biological activity etc.

The   perennialplant,   Coleus AromaticusBenth. (Synonyms Coleusam boinicusLour., Plectranthusamboinicus) known asnavara or panikoorka in Kerala has many traditional medicinal uses, especially for the treatment of coughs, sore throats and nasal congestion, and also for a range of other problems such as infections, rheumatism and flatulence. Fresh leaves have been tested as a cure for reproductive tract infections (RTI) among women [4] and as antimicrobial agents [5].We have chosen the leaves of this herb as a bioreductant for Ag nano particle synthesis and the influence of this leaf extract in the bactericidal properties, morphology and size of the synthesized nanoparticles,.

2. Experimental

The leaves (Figure 1) collected from our campus were washed several times with deionised water. The extract from the navara leaves were taken in three different ways:

Fig.1. Coleus aromaticus leaves

In one method 50g of fresh cleaned leaves were crushed and boiled with 170 ml of distilled water for 5-10 minutes, cooled and filtered. The extract (hereafter denoted as A) was stored at 4°C for further experiments.

In another method the juice from the leaves were directly extracted from the leaves. For this purpose the leaves were made soft either by steaming it for 5 minutes (extract hereafter referred to as B) or warming it in an air oven for 5 minutes (extract hereafter referred to as C).

- Green   synthesis   of   silver nanoparticles using the navara leaf extracts

  2 ml extract (either A, B, or C) is added to 10 ml of aqueous solution of $AgNO_3$(1x10^{-3} M). The solution was allowed to stand in the dark. After 2-3 hours of standing in the dark a colour change was observed which intensified with time. After keeping for 24 hours the colloidal suspension of Ag nanoparticles was

centrifuged and washed several times with deionised water. This colloidal suspension of Ag was found to be stable even after keeping for 1-2 months.

- Characterization of green synthesized Ag nanoparticles

The absorption spectra of the nanoparticles were recorded using a double beam UV-Vis spectrometer (Shimadzu UV 2450) in the wavelength range of 200-1000 nm at room temperature. Morphology and size of the particles were examined using a scanning electron microscope (Jeol JSM - 6390). For the SEM analysis the particles were spread on a carbon coated copper grid by dropping a small drop of sample which was dried prior to measurements. The energy dispersive X-ray spectra of a representative sample were taken to ascertain the presence of Ag in the sample.

- Bactericidal activity of the Ag nanoparticles

The silver nanoparticles obtained using the navara extracts were tested for antimicrobial activity by Agar well diffusion method. The inhibition against the gram positive microorganisms viz. Staphylococcus Aureus and Bacillus Subtillis, as well as that against gram negative organisms viz. Salmonella Typhi and Escherichia Coli were checked.

3. Results and Discussion

On adding the extracts to 10 ml of $AgNO_3$ (1×10^{-3}M) a colour change from pale yellow to reddish brown was observed after 2-3 hours which intensified with time. The solution was allowed to stand in the dark for 24 hours for completion of the bioreduction process. The appearance of brown colour is usually taken to be a convenient signal to indicate the formation of Ag nanoparticles [6]. The unique optical properties of these nanoparticles are due to the property of Surface Plasmon Resonance (SPR) which is the collective oscillation of the conduction electrons in resonance with the wavelength of the irradiated light. The position of the absorbance band as well as its width is determined by the size and shape of the metal nanoparticle.

The absorption spectra of the nanoparticles prepared via mediation of the steamed leaves extract shows two peaks centered at 270 nm and 332 nm (Figure2).
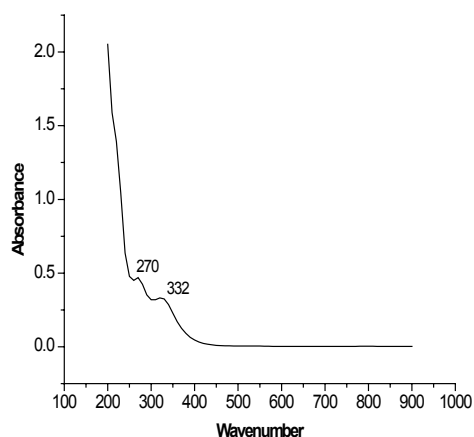

Fig. 2. UV-Vis spectra of Ag nanoparticles synthesized using the extract from steamed navara leaves.

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The appearance of more than one peak is likely due to the formation of nano particles of various shapes and sizes while the presence of only one peak is likely an indication of the presence of spherical particles only [7]. This is futher confirmed from the scanning electron micrograph (Figure 3) which shows the presence of nanoparticles of sizes 90 nm, 76 nm and 60 nm.
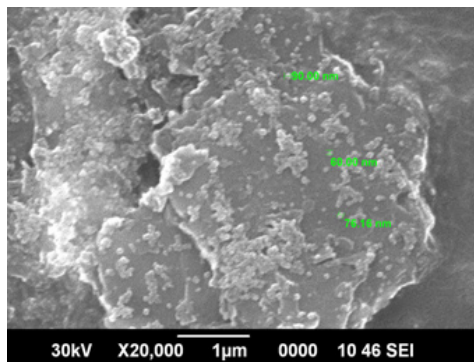

Fig.3. SEM of Ag nanoparticles prepared using steamed leaf extract of navara as bioreductant

The silver nanoparticles synthesized with the extract of oven warmed leaves of navara also give rise to a similar absorption spectrum (Figure 4) with two peaks at 272 nm and 327nm pointing to the presence of particles with varying sizes. This observation is also supported by SEM analysis (Figure5).
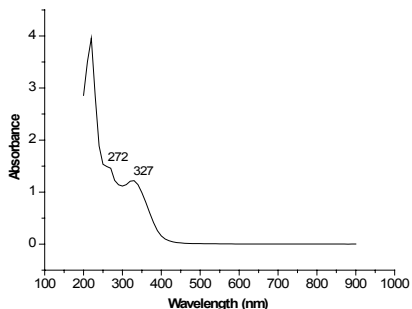
Fig.4. UV-Vis spectra of Ag nanoparticles synthesized using the extract from oven warmed navara leaves
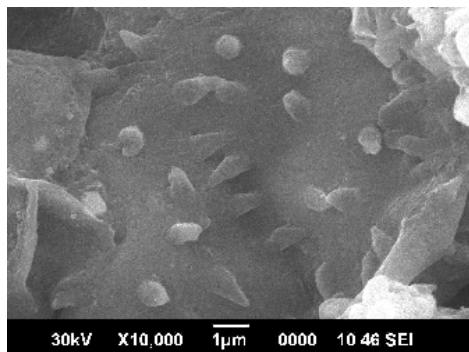
Fig. 5. SEM of Ag nanoparticles prepared using extract of oven warmed navara leaves as bioreductant

The Ag nanoparticles synthesized from the aqueous leaf extract shows only one peak in the UV-Vis absorption spectrum (Figure 6). This could be due to the fact that the particles might be of uniform shape and size. The SEM (Figure 7) also confirms this monodisperse nature of the nanoparticles formed and the EDX spectrum (Figure 8) is a further evidence of the observed particle being Ag itself
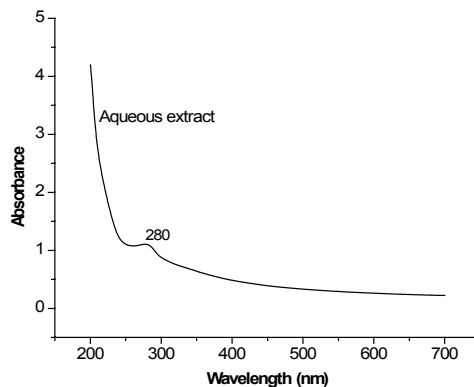

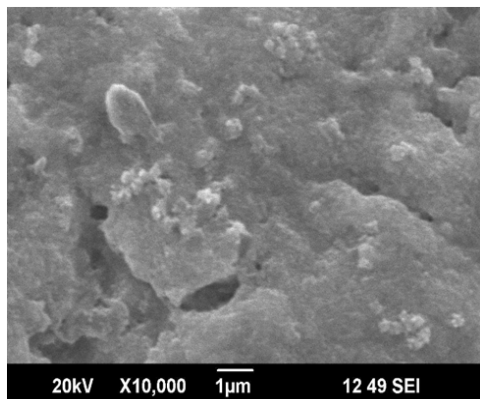*Fig.6. UV-Vis spectra of Ag nanoparticles synthesized using the aqueous extract of navara leaves.*

Fig.7. SEM of Ag nanoparticles prepared using aqueous extract of navara leaves as bioreductant
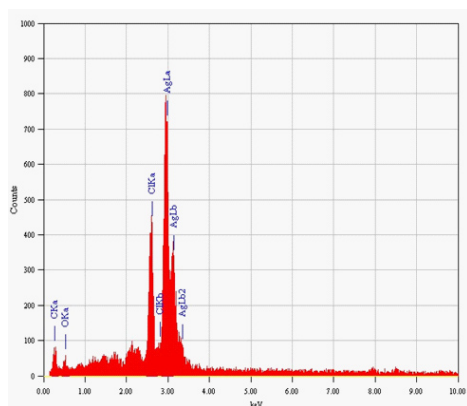

Fig.8. EDX spectra of Ag nanoparticles synthesized using aqueous extract of navara leaves as bioreductant

From the UV-Vis spectra and scanning electron micrographs it is to be assumed that the Ag nano particles formed using the navara leaf juices (B and C) as bioreductant are of different shapes and sizes while that prepared using the aqueous extract consists of spherically shaped particles of uniform size. The SPR bands undergo red-shift or blue-shift depending on the quantum size effects [8]. The bands with λ_{max} in the range 270-280 nm belong to the doubly charged Ag cluster $Ag4^{2+}$ while the low intensity band with λ_{max} 327nm is related to the cluster Ag_9^+. Hypsochromic band shift usually responds to dimerisation and formation of more coarse atomic aggregates. These particles with absorption spectra in the aforementioned ranges are usually referred to as sub colloidal particles [9].

Bactericidal action

Table 1 shows the antimicrobial test results ofnavara extracts and Ag nanoparticles prepared from these extracts in terms of the zone of inhibition. While none of the extracts showed any inhibitory effects, the nanoparticles show distinctive effects against some of the tested microorganisms. Ag NP's prepared from extracts B and C showed similar activity against all the microorganisms tested except S.typhi against which they were inactive. A quite interesting result here is the selective antibacterial activity of the Ag nanoparticles synthesized using the aqueous navara extract (C) towards E.Coli. The Ag particles are not active against the other microorganisms used in the study. These findings substantiate how the characteristics of the bioreductantcould influence the antimicrobial properties of Ag nanoparticles.

Table 1. Antibacterial susceptibility test results

Nanoparticle (extract used for synthesis)	Test Microorganism (Zone diameter in mm)			
	E. Coli	S. typhi	S. aureus	B. subtilis
A	-	-	-	-
B	-	-	-	-
C	-	-	-	-
Ag (A)	12	-	-	-
Ag (B)	11	-	12	10
Ag (C)	12	-	13	10

4. Conclusions

In an attempt to identify benign ecofriendly and easily available plant materials for bioreduction of Ag ions to Ag nanoparticles we have demonstrated the use of coleus aromaticus leaves in the cost effective synthesis of stable Ag nanoparticles with morphologies and sizes depending on the nature of extraction of the plant materials. It is also clear that the method of extraction affects the antimicrobial activity of themetallic nanoparticle. These studies in turn point to the need to identify plant resources with potential to facilitate the bioreduction of metal ions and selectively and synergistically enhance the properties of metallic nanoparticles.

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Computational Studies on Structural Characterization of Werner Complex Hexaammine Cobalt (iii) Chloride

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Abstract

Computational studies on structural characterization of Werner complex - Hexaammine Cobalt (III) Chloride[1]: The synthesis and characterization of Werner complex Hexaammine Cobalt (III) Chloride was done by combining experimental and theoretical aspects. The present work emphasizes the molecular structure, vibrational spectra and energies of Hexaammine Cobalt (III) Chloride. The computational calculations were done by Hartree - Fock and ab initio levels of theory with complete relaxation in the potential energy surface using Pople type 3-21G basis set. The IR frequencies were calculated and the scaled values have been compared with experimental IR values. The observed and the calculated frequencies are found to be in good agreement. The experimental spectra and theoretically constructed bar type spectrograms are in good correlation. Optimization energy, point group and dipole moment also were calculated.

Methods and Materials

Preparation of Hexaammine Cobalt (III) Chloride:[2] Dissolve about 1.2 g of ammonium chloride and 1.8 g of cobalt chloride in 25 ml of water. Add 1g of charcoal and cool in ice. Add 4ml of concentrated ammonium hydroxide and keep the solution at 10^0 C for 15minutes. Add slowly 3ml of hydrogen peroxide and shaking the solution well. Gradually raise the temperature to $50 – 60^0$C and keep the flask at this temperature with shaking until the last trace of pink color is removed. Cool and filter. Transfer the crystal to a beaker containing 0.5 ml of concentrated HCl in 15ml water. Filter the solid add 2 to 3 ml concentrated HCl and cool the solution in

ice. Collect the golden brown crystal.

Computational calculation using Gaussian 03: The chemical system is described by set of approximations ab initio & Hartree – Fock method. Basis Sets used is 3-21G . The number of digits (2 here) indicates how many sub-orbitals each valence atomic orbital is split into and the number three indicates the Gaussian primitives used for core (inner) electrons.
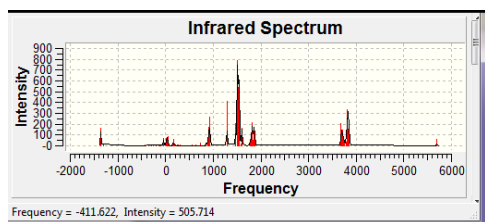
Results and Discussions

INFRARED SPECTRUM

Fig. 1: IR spectrum of Hexaammine Cobalt (III) Chloride from the computational calculation
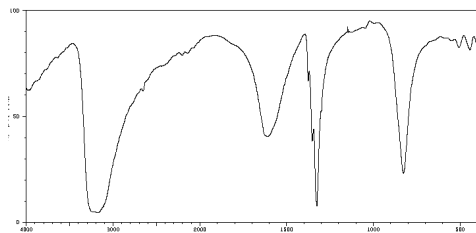
Fig. 2: IR spectrum of prepared Hexaammine Cobalt (III) Chloride

IR spectrum of laboratory synthesised Hexaammine Cobalt (III) Chloride & computationally calculated are presented in Fig. 1 & 2 respectively. The N-H stretching frequency value of the prepared one is at 3300 - 3500 cm^{-1} & computationally obtained at 3600-3900cm^{-1}. N-H bending frequency is at 1600cm^{-1} and

the corresponding computational value is 1700 -1800 cm^{-1}.
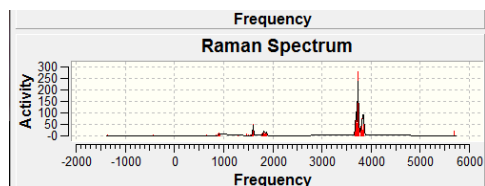
RAMAN SPECTRUM

Fig. 3: Raman spectrum of Hexaammine Cobalt (III) Chloride from the computational calculation

IR and Raman spectrometers serve as compatible techniques to obtain molecular spectra. The gross selection rule for the Raman is that the molecule must have a mode such that the motion of the molecule changes its polarizability. For a molecule to be IR active, it should possess a change in dipole moment. The two instruments have different selection rules, so some peaks that can be seen in the IR cannot be seen in the Raman and vice-versa. If the molecule is both Raman and IR active then we can say that the molecule is asymmetric. From the computational study of Hexaammine Cobalt(III) Chloride, it is found that this complex is both Raman and IR active. Hence the complex is asymmetric.

Optimization Energy

In the field of Computational Chemistry, energy minimization (also called energy optimization or geometry optimization) is the process of finding an arrangement in space of a collection of atoms where, according to some computational model of chemical bonding, the net inter-atomic force on each atom is acceptably close

to zero and the position on the potential energy surface is a stationary point. This technique is used to find a local energy minimum, which gives the most stable state.

Using the calculation method RHF and basis set 3-21G we found that the optimization energy for Hexaammine Cobalt(III) Chloride is -3082.3846 a. u. Hence we can say that the complex is stable.

Imaginary Frequency

The frequency calculation includes intensities, associated normal modes, zero point energy, and various thermo - chemical properties. Frequency value less than zero are known as imaginary frequencies. The number of imaginary frequencies indicates the sort of stationary point to which the given molecular structure corresponds. By definition, a structure which has n imaginary frequencies has an nth order saddle point (corresponds to transition state structure).

A first order saddle point is one having one imaginary frequency corresponding to a transition state. In Hexaammine Cobalt(III) Chloride one imaginary frequency means during the formation of complex only a single transition state exists.

Point Group

In geometry, a point group is a group of geometric symmetries that keep at least one point fixed. From the computational calculation, we obtained the point group of Hexaammine Cobalt (III) Chloride as C_1, and is designated as E. It is the identity element because it consists of no change or movement. If the molecule is unmoved, it appears the same as if it had been rotated 360^0. Hence we can say that this complex has identity symmetry element only.

Dipoleoment

Dipole moment of Hexaammine Cobalt(III) Chloride is obtained at 11.4046 D. This may be due to fluxional behavior of this complex.

Conclusion

Computational chemistry is simply the application of chemical, mathematical and computing skills to the solution of interesting chemical problems and complements experimental data on the structures, properties and reactions of substances. Computational chemistry has become a useful way to investigate materials that are too difficult to find or too expensive to purchase. It also helps chemists make predictions before running the actual experiments so that they can be better prepared for making observations. The project characterized some of the properties of Hexaammine Cobalt (III) Chloride through one of the computational method – Hartree-Fock; using the basis set 3-21G. Energy optimization, dipole moment, frequencies were obtained computationally. The negative energy value establishes the stability of the complex. Spectral datas confirm the different stretching frequencies. Also experimental and computational IR spectral values are compared. Computational approaches taking away from the traditional chemical labs make chemistry environment friendly and economic.

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Enhancement of Low Contrast Image Using Stochastic Resonance

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Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing `better' input for other automated image processing techniques. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer. Image enhancement is applied in every field where images are ought to be understood and analyzed. Many images have very low dynamic range of the intensity values due to insufficient illumination and therefore need to be processed before being displayed. During this process, one or more attributes of the image are modified. The choice of attributes and the way they are modified are specific to a given task. Moreover, observer-specific factors, such as the human visual system and the observer's experience, will introduce a great deal of subjectivity into the choice of image enhancement methods. There exist many techniques that can enhance a digital image without spoiling it. The enhancement methods can broadly be divided in to the following two categories:

1. Spatial Domain Methods

2. Frequency Domain Methods

Spatial domain techniques directly deal with the image pixels. The pixel values are manipulated to achieve desired enhancement. In frequency domain methods, the image is first transferred in to frequency domain. It means that, the Fourier Transform of the image is computed first. All the enhancement operations are performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image. These enhancement operations are performed in order to modify the image

brightness, contrast or the distribution of the grey levels. As a consequence the pixel value (intensities) of the output image will be modified according to the transformation function applied on the input values.

A new technique for image enhancement is based on stochastic resonance. Earlier noise was considered to be a nuisance that decreases the signal-to-noise ratio (SNR) of signal processing systems. Stochastic resonance, on contrary, is a phenomenon in which noise can be used to enhance rather than hinder the system performance. Traditionally considered undesirable, noise can sometimes play a constructive role in image processing also. Stochastic resonance (SR) is a counter-intuitive phenomenon where the presence of noise in a nonlinear system is essential for optimal system performance. Principle objective of Image enhancement is to process an image so that result is more suitable than original image for specific application. Digital image enhancement techniques provide a multitude of choices for improving the visual quality of images. Appropriate choice of such techniques is greatly influenced by the imaging modality, task at hand and viewing conditions.

In [1] and [2] several spatial domain methods for image enhancement has been proposed. These methods are very problem-oriented i.e. a method that works fine in one case may be completely inadequate for another problem. The spatial domain techniques can be divided into two broad categories:

1. Point processing

2. Histogram processing

In point processing enhancement at any point in an image depends only on the gray level at that point. Point processing include techniques like image negative, Power- law transformations, threshold transformation, intensity transformation. These transformations will be based on certain expressions which can be used for contrast enhancement and highlighting. Grey level slicing is the spatial domain equivalent to band-pass filtering. The point processing methods are most primitive, yet essential image processing operations and are used primarily for contrast enhancement.

Histogram processing is based on manipulation histograms of the images, which include methods like histogram equalization and histogram matching [1]. The histogram of an image (i.e., a plot of the graylevel frequencies) provides important information regarding the contrast of an image. Histogram equalization as explained in [1],[2] and[3] is a transformation that stretches the contrast by redistributing the gray-level values uniformly. Only the global histogram equalization can be done completely automatically. A key advantage of the method is that it is a fairly straightforward technique and an invertible operator.

Frequency domain techniques for image enhancement is described in [1] and [5] which involves use of high pass filter, low pass filter, high boost filter, homomorphic filter etc.. High pass and low

pass filters are used to extract the high and low frequency components respectively of an image and hence cannot be used for contrast enhancement. High boost filter enhances the image by adding back the original image to the filtered result. It is advantageous only sometimes and hence is not a reliable technique. Homomorphic filtering requires extraction of luminance and reflectance components of the image, hence the computation is more complex.

Noise is usually considered to be a nuisance that decreases the signal-to-noise ratio (SNR) of signal processing systems. Noise is the fundamental enemy for communications engineers, whose goal is to ensure messages can be transmitted error-free and efficiently from one place to another, at the fastest possible rate. When random noise in the form of electronic fluctuations or electromagnetic interference corrupts transmitted messages, this places limits on the rate at which error-free communication can be achieved. If everything else is ideal, then noise is the enemy. It was traditionally believed that the presence of noise can only make the system worse. However, recent studies have convincingly shown that in non-linear systems, noise can induce more ordered regimes, which cause the amplification of weak signals and increase the signal to noise ratio (SNR). In other words, noise can play a constructive role in enhancing weak signals.

Stochastic resonance is a phenomenon where the output signals of some nonlinear systems can be amplified by adding noise to the input signal. Over the last two decades, stochastic resonance has continuously attracted considerable attention. The term is given to a phenomenon that is manifest in nonlinear systems whereby generally feeble input information (such as a weak signal) can be amplified and optimized by the assistance of noise. More technically, stochastic resonance occurs if the SNR, input/output correlation has a well marked maximum at a certain noise level [15]. Stochastic Resonance (SR), although a term originally used in a very specific context, is now broadly applied to describe any phenomenon where the presence of noise in a nonlinear system is better for output signal quality than its absence. There are several key terms in the previous sentence that require clarification. The first key term is nonlinear. Noise cannot be beneficial in a linear system, and it is only the more complex interactions between nonlinearities and randomness that can (sometimes) lead to SR. The third key term is the word noise itself. Noise is usually associated with words such as nuisance, undesirable, or irritating, and the concept of it being useful is apparently contradictory. This idea can be distilled into stating that whenever SR occurs, it must be true that

performance(noise + nonlinearity) > performance(nonlinearity)

In order to exhibit stochastic resonance, a system should possess three basic properties:

1. A non-linearity in terms of threshold

2. A sub-threshold signal like a signal with small amplitude

3.   A source of additive noise

The general behaviour of stochastic resonance mechanism shows that at lower noise intensities the weak signal is unable to cross the threshold, thus giving a very low SNR. For large noise intensities the output is dominated by the noise, also leading to a low SNR. But, for moderate noise intensities, the noise allows the signal to cross the threshold giving maximum SNR at some optimum noise level. Thus, a plot of SNR as a function of noise intensity shows a peak at an optimum noise level as shown in Fig.1.
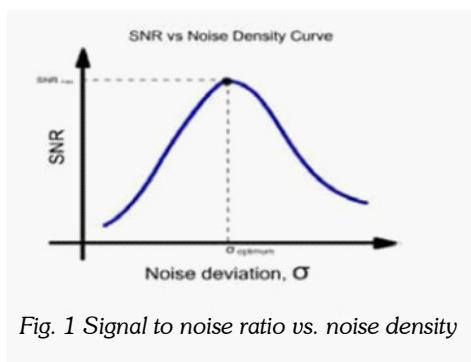
Fig. 1 Signal to noise ratio vs. noise density

The word resonance in the term stochastic resonance was originally used because the signature feature of SR is that a plot of a performance measure—such as output signal-to-noise ratio (SNR)—against input noise ''intensity'' has a single maximum at a nonzero value. Such a plot, has a similar appearance to frequency-dependent systems that have a maximum SNR, or output response, for some resonant frequency. However, in the case of SR, the resonance is ''noise-induced'' rather than at a particular frequency.

While noise or variability may not be truly random—it can, for example, be constant or deterministic (even chaotic)—it is often possible to characterize observations by modeling it as random. Consequently, SR research has tended to focus on the stochastic case. The most common assumption is that the noise is white— that is, constant in power across all frequencies—and Gaussian distributed. In most cases, changing the distribution or power spectrum of the noise does not change the fact that SR occurs. The important point is that unpredictable variability or fluctuations can be said to be present. While SR was initially considered to be restricted to the case of periodic input signals, the literature reveals that it now is widely used as an all-encompassing term, whether the input signal is a periodic sine wave, a periodic broadband signal, or aperiodic. An appropriate measure of output performance depends on the task at hand, and the form of input signal.

Any random signal can be represented as sum of sinusoidal components of different frequency, amplitude and phase. Same is true for images also. When a Gaussian noise of standard deviation s is added to the image and the noise added image is thresholded the SNR of output signal is given by the below equation which is of the form SNR where Bi is the amplitude of the sinusoidal component of input signal.

$$SNR = \frac{P_S}{P_N} = \frac{2f\Delta^2}{3\sigma^2} \sum_{i=1}^{N} B_i^2 \, exp\left(\frac{-\Delta^2}{2\sigma^2}\right)$$

Δ threshold

Algorithm

A low contrast image can be considered to be a subthreshold signal since the excursion of its intensity values about the mean (in other words, the standard deviation) is very low. By successive noise addition of increasing intensities followed by hard thresholding and averaging, the image can be made to make a binary transition into the high contrast state at some optimum amount of added noise. The SR based algorithm has been stated as follows. For colored images, the following steps should be implemented on all three color bands in parallel configuration.

Step 1 A very low contrast image I(x, y) is taken as an input image. Set F, CEF = 0.01.

Step 2 Produce N frames of random noise, ξ(x, y), of mean zero and standard deviation σ0.

Step 3 Each of the noise frames is added to the low contrast image I(x, y) generating N different noisy low contrast images (for single noise standard deviation).

Step 4 Each noisy image is thresholded using a predetermined threshold (taken as the standard deviation of noise itself).

For fingerprint images the pixel values above the threshold is adjusted to 255 and the pixel values below the threshold is adjusted to 0.

For greyscale images the pixel values above the threshold is tripled and the pixel values below the threshold is doubled.

Step 5 All the thresholded frames are averaged to produce an enhanced image of good contrast.

Step 6 Calculate performance metrics F, CEF(only for colour images) and PQM for this output.

It should be noted that since the input image is analogous to a weak subthreshold signal, the noise intensity plays a prominent role for it to cross a threshold. This is why, the additive noise standard deviation has itself be considered as the threshold so that it serves as a level around which the excursion of the subthreshold signal maybe noted and utilized in the averaging process.

Step 7 To make the algorithm adaptive, the process is stopped when CEF +F becomes maximum within the constraint that PQM is close to 10 (say, 10 ± 1).

For fingerprint images a good enhancement is achieved for PQM value near to 2.5.

Step 8 Otherwise increase standard deviation of noise by a unit. Repeat Step 1 to Step 6 and analyze values of performance metrics.

Platform

MATLAB 7.1 platform can be used for implementing this project. MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. Using the MATLAB product, you can solve technical computing problems faster than

with traditional programming languages, such as C, C++, and Fortran.

The Image Processing Toolbox software is a collection of functions that extend the capability of the MATLAB numeric computing environment. The toolbox supports a wide range of image processing operations, including:

- Image enhancement, filtering, and deblurring

- Image analysis, including segmentation, morphology, feature extraction, and measurement

- Spatial transformations and image registration

- Image transforms, including FFT, DCT, Radon, and fan-beam projection

- Workflows for processing, displaying, and navigating arbitrarily large images

- Modular interactive tools, including ROI selections, histograms, and distance measurements

- ICC color management

- Multidimensional image processing

- Image-sequence and video display

- DICOM import and export

The responses of the proposed technique for Gaussian noise distribution have been displayed in Fig. 2, Fig.3(a), Fig.3(b), Fig.3(c)and Fig.3(d) has been made low contrast by manipulation. All the results have been obtained for N= 100. The following observations can be made from outputs for varying noise intensities.

- The image obtained after averaging of thresholded frames for each noise deviation is observed to start from white and with increasing noise intensity accentuates the contrast and colorfulness of the image. However, beyond optimum noise intensities, noise starts dominating the integrated image making it appear noisy.

- At some optimum noise deviation performance metrics are observed to be maximal (F+CEF) under the constraint of good perceptual quality

- Contrast quality is increased multifold (F is over 2 times)

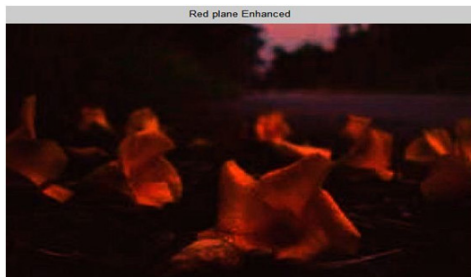- Color is observed to be implicitly preserved. Remarkable color enhancement is obtained
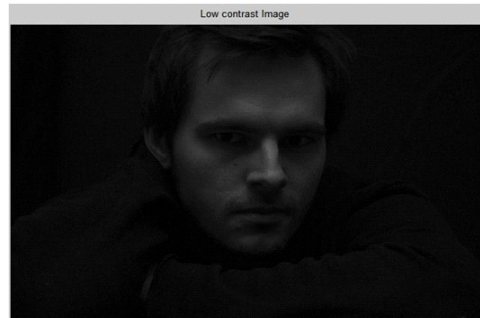
Fig 2 a)Low contrast grayscale image
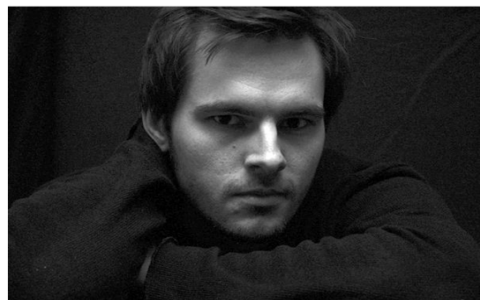
Fig 2 b)Enhanced image
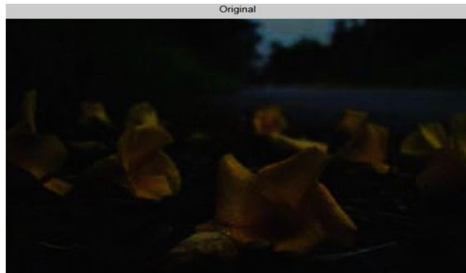
(a)
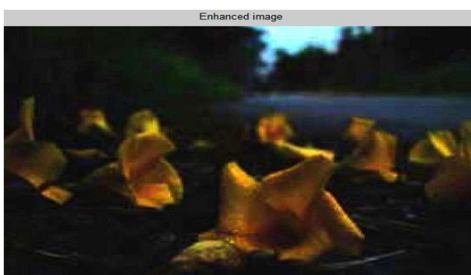

(b)

Fig 3 a)Low contrast colour image b)Red plane enhanced

(c)

(d)

Fig 3 c)Blue and red plane enhanced d)Enhanced image

Contrast enhancement of dark images using noise induced non-dynamic stochastic resonance is a good method for enhancing the quality of low contrast images. In this technique a low contrast image is treated as subthreshold and adding random noise followed by thresholding and averaging, the contrast of the input image could be increased. SR-based contrast enhancement has two advantages over the other enhancement techniques. First, it is able to enhance very low-contrast images. This is because, in this approach random noise is added to all pixels of very low-contrast image and then thresholded the noisy image. Since the added noise is random, so, the thresholded image for individual random noise is different. Now, multiple noisy threshold images are averaged, which is basically non-linear averaging. The error generated owing to non-linearity (threshold) (in one noisy image) is minimized by averaging of different thresholded noisy images. Hence, it enhances specially those regions where pixels information are very less. Second, there is no blocking or spot kind of artifacts introduced in SR enhanced image. This is because of averaging operation or linearity operation of multiple thresholded images. Four types of noise distributions - Gaussian, Uniform, Poisson and Gamma could be added. Best performance could be observed for Gaussian model. Using quantitative characterization of the technique in terms of contrast and color enhancement along with perceptual quality measure it can be shown that it reaches higher performance metrics as compared

to existing spatial domain techniques like of adaptive histogram equalization, and histogram equalization

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