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UTILISATION OF INTERNET WEB - RESOURCES BY THE FACULTY MEMBERS, RESEARCH SCHOLARS AND STUDENTS OF ARTS AND SCIENCE COLLEGES IN ERODE DISTRICT-TAMIL NADU

N.Valarmathi*

Abstract

The Survey was conducted with 500 faculty members and students belonging to arts and science colleges in erode district that provide internet facility to both the teachers and students and expect them to utilize it for educational purposes. It is necessary to conduct a study to determine whether internet is used for academic activities and how the internet has influenced the academic efficiency of the target users. The research paper also explores the satisfaction level of the user with the internet facility provided by the arts colleges. The study has particularly been taken up to assess the benefits of internet over conventional documents. It has been undertaken mainly to highlight the utilization of the internet by the faculty members, research scholars and students of arts & science colleges in erode district only. It includes the respondent's level of satisfaction of internet library service, type of account holding in different e-mail services, purpose of using the e-mail, frequency of using search engines, usage level of advanced search engines and metadata's search engines, types of websites preferred by the respondents, purpose of using the websites, opinion about internet resources and internet accessing difficulties.

Introduction

Today, the Internet plays a vital role in the teaching, research and learning process. It is assumed that the college students in India feel more dependent on the internet for their class assignments and for the latest information of their subject areas than conventional resources of information. Faculty also feel a bit handicapped in updating their knowledge base quickly without using the internet for their research and classroom teaching activities in the era of networked information, Internet, the largest worldwide network among various networks, has emerged as the most powerful tool for an instant access to information. The information is now just a "finger touch" away from the user and it

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would not be inappropriate to say that the internet has become the biggest global digital information library which provides the fastest access to the right kind of information in nano-seconds of time to end-user at any time and at any place in the world. The internet has become the most extensively used information source that empowers the average person to get in roaming with the latest information

Internet and Library

Library is committed to provide access to informational, educational, recreational and cultural resources for library users of all ages and backgrounds. Throughout its history, Library has made information available in a variety of formats, ranging from print materials to audiovisual references. The library's computer system provides the opportunity to integrate electronic resources from information networks around the world with the library's other resources. The library strives to balance the rights of users to access information resources with the rights of users to work in a public environment, free from sounds and images intended to harass other library users or library staff. The library's goal in providing internet access is to enhance its existing collection in size and depth and as a public access agency, to give anyone who wishes to use the internet the chance to do so.

Role of Libraries in Arts and Science College

The library is regarded as the 'nerve centre of knowledge', the centre of intellectual life and the heart and soul of the academic institution. This means that discoveries are actually made in the library and subsequently tested in the laboratory. It occupies an important place in the modern education system and maintains the expensive educational resources of the academic institutions. It is the responsibility of the arts and science college libraries to provide right information at right time to right user to save the time of the user. The libraries are primarily responsible for the selection and collection of material appropriate for libraries, preservation and organization of the collection and dissemination of the material or the information, which it contains. Libraries as centre of learning are playing an important role in sustaining and satisfying the information requirements of parent institutions. For the efficient, effective and scientific development of information resources and services should be based on the inputs from studies and the users of Arts and Science College libraries.

Review of Literature

Chadiha (1998) describes that social work students, faculty and staffs are increasingly utilizing information technology applications such as electronic mail. Students are also increasingly utilizing the internet and online library resources for their class assignments. The authors describe application of information technology to social work domains such as practice, advocacy, networking, communication, participation in policy formation and teaching. This paper describes the integration

of the internet within a foundation level social work class on human diversity. The authors conclude by stating advantages and disadvantages of incorporating information technology applications, such as the internet, within the social work curriculum. One advantage is that students have access to international / global perspectives, thus cross-cultural comparisons and also, for the fact that students can connect with agencies and policy-making process. The Internet expedites access to information and sharpens computer skills.

Becker (1998) has conducted a study on the Internet us by 2,500 teachers form public and private schools of U.S. The study reveals that 90% of the teachers have Internet access. A majority of the teachers with 59% of respondents have Internet access at home. A majority of the teachers 68% of them use the internet to find information resources for preparing their lessons. A majority of the teachers 62% respondents use Web search engines to find information resources.

Conbo et al. (2000). examine student's reaction to the potential for using computer software to assist social work students in learning practice evaluation techniques. Students in one research class at Yeshiva University used a program designed specifically for computer tasks of data entry, data analysis and graphics presentations of single system-design research in social work practice. An evaluation of the program was conducted with 136 students and results showed that more than 95% of the students and results showed that more than 95% of the students thought the program added a valuable component to research. Another 81.9% found the program helpful in evaluating practice. The authors encouraged further development of evaluation software programs.

Laite (2000) has surveyed 406 graduate and undergraduate students from Shippensburg University. The survey reveals that 57.6% of the undergraduate students use the internet 1-2 times per week and another 37.1% use it 1-2 times daily. 54.7% of the graduate students use Internet 1-2 times per week and 37.7% use it 1-2 times daily. The survey shows that the most used internet service is e-mail. 100% of the graduates and undergraduate students used email services.

Carr, L.C. Marlowe (2001) has studied the utilization of on-line services, by social workers and compartes their demographic characteristics with those of NASW members. 162 social workers are selected from 32 on-line social work discussion groups. The results show significant differences in usage by gender: 22.7% of the NASW members are males, yet 53.5% of the on-line participants are men. Social workers associated with colleges or universities are better represented in the online group. Electronic mail is the most frequently used on-line service. The article concludes with recommendations for NASW and schools of social work in terms of technology training and utilization. For instance, almost 80% of those surveyed feel that social work schools should incorporate computer and on-line usage into cirriculum.

Statement of the problem

In this scenario, the researcher has made an attempt to analyze the empirical resources available from the internet library and how the faculty are utilizing the library resources in their effective teaching, sensitive application of subject areas, and how the research scholars are utilizing the resources for their articles, project works and publications and also how the students are utilizing the library resources for their academic as well as developmental purpose. This study was conducted to analyze the utilization of internet by the faculty, researchers and students of arts & science college libraries in erode district. It traces out the quantum and duration of time utilization in search of information through internet.

Objectives of the study

The following are the objectives of the present research study:

1. To know the origin and development of internet web resources.
2. To analyze the factors implemented by the faculty members, research scholar, and students in utilizing the internet web resources.
3. To analyze the expectation and level of satisfaction perceived by the internet web resource users in the arts and science colleges.
4. To identify the problems faced by the respondents while using the internet services.
5. To offer suitable suggestions based on the research study.

Field work and collection of data

The fieldwork for the study was conducted during the period between September 2011 and July 2012. Personal interview by the researcher was the major tool of data collection. Interview was conducted with the respondents in Arts and Science colleges of Erode District. The data thus collected were categorized and posted in the master table for further processing.

Methodology

Samples are collected from the faculty members, research scholars and students of arts & science colleges in erode district. Total sample size of the respondents = 500. A sample design is a definite for obtaining a sample from a given population. The size of the sample refers to the technique or the procedure the researcher would adopt in selecting items. Sample design is determined on 17 arts and science colleges before data is collected. The respondents are selected according to the convenience of the researcher.

Analysis and findings of the study

Table 1-Quantum of Time Spent In the Library

Quantum of time spent in the library	No.of Respondents	Percentage %
Less than 1 hours	137	27.40
1-2 hours	106	21.20
2-3 hours	103	20.60
3-4 hours	70	14.00
Above 4 hours	84	16.80
Total	**500**	**100**

It could be observed from the above table that 27.40% of the respondents are spending their time in the library for less than 1 hour, 21.20% of the respondents are spending their time in the library for 1-2 hours, 20.60% of the respondents are spending their time in the library for 2-3 hours, 14.00% of the respondents are spending their time in the library for 3-4 hours, 16.80% of the respondents are spending their time in the library above 4 hours.

Majority (27.40%) of the respondents are spending less than 1 hour in the library.

Table 2- Visiting time to the Library

Visiting time to the Library	No.of Respondents	Percentage %
Morning	147	29.40
Evening	227	45.40
Lunch hour	57	11.40
Class hours	42	8.40
Total	**500**	**100**

It could be observed from the above table that 29.40% of the respondents are using the library in morning session, 45.40% of the respondents are using the library in evening, 11.40 % of the respondents are using the library in lunch hour and 8.40% of the respondents are using the library in class hours. Majority (45.40%) of the respondents are using the library in evening.

Table 3 - Purpose of Gathering Information

Purpose of gathering information	No.of Respondents	Percentage %
For writing seminar conference papers	39	7.80
For doing research	42	8.40
For writing journal articles	97	19.40
For taking classes	89	17.80
For writing books	32	6.40
For the purpose of preparing examination	90	18.00
General purpose	111	22.20
Total	**500**	**100**

It could be observed from the above table that 7.80% of the respondents are using the library for writing seminar conference papers, 8.40% of the respondents are using the library for doing research, 19.40% of the respondents are using the library for taking classes, 17.40% of the respondents are using the library for writing books,6.40% of the respondents are using the library for writing journal articles, 18.00% of the respondents are using the library for the purpose of preparing examination, 22.20.% of the respondents are using the library for general purpose. Majority (22.20%) of the respondents are using the library for general purpose.

Table 4- Respondents' Frequency of Using the Internet

Frequency of Using the Internet	No.of Respondents	Percentage %
Daily	84	16.80
Every alternate day	119	23.80
Once in a week	83	16.60
Once in a fortnight	61	12.20
Once in a month	60	12.00
As and when required	93	18.60
Total	**500**	**100.00**

The table shows the respondents' frequency of using the internet. Among the total respondents, 16.80% of the respondents daily use the internet every alternate day, 23.80% of the respondents use the internet, 16.60% of the respondents use the internet, 12.20% of the respondents once in a fortnight using the internet, 12.00% of the respondents once in month using the, internet 18.60% of the respondents use the internet as and when required. Majority 23.80% of the respondents use the internet alternate day.

Table 5-Status Composition and Preferred Search Engines

Preferred search engines / Status Composition	Google	SIFY	Yahoo	Lycos	Hot bot	123 India	Excite	Open text	Media finder	MSN search	Info seek	Alta vista	
Asst professor	1	4	8	9	12	3	6	10	5	7	11	2	
Associate professor	1	4	6	5	10	3	7	12	8	9	11	2	
Professor	1	4	10	8	7	3	6	12	5	9	11	2	
Administrative Staff	2	5	10	6	7	3	8	11	4	9	12	1	
Research scholars	1	5	8	6	7	3	10	12	4	9	11	2	
Students	2	4	11	6	12	3	5	7	10	8	9	1	
Sum of Ranks(Rj)	8	26	53	40	55	18	42	64	36	51	65	10	$\sum Rj = 468$
$(Rj - \overline{Rj})^2$	961	169	196	1	256	441	9	625	9	144	676	841	**S =4328**

The table 5 shows that the status composition of the respondents and preferred search engines.

The significance of the value is tested by formulating the following null hypothesis.

"There is no similarity in the ranking of preferred search engines by different status composition of the respondents".

Calculated value

S=4.328

W=0.846

Table value

At 5% level for k=6, n=12, s=19.7

The calculated of s is 4328 which is higher than the table value which fact shows w=0.846 is significant at 5% level. Hence the null hypothesis is rejected. So there is a similarity in the ranking of preferred search engines by different status composition of the respondents. The lowest value observed among R_j is 8. This shows that the users of all status composition level gives more importance to the preferred search engine is "Google".

Table 6-Status Composition and Satisfaction of Internet Sources

Satisfaction / Status Composition	Publishers home pages	societies and Associates	Data base	Library websites	Health	information	Reference sources	University college websites	E-Journals	General Information	Job websites	Newspapers and magazines	
Asst professor	2	4	7	6	5	1	8	11	10	9	12	3	
Associate professor	2	4	7	5	6	1	9	12	10	8	11	3	
Professor	2	5	12	4	6	1	7	10	8	9	11	3	
Administrative staff	7	2	4	5	6	1	8	11	10	9	12	3	
Research scholars	4	1	7	3	6	2	8	12	9	10	11	5	
Students	4	2	8	6	7	1	9	10	5	12	11	3	
Sum of Ranks(Rj)	21	18	45	29	36	7	49	66	52	57	68	20	$\sum Rj = 468$
$(Rj - \overline{Rj})^2$	324	441	36	100	9	1024	100	729	169	324	841	361	**S = 4458**

The table 6 shows that the status composition and satisfaction of internet sources of the respondents.

The significance of the value is tested by formulating the following null hypothesis.

"There is no similarity in the ranking of factors available from the internet sources based on the respondents' satisfaction by different status composition".

Calculated value

S=4458

W=0.866

Table value

At 5% level for K=6, N=12, S=19.7

The calculated value of S is 4458 which is higher than the table value, which shows W=0.866 is significant at 5% level. Hence the null hypothesis is rejected. So there is a similarity in the ranking of factors available from the internet sources based on the respondents' satisfaction by different status composition.

The lowest value observed among R_j is 7. This shows that the users of all status composition give more importance to "Current Information".

Suggestions

1. The colleges should make some efforts to procure and supply E-journal and other E-documents at free of cost.
2. Majority of the students are spending one hour or less than an hour in library browsing centre. Hence, the library browsing centre should take the adequate steps to increase the browsing hours to the students without affecting their study hours.
3. Almost all of the browsers have noted that number of systems and equipments are inadequate. So that colleges should take the necessary steps to install more systems and to update their equipments with latest technological development.
4. It is also found that the lower processing speeds engines are common problem for all the users. So, the library management should take steps to install high speed users and to add LCD monitors in the browsing centre.
5. All the academic news should be provided at the college website and it should be regularly updated.
6. More efficient technical staff should be appointed and they should always be present in the Internet section for expert advice.

Conclusion

Internet has emerged as the single most powerful vehicle for providing access to unlimited information. Internet is an inseparable part of today's arts and science educational system. The dependency on Internet and its services is increasing day by day and the users of arts and science colleges too are depending more and more on internet for their various educational purposes. Internet facility has enabled the teachers and the students to enhance their academic excellence by providing them the latest information and access to the worldwide information.

In order to make the Internet more beneficial, the library staff who have acquired a good deal of efficiency in the collection, organization and retrieval of information should feel duty-bound to see that the users are able to obtain right information at the right time. For this, they should organize and classify the information on a Website in such a way that the users are able to find easily the information they need for their studies and research purposes. The library services supplemented by internet services can prove a great boon to the users in getting the right information at the right time. More efforts by librarians at various colleges are needed to educate users to effectively use the internet and its techniques and applications.

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ANTI–INFLAMMATORYAND WOUND HEALING PROPERTY EVOKED BYOYSTER MUSHROOM *(PLEUROTUSFLORIDA)*

S.Sheela Devi[*], J.Dhanalakshmi[**] and S.Selvi[**]

Abstract:

Mushrooms are part of larger group of plants known as fungi. A fungus is different from an ordinary green plant because it cannot make its own food. Mushrooms are white rot fungi regarded as one of the well known food and possessing various kinds of biopharmaceuticals compounds. The present study consolidates in the aspects of cultivation of Pleurotus florida *mushroom under laboratory conditions and to analysis the presence of phytochemicals and their anti-inflammatory and wound healing activity. The fresh fruiting bodies of mushroom were harvested, dried, powdered and extracted (using ethanol). The phytochemical compounds were analysed and the extract were tested for anti-inflammatory activity by carrageenan induced paw edema method in rats. Anti-inflammatory effect was compared with positive control Indomethecin (10mg/kg) and negative control carragenan (1% w/v) and observed that the ethanolic extract of* Pleurotus florida *(fresh) showed very good anti-inflammatory activity. The present study was also carried out to evaluate the wound healing efficiency of* Pleurotus florida *dried and fresh sample extract. The ethanolic extract of both fresh, dried* Pleurotus florida *of 100mg/kg b.w and 200mg/kg b.w was administered orally to experimentally induced wounds in rats and compared the effects with an antiseptic agent, Povidone ointment (positive control – apply topically) and normal control. The model selected were excision wound model so treated animals showed a significant reduction in period of epithelizationand wound contraction. It was noticed that the dried sample of* Pleurotus florida *(100mg/kg b.w and 200mg/kg b.w) reduced the wound when compared with normal control.*

Keywords:

Cultivation of Oyster mushroom, Pleurotus florida, *phytochemical, anti-inflammatory, woundhealing.*

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1. Introduction

Plants are living things that are seen growing on the surface of the earth and usually have root, stem, leaves and produce fruits and seeds. Most plants are edible and contain different amount of vitamins, protein or carbohydrates etc., these helps the body to replace worn out cells or tissues, digest food and combat ailments among other health related problems. Man has used plants from the earliest times to cure disease and relieve physical suffering (Mbagwu*et al.,* 2005). The most important drug obtained from tropical plants is quinine and is used as a cure for malaria. (Cowley *et al.,*2002).Mushrooms are part of longer group of plants known as fungi. A fungus is different from an ordinary green plant because it cannot make its own food. Fungi have been around since prehistoric days. Remains of fungi have been found in dinosaur pits. They belong in a kingdom of their own separate from plants and animals. Fungi differ from plants and animals in the way they obtain their nutrients. Mushrooms are one of the oldest form of life on this planet, pre-dating plants and animals. (Maheshwari *et al*.,2012). Mushrooms have been used for the thousands of years as culinary and medicinal ingredient. Traditionally it has been used to strengthen veins and relax tendons. It has been observed to lower cholesterol level and to favourably change the cholesterol distribution in lipoproteins. *Pleurotus* mushroom commonly known as Oyster mushrooms, are quite easily cultivated artificially most often in liquid medium.The species of the *Pleurotusgenus* are considered to be an important source of dietary fiber and contain other important nutrients.(Vamanu*et al*.,2012).Mushrooms are not only source of nutrients but also preventing disease such as hypertension, hypercholesterolemia and cancer. Antimicrobial compounds isolated from mushroom (*Lentinulaedodes*) liquid cultures include lentinamicin, beta ethyl phenyl alcohol and lentin, an antifungal protein. The second major attribute of mushroom is their medicinal properties which related to the use of mushroom products for medicinal purposes in recent years.

Inflammation is a normal protective response to tissue injury caused by physical trauma, noxious chemical or microbial agents. The most commonly used drug for management of inflammatory conditions are non steroidal anti-inflammatory drugs (NSAIDs), which have several adverse effects especially gastric irritation leading to formation of gastric ulcers (Tripathi*et al*., 2008). In India, there has been interest in the potential of medicinal plant for development of drugs with wound healing properties as taught in a popular form of Indian medicine known as Ayurveda (Jain *et al*., 2006).

2. Materials and Methods

2.1. Cultivation of *Pleurotusflorida* (Ranasingh et al., 2010)

Substrate is the raw material used to grow mushrooms and its treatment involves cleaning, chopping, soaking and boiling. The paddy straw was cut by chopper into finger size (3 to 5 cms-long) pieces. A kilogram of fresh paddy straw absorbs about one-and-a-half times its weight of water after being soaked overnight (8 to 12 hours). After soaking drained the brownish water. Squeezed excess moisture. Then large metallic vessel was used with a loose lid on top to boil soaked pieces till steam builds up. The boiled straw was removed and excess water drained out. Spread the straw on a clean plastic sheet. Sterilized straw were filled in the cultivation bag. One bottle of spawn is about 200 grams and could be used for a maximum of three bags (about six kg of wet straw).

Compact alternate layers of straw and spawn were packed. A small space adequate to tie up the mouth of the bag is kept at the top. The poly bag can now stand on its base if it is properly and uniformly filled and compacted. The bags were then kept in the dark in a clean, dry place to permit spawn run or multiplication of the mycelia from the grains on the straw. It took about 8 to 15 days depending on the temperature and spawn. Favourable temperature for good spawn run is between 25Ú C and 32ÚC. Check each bag for sign of contamination by identifying any coloured patch. One could be noticed that spawn run is complete when all bags turn white and compact. The bags need to be brought out in light.

The top of the bags are rolled down to one third of the length and a gentle mist of water was sprayed from the sides. This is done 2 to 3 times a day. Light is needed for at least 12 to 16 hours a day. After opening of the bags, within two days, small pinheads will be noticed. The pinheads will grow to produce oyster shaped mushrooms. Once bunches of oyster mushrooms enlarge, the spraying of water continues lightly so that the substrate does not become dry. When mushrooms reach a size of 4 to 7 cms it is time to harvest them by detaching from bag. This would be the first crop known as ‘flush’. Flushes will continue for another 7 to 14 days with short gaps initially and long gaps for the last few crops.

Source: The source inocula for the present study was obtained from Shivasakthi Mushroom Farm, Kavandhapadi at Erode, India.

Sample for Research: The above Cultivated Oyster Mushroom was used for the present research work.

2.1.1. Extraction of *Pleurotus florida* Fresh Sample:

25g of Cultivated fresh Oyster mushroom were cleaned and chopped into finer pieces and placed in a clean conical flask and 50ml of ethanol were added, the contents of the flask were shaken for 72 hours in a cooling shaker. After 72 hours the contents were emptied in the beaker and the

alcohol allowed for evaporation and the extract used for the study.

2.1.2. Extraction of *Pleurotu florida* Dried Sample:

25g of Cultivated Fresh Oyster mushroom were cleaned, chopped into finer pieces and shade dried. The shade dried mushroom was placed in a clean conical flask and 50ml of ethanol were added, the contents of the flask were shaken for 72 hours in a cooling shaker. After 72 hours the contents were emptied in the beaker and the alcohol allowed for evaporation and the extract used for the study.

2.2.Qualitative Analysis of Phytonutrients of crude mushroom extracts:

Phytonutrients such as Carbohydrates, proteins, aminoacids, alkaloids, flavonoids, glycosides, tannins, phytosterols, triterpenoids and saponins were analysed from the ethanolicextrateof *Pleurotus florida* dried and fresh sample.

2.3. Screening for Wound Healing Activity of the Mushroom Extracts(Fresh and Dried)

Models for wound healing:

The wound model selected for this study was Excision Wound model.

Induction of Wound:

Experimental animals - Male Albino Wistar rats weighing 200-250 g were used. The animals were caged individually after wounding for treatment till completion of wound healing. In each group of different models six animals were used. The experiments were conducted after obtaining approval from Institutional Animal Ethical Committee, NandhaCollege of Pharmacy, Erode, TamilNadu.

Excision wound model: Anexcision wound has inflected by cutting away approximately 500mm full thickness of shaved skin of a predetermined area on the anterior-dorsal side of each subsequently on alternate. Group I animals treated as normal control (treated with 0.5%w/v Carboxymethyl Cellulose which is used as a vehicle solution), Group II animals were treated with Povidone iodine ointment topically for 7days. Group III animals treated with ethanolic extract of *Pleurotus florida* per oral (100mg/kg p.o)., along with 0.5%w/v Carboxymethyl Cellulose, Group IV animals treated with ethanolic extract of *Pleurotus florida* fresh 200mg/kg p.o., along with 0.5%w/v Carboxymethyl Cellulose, Group V animals treated with ethanolic extract of *Pleurotus florida* dried sample 100mg/kg p.o., along with 0.5%w/v Carboxymethyl Cellulose, Group VI animals treated with ethanolic extract of *Pleurotus florida* dried sample 200mg/kg p.o., along with 0.5%w/v Carboxymethyl Cellulose, for 7 days. Changes in the wound area were calculated after 1^{st},3^{rd}, 5^{th}, and 7^{th} day.

Assessment of wound healing:

Wound concentration was studied by placing the wax paper, on the raw wound area, every alternative day till the wounds were completely covered with epithelium. These wound tracing were retraced on a mm scale in graph paper. The wounds were determined and expressed as percentage of original wound size.

Statistical analysis:

The values are expressed as mean ± SEM. The data were, analysed by ANOVA followed by Dunnet's test P values.

2.4. Evaluation of Anti-inflammatory Activity of the Mushroom Extracts (Fresh and Dried)

The activity was evaluated by using acute model - Carrageenan induced rat paw edema method. The experiments were conducted after obtaining approval from Institutional Animal Ethical Committee, Nandha College of Pharmacy, Erode, TamilNadu.

The drug Indomethacin -10 mg/kg was given. The Chemical name of the drug Indomethacin.: 1-(4.Chlorobenzoyl)-(-methoxy-2-methylindol-3-yl) acetic acid.

Experimental animals

Male *Albino Wistar* rats weighing between 200-250 g were used for the experiments. They were kept in polypropylene cages under standard laboratory conditions (12: 12 hr light/dark cycle at 24ÚC. Rats were provided with commercial rat diet and water *adlibitum*. Animals were quarantined and acclimatized to laboratory conditions for 7 days prior to study initiation. Animals were observed for general health and suitability for testing during this period.

Carrageenan induced rat paw edema

The anti-inflammatory activity of the test compounds was evaluated in *Wistar Albino* rats employing the method of (Winter *et al*., 1963). Animals were fasted overnight and were divided into control, standard and different test groups. Animals in the standard group received Indomethacin at the dose of 10 mg/kg, by oral route. Before this all the test compounds were administered by oral route at the dose of 100 and 200 mg/kg/day for 10days. Required quantity of the test compound were

weighed and made suspension with 0.5%w/v Carboxy methyl cellulose. This suspension was administered orally to all the rats at a specific time each day throughout the period of the study. The rats in the control group received the vehicle solution (0.5%w/v Carboxy methyl cellulose) without test compounds. One hour after test drugs administration on termination day, rats in all the groups were challenged with 0.1 ml of 1% Carrageenan in the sub plantar region of right hind paw. Paw volumes were measured before and every one hr up to 3 hrs after the challenge of Carrageenan using Vernier caliber. The percent inhibition of paw thickness for treated groups was calculated by comparing with mean paw thickness of control group.

% Inhibition = Vc – Vt /Vc

(Vc- Control Mean paw thickness, Vt – Test paw thickness)

Statistical Analysis

The experimental values were mentioned as Mean ± S.E.M (N=6) Standard Error of the Mean - S.E.M.The paw thickness were statistically analyzed by One-Way Analysis of Variance (ANOVA) followed by Dunnett's test. P value <0.05 was considered statistically significant using Graph Pad software.

3. Results and Discussion

Much work has been carried out on *Pleurotus florida* mushroom cultivation, biomass production by means of solid and liquid-state fermentation, and medicinal properties. Studies on mushroom cultivation have been focused on optimization of alternative substrates. It has been shown that a wide variety of agricultural (by-) products, weeds and wastes can be successfully used to produce food, feed, enzyme and medicinal compounds and to degrade and detoxify wastes. The maximum yield of *Pleurotus florida* was obtained when it was cultivated on soybean straw (875.66gm/kg straw) with 87.56% Biological Efficiency(B.E)., this was followed by yield on soybean + paddy straw (852.00gm/kg straw) with 85.20% B.E. while least was recorded with wheat straw+ paddy straw (723.66gm/kg straw). The moisture content was maximum on paddy straw (92.45%) followed by soybean + wheat straw (90.23%) there was slight variation with other substrate indicating that moisture content is independent of the substrate.

Figure I

Oyster mushroom Cultivated in our laboratory using paddy straw.

Table I

Qualitative Analysis of Phytonutrients of *Plerotusflorida* crude mushroom extract:

Assay	Phytonutrients	Availability
In vitro assay	**Carbohydrates**	+
	Glycosides	+
	Protein and Amino acids	+
	Flavanoids	+
	Alkaloids	+
	Tannins	+
	Saponins	–
	Phenols	–

3.2.Anti inflammatory activity

The development of oedema in carrageenan induced rat-paw oedema model follows a biphasic response (Crunkhorn*et al*., 1971). The first phase that occurs between 0 to 2.5 hrs after injection has been attributed to histamine or serotonin release. The second phase occurs at3 hrs and is caused by the release of bradykynin, protease, prostaglandin and lysosome

(Di-Rosa *et al*.,1971). On the basis of the time of action of *Sidacordifolia*Linn, Sutradhar*et al*. inferred that chloroform & methanol extracts of *Sidacordifolia* Linn exhibited sufficient inhibition of paw oedema (Sutradhar*et al*., 2006). The Aqueous Extract (AE) also showed a significant inhibition at a dose of 400 mg/kg administered orally, but did not block the oedema induced by arachidonic acid (Franzotti*et al*., 2000). A new alkaloid, 1,2,3,9 tetrahydro-pyrrolo (Sosa *et al*., 2002). quinazolin-3-ylamine isolated from *Sidacordifolia*Linn produced inhibition of paw oedema at the doses of 25 and 50 mg/kg(Sutradhar*et al*., 2007). In present study extract of *Pleurotus florida* fresh sample at a dose of 100mg/kg & 200mg/kg showed 48.83% & 53.48% inhibition (P value <0.05) of rat-paw oedema respectively compared to the dried mushroom sample.

Table II

Effect of Ethanolic extract of *Pleurotusflorida*on Carrageenan induced paw edema in rats.

Test groups	Reduction of paw thickness in mm				
	0 hr	1st hr	2nd hr	3rd hr	4th hr
Group A	0.12±0.01	0.58±0.07	1.20±0.01	1.58±0.04	0.87±0.09
Group B	0.13±0.01	0.29±0.04**	0.53±0.01**	0.78±0.01**	0.45±0.04**
Group C	0.12±0.01	0.39±0.005**	0.7±0.01**	1.12±0.05**	0.57±0.07*
Group D	0.10±0.008	0.31±0.02**	0.6±0.02**	0.98±0.02**	0.51±0.05**
Group E	0.12±0.005	0.5±0.01ns	0.9±0.02**	1.38±0.04*	0.89±0.01ns
Group F	0.12±0.02	0.46±0.02*	0.8±0.02**	1.21±0.05**	0.82±0.02ns

Values are mean ± SEM ; n=3 in each group,

*P<0.05 when compared to negative control ;

** P<0.01(one way ANONA followed by Dunnet's test).

Group A - negative control (Carragenan 1% w/v) +0.5 % w/v Carboxymethyl Cellulose(Vehicle)

Group B - Carragenan 1% w/v + (Vehicle) + positive control (Indomethecin 10mg/kg).

Group C –Carragenan 1% w/v + (Vehicle) + *Pleurotus florida* fresh sample (100mg/ml).

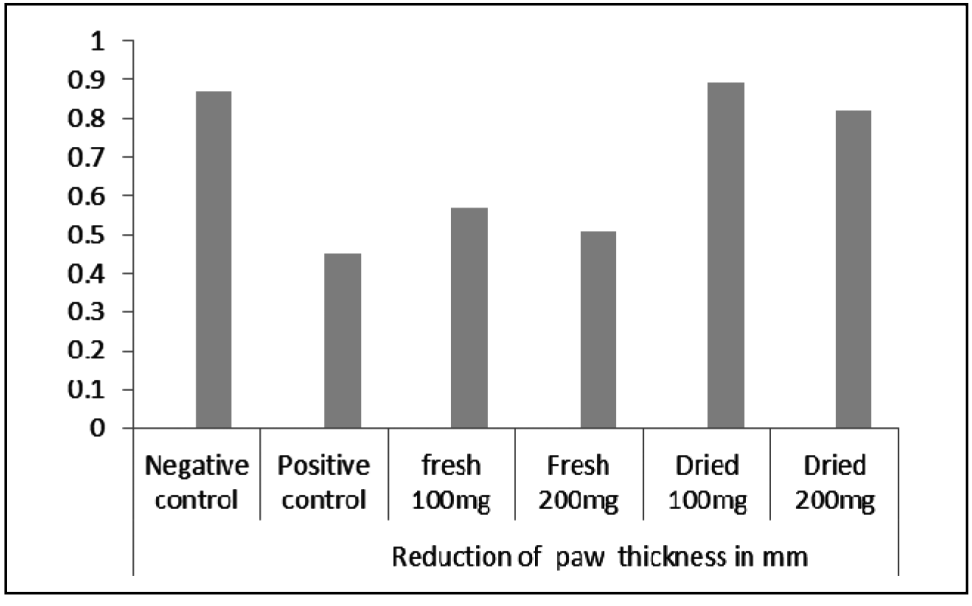
Group D –Carragenan 1% w/v + (Vehicle) + *Pleurotus florida* fresh sample (200mg/ml).

Group E –Carragenan 1% w/v + (Vehicle) + *Pleurotus florida* dried sample (100mg/ml).

Group F –Carragenan 1% w/v + (Vehicle) + *Pleurotus florida* dried sample (200mg/ml).

Graph I

Effect of Ethanolic extract of *Pleurotusflorida*on Carrageenan induced paw edema in rats



The effect of ethanolic extracts of *Pleurotus florida* fresh sample (100 & 200 mg/kg) and *Pleurotus florida* dried sample (100 & 200 mg/kg) in Carrageenan induced paw edema in rats is shown in Table II and Graph I. The ethanolic extract of *Pleurotus florida* fresh sample(100 & 200 mg/kg) prevented the formation of edema induced by Carrageenan and thus showed significant anti-inflammatory activity (P value<0.05). The ethanolic extract of *Pleurotus florida* fresh sample(100 & 200 mg/kg) reduced the edema induced by Carrageenan by 23.45% after 3h injection of noxious agent as compared to the negative control treated group. Pain, inflammation and pyrexia are the most usual disturbing symptom in day to day life. Plenty of drugs are available in the market for relieving these symptoms and which are also sold over the counter (OTC). However, they have high tendency of causing adverse drug reaction from a trivial nausea and vomiting to gastric irritation leading to peptic ulcer, perforation and may also even lead to death (Chandrashekeret *al*., 2012). Southern part of India has a tradition of using herbal preparation from centuries especially in DakshinaKannada (Mangalore district, Karnataka, India). However no scientific data are available for many herbal drugs which are locally used. Hence evaluating these herbal drugs, it would be worthwhile to have scientific approach of using them.

Figure II

Image of paw edema in Albino rats

3.3. Wound healing activity

A better healing pattern with complete wound closure was observed in mice treated within 7 days while it took about 15 days in control mice with different concentration of ethanol extract (Table III and graph II). There was a significant reduction in wound area from day two onwards in treated mice and also on later days the closure rate was much faster than when compared with control mice.

Table III.

Effect of extract of *Pluerotusflorida* on excision model in mice

Test groups	Reduction of Wound size in mm			
	1st day	3rd day	5th day	7th day
Group I	22.53±0.6	4.86±0.1	8.06±0.3	11.36±0.6
Group II	17.36±0.4**	11.63±0.2**	14.8±0.2**	16.76±0.3**
Group III	28.96±0.2**	10.2±0.3**	17.53±0.7**	27.73±0.2**
Group IV	30.5±0.5**	12.1±0.2**	20.63±0.2**	30.7±0.2**
Group V	25.3±0.5*	5.76±0.2 ns	9.06±0.4 ns	11.63±0.4 ns
Group VI	18.1±0.4**	7.13±0.1**	11±0.1**	17.06±0.1**

Values are mean ± SEM ; n=6 in each group,

*P<0.05 when compared to normal control ;

** P<0.01(one way ANONA followed by Dunnet's test).

Group I -normal control with wound induced +0.5 % w/v CarboxymethylCellulose (Vehicle)

Group II - wound induced +(Vehicle)+positive control (Povidone iodine ointment).

Group III – wound induced + (Vehicle)+*Pleurotus florida* dried sample (100mg/kg orally).

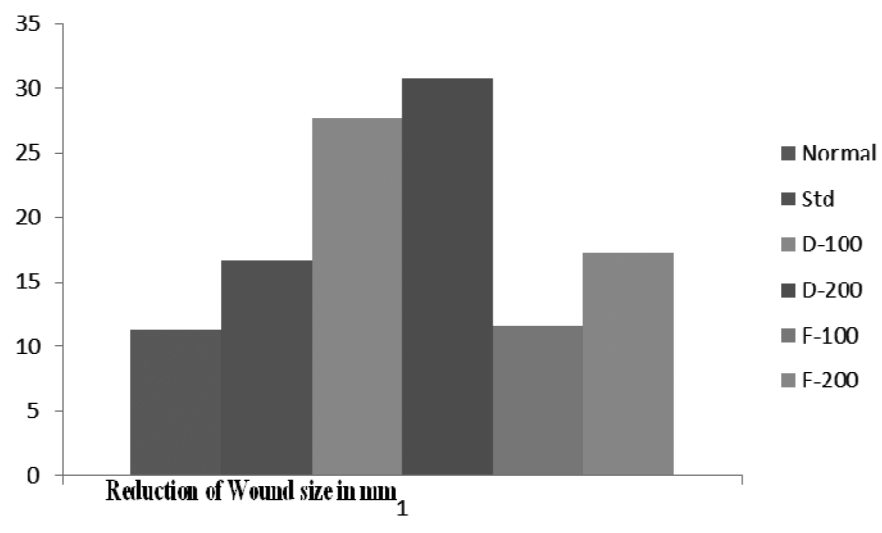
Group IV – wound induced +(Vehicle)+ *Pleurotus florida* dried sample (200mg/kg orally).

Group V- wound induced +(Vehicle)+ *Pleurotus florida* fresh sample (100mg/kg orally).

Group VI – wound induced + (Vehicle)+*Pleurotus florida* fresh sample (200mg/kg orally).

Graph II

Reduction of wound size by ethanolic extract of *Pleurotusflorida*



Group I -normal control with wound induced +0.5 % w/v CarboxymethylCellulose(Vehicle)

Group II - wound induced +(Vehicle) + positive control (Povidone iodine ointment).

Group III – wound induced + (Vehicle) + *Pleurotus florida* dried sample (100mg/kg orally).

Group IV – wound induced +(Vehicle) + *Pleurotus florida* dried sample (200mg/kg orally).

Group V- wound induced +(Vehicle) + *Pleurotus florida* fresh sample (100mg/kg orally).

Group VI – wound induced + (Vehicle) + *Pleurotus florida* fresh sample (200mg/kg orally).

Wounds are referred to as disruption of normal anatomic structure and function. Skin wounds could happen through several causes like physical injuries resulting in opening and breaking of the skin (Geald*et al*., 1994). The most common symptoms of wounds are bleeding, loss of feeling or function below the wound site, heat and redness around the wound, painful or throbbing sensation, swelling of tissue in the area and pus like drainage (Rashed*et al*., 2003). Wound healing is a very complex, multifactor sequence of events involving several cellular and biochemical processes. The aim in these processes is to regenerate and reconstruct the disrupted anatomical continuity and functional status of the skin.

Study on animal models showed enhanced rate of wound contraction and drastic reduction in healing time than control, which might be due to enhanced epitheliasation. The animals treated with 100 mg/kg body weight and 200 mg/kg body weight dried extract showed significant results when compared with different groups and normal control. The treated wound after six days exhibit dryness of wound margins with tissue regeneration (Hernandez *et al*., 2001).Alkaloids, flavanoids, glycosids, proteins, and tannins are the major phytoconsitituent present in this plant which may be responsible for wound healing action. The plant *Portulacaoleracea* containing the tannins possesses wound healing activity as that of the *Pleurotusflorida*. The ethanolic extract of the plant *Vernoniascorpioides* possess wound healing action by improving regeneration and organization of the new tissue due to the presence of tannins (Leite*et al*., 2002).

Figure III

First day wound in mice

Third day wound reduction in mice

Seventh day wound reduction in mice

Summary and Conclusion

Inflammation is characterized by external symptoms likeswelling and red coloured patches on the skin which istriggered and progresses by complex mechanism involving several factors (Winyard& Willoughby*et al*, 2003).The anti-inflammatory activity of *Pleurotus florida* was determined by the carrageenan-induced paw edemain Albino rats. These models are well accepted experimental models for the evaluation of acute and chronic anti-inflammatory activity respectively. Inflammatory reactions induced by carrageenan injection in early hour are mediated by secretion of histamine, 5-hydroxytryptamine, bradykinin. While in late hours, inflammation is due to synthesis of prostaglandins (PGs)etc. (Ferreira *et al*., 1974; Larsen & Henson*et al*, 1983).The result obtained from the experiment it is concluded that the ethanolic extract of *Pleurotus florida* fresh sample(200mg/kg) having good anti-inflammatory activities and it showed dose dependent activities. The results support thetraditional use of this mushroom in inflammation.

The wound healing property of the ethanolic extract of *Pleurotus florida* appears to be due to the presence of its active principles, which accelerate the healing process and confer tensile strength to the healed wound.Study on animal models showed enhanced rate of wound contraction and drastic reduction in healing time than control, which might be due to enhanced epitheliasation. The animals treated with 100 mg/kg body weight and 200 mg/kg body weight dried extract showed significant results when compared with different groups and normal control. The treated wound after six days exhibit dryness of wound margins with tissue regeneration (Hernandez *et al*., 2001).Alkaloids, flavanoids, glycosids, proteins, and tannins are the major phytoconsitituent present in this plant which may be responsible for wound healing action.Inwound healing conditions and suggest the presence of biologically active components which may be worth further investigation and elucidation.

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METHODOLOGICAL FACTOR OF REMOTE SENSING IMAGE CLASSIFICATION PROCESS – A VISION

T. Balaji [*], M. Sumathi [**]

Abstract

The intent of classification process is to categorize all the pixels in a digital image into several land cover classes or themes. The object of image classification is to identify and portray, as a unique gray level or color the features occurring in an image in terms of the object or type of land cover. Remote sensing image classification is a complex process that may be affected by many factors. This paper examines current practices, problems, and prospects of image classification in remote sensing. The emphasis is placed on the summarization of major advanced classification approaches and the techniques used for improving classification accuracy. In addition, there are some important mathematical techniques and methods for improving classification performance of a remote sensing imagery data. It suggests that designing a suitable image processing procedure is a prerequisite for a successful classification of remotely sensed data into a thematic map. Effective use of multiple features of remotely sensed data and the selection of a suitable classification method are especially significant for improving classification accuracy. However, SVM is needed to identify and reduce uncertainties in the image processing chain to improve classification accuracy and performance. The mathematical training and prediction analysis of a general familiarity with remote sensing classifications meet typical map accuracy standards.

Keywords

Remote Sensing, GIS, Prediction, Training, Supervised and Unsupervised, PCA, SVM

1. Introduction

Remote-sensing research focusing on image classification has long attracted the attention of remote-sensing community because classification results are the basis for many environmental and

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socio-economic applications. Scientists and practitioners have made great efforts in developing advanced classification approaches and techniques for improving classification accuracy. However, classifying remotely sensed data into a thematic map remains a challenge because many factors, such as the complexity of the landscape in a study area, selected remotely sensed data, and image-processing and classification approaches, may affect the success of a classification [1]. Continuous emergence of new classification algorithms and techniques in recent years necessitates such a review, which will be highly valuable for guiding or selecting a suitable classification procedure for a specific study. Remote sensing image analysis is an important research area for the last four decades. There is also an extensive literature on classification of remotely sensed imagery using parametric or nonparametric statistical or structural techniques.

This paper focused on providing a summarization of major advanced classification methods and techniques used for improving classification accuracy, and on discussing important issues affecting the success of image classifications. Common classification approaches, such as K-means clustering, Principle Component Analysis (PCA), Support Vector Machine (SVM) method, discriminate analysis, Feature based methods and machine learning principles, etc. Especially, there are some machine learning algorithms such as SVM to improve the classification accuracy of remote sensing imagery data. The major steps of image classification may include determination of a suitable classification system, selection of training samples, image pre-processing, and feature extraction, selection of suitable classification approaches, post-classification processing and accuracy assessment [2].

2. Remote Sensing Image Classification Process

Remote sensing classification is a complex process and requires consideration of many factors. The remote sensing image classification may include determination of a suitable classification system such as selection of training samples, image preprocessing, feature extraction, selection of suitable classification approaches and accuracy assessment. The user's need of the study area consists of scale, economic condition, and analyst's skills are important factors influencing the selection of remotely sensed data, the design of the classification procedure and the quality of the classification results [3]. This section focuses on the description of the major steps that may be involved in remote sensing image classification.

2.1. Selection of Remotely Sensed Data

Remotely sensed data vary in spatial, radiometric, spectral, and temporal resolutions. Understanding the strengths and weaknesses of different types of sensor data is essential for the selection of suitable remotely sensed data in image classification. The selection of suitable sensor

data is the first important step for a successful classification for a specific purpose. It requires considering factors such as user's need, the scale and characteristics of a study area, the availability of various image data and their characteristics, cost and time constraints, and the analyst's experience in using the selected image. Another important factor influencing the selection of sensor data is the atmospheric condition. The frequent cloudy conditions in the moist tropical regions are often an obstacle for capturing high-quality optical sensor data. Since multiple sources of sensor data are now readily available, image analysts have more choices to select suitable remotely sensed data for a specific study.

2.2. Selection of Classification System and Training Samples

A suitable classification system and a sufficient number of training samples are prerequisites for a successful classification. We have identified three major problems for vegetation classifications: defining adequate hierarchical levels for mapping, defining discrete land-cover units discernible by selected remote-sensing data, and selecting representative training sites. In general, a classification system is designed based on the user's need, spatial resolution of selected remotely sensed data, compatibility with previous work, image processing and classification algorithms available, and time constraints. Such a system should be informative, exhaustive and separable. A sufficient number of training samples and their representativeness are critical for image classifications. Training samples are usually collected from fieldwork or from fine spatial resolution photographs and satellite images. Therefore, selection of training samples must consider the spatial resolution of the remote-sensing data being used, availability of ground reference data, and the complexity of landscapes in the study area.

2.3. Image Preprocessing

Preprocessing of satellite images prior to image classification and change detection is essential. Image preprocessing may include the detection and restoration of bad lines, geometric rectification or image registration, radiometric calibration and atmospheric correction, normalization, masking and topographic correction (e.g., for clouds, water, irrelevant features). The normalization of satellite imagery takes into account the combined, measurable reflectance of the atmosphere, aerosol scattering and absorption, and the earth's surface. It is the volatility of the atmosphere which can introduce variation in the reflectance values of satellite images acquired at different times. Geometric rectification of the imagery resamples or changes the pixel grid to fit that of a map projection or another reference image. Accurate geometric rectification or image registration of remotely sensed data is a prerequisite for a combination of different source data in a classification process.

2.4. Feature Extraction and Selection

The first step in the process is extracting image features to a distinguishable extent. The second step involves matching these features to yield a result that is visually similar. Selecting suitable variables is a critical step for successfully implementing an image classification. Many approaches such as principal component analysis, minimum noise fraction transform, discriminant analysis, decision boundary feature extraction, non-parametric weighted feature extraction, wavelet transform, and spectral mixture analysis may be used for feature extraction, in order to reduce the data redundancy inherent in remote sensing data. In practice, comparisons of different combinations of selected variables are often implemented and a good reference dataset is vital.

2.5. Selection of a Suitable Classification Method

Many factors such as spatial resolution of the remotely sensed data, different sources of data, a classification system, and availability of classification software must be taken into account when selecting a classification method for use. Different classification methods have their own merits and results may be obtained depending on the classifiers chosen. The following diagram shows the major steps in two types of image classification:

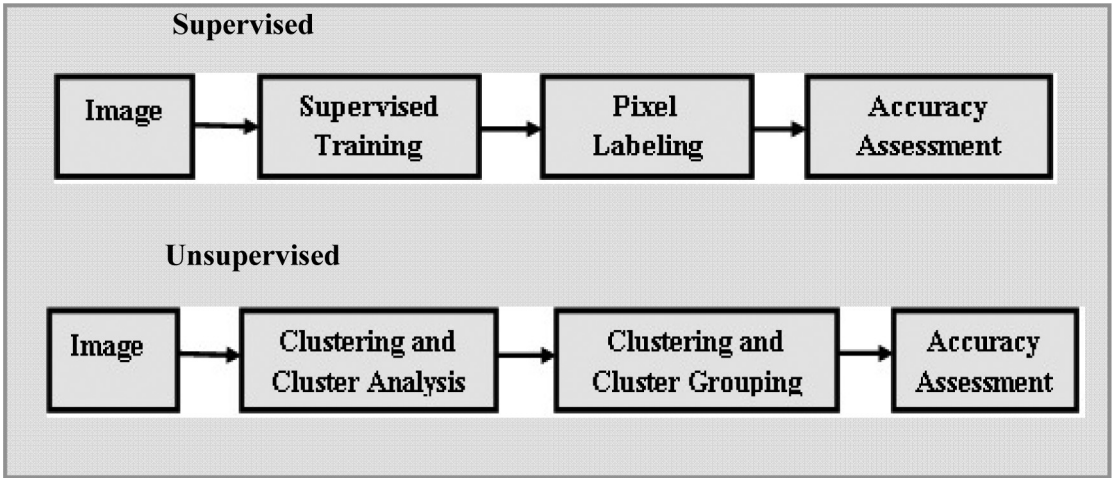


Fig. 1. Supervised and Unsupervised Remote Sensing Image Classification

2.6. Evaluation of Classification Performance

Evaluation of classification results are important process in the classification procedure. Different approaches may be employed, ranging from a qualitative evaluation based on expert knowledge to a quantitative accuracy assessment based on sampling strategies. To evaluate the

performance of a classification methods there are six criteria needs to be proposed are accuracy, reproducibility, robustness, ability to fully use the information content of the data, uniform applicability and objectiveness. Classification accuracy assessment is the most common approach for an evaluation of classification performance.

2.7. Classification Accuracy Assessment

Before implementing a classification accuracy assessment, one needs to know the sources of errors. In addition to errors from the classification itself, other sources of errors, such as position errors resulting from the registration, interpretation errors, and poor quality of training or test samples, all affect classification accuracy. A classification accuracy assessment generally includes three basic components: sampling design, response design, and estimation and analysis procedures. The error matrix approach is the most widely used accuracy assessment classification process. In order to properly generate an error matrix, one must consider the following factors: reference data collection, classification scheme, sampling scheme, spatial autocorrelation, and sample size and sample unit. The basic accuracy assessment method is systematically involved in advanced topics fuzzy-logic and multilayer assessments, and explained principles and practical considerations in designing and conducting accuracy assessment of remote-sensing data.

3. Effective Method of Svm

The SVM is a powerful technique for remote sensing image classification. In this paper, we propose a simple procedure or a function which is usually gives a reasonable results. The main goal of this paper includes: 1. Train a visual classifier for different image classes 2. Achieve the performance of the classifier 3. Visual content used for Mapping (feature in image) 4. Obtain the train image data. This SVM approach is guide to achieve the highest accuracy. Also, we intent to solve challenging or difficult problems in remote sensing image data sets. The SVM also belongs to the class of supervised learning algorithms in which learning machine is given a set of examples with the associated labels. The SVM is to construct a hyper plane that separates two classes or extended to multi-class problems. The SVM algorithm tries to achieve maximum separation between the classes. The SVM for separating the classes with a large margin minimize a bound on the expected generalization error. This means that new examples (data points with unknown class values) arrive for classification, the chance of making error in our prediction based on the learned classifier should be minimum.

3.1. Visual Content used for Feature Mapping

The SVM training function uses an optimization method to identify support vectors S_i, weights W_i and bias b that are used to classify vector x according to the following equation:

$$C = \sum_{i=0}^{n} W_i \, . \, K(S_i, x) + b$$

Where, K is a kernel function. If C e" 0, then x is classified as a member of the first group, otherwise it is classified as a member of the second group.

3.2. Performance of SVM Classifier

The performance of the SVM classifier helps to score ranks of all the spatial and spectral features of remote sensing test images. The bias term is not needed for this ranking, only classification feature vector should be observed. It will be measured by the retrieval performance qualitatively and quantitatively by computing precision SVM methods. The precision method is computed by varying the threshold on the classifier. In order to assess the retrieval performance by a single number, the average precision (AP) is often computed.

The performance of the active support vector learning algorithm (active SVM) is compared with the following multispectral remote sensing image classification algorithms. The methods SVM 1and SVM 2 represents extreme conditions on the use of labeled samples.

Conventional SVM 1: The conventional support vector machine using only the initial labeled set as the entire design set. In this method, the labeled set is very small in size but the labels are accurate.

Conventional SVM 2: The conventional support vector machine using 10% of the entire set of pixels as the entire design set. A large fraction of the entire data constitutes the labeled set, but the labels may be inaccurate.

4. Prediction and Training of Remote Sensing Classification

Remote sensing image classification prediction encompasses two levels: classifier construction and the usage of the classifier constructed. The building of a classification model by describing a set of predetermined classes from training set as well as the result of learning from that dataset. Each sample in the training set is assumed as a predefined class, it may be determined by the class attribute label [3]. The use of SVM classifier built to predict or classify unknown objects based on the patterns observed in the training set. The predication training method of remote sensing classification is shown in figure 2.

Image classification analyzes the numerical properties of various image features and organizes data into categories. Classification algorithms typically employ two phases of processing namely, *training* and *testing*. In the initial training phase, characteristic properties of typical image features are isolated and based on a unique description of each classification category, *i.e. training*

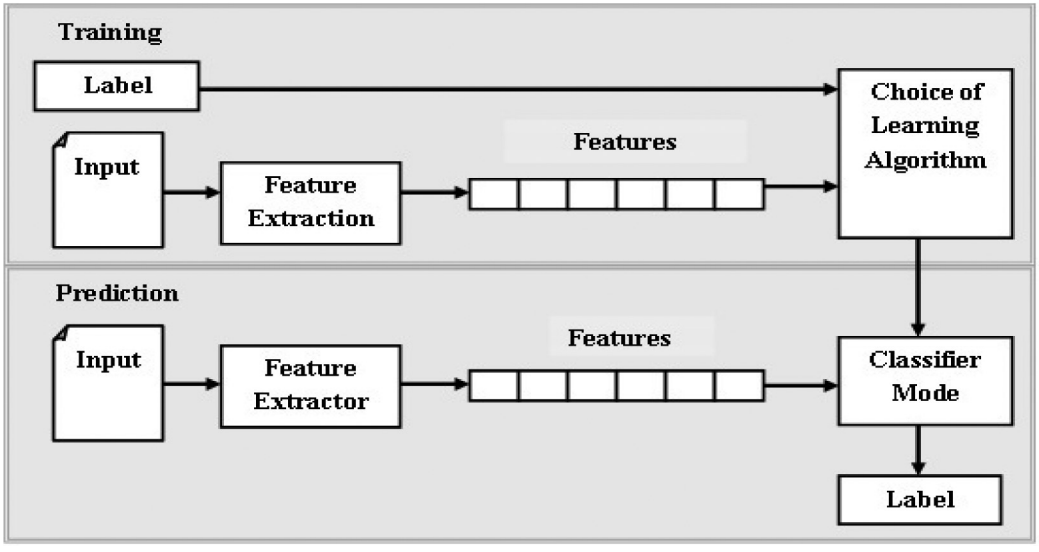


Fig. 2. Prediction and Training method of Remote Sensing Image Classification

class is created. In the subsequent testing phase, these feature-space partitions are used to classify image features. The description of training classes is an extremely important component of the classification process. In supervised classification, *statistical* processes or *distribution-free* processes can be used to extract class descriptors. Unsupervised classification relies on *clustering* algorithms to automatically segment the training data into prototype classes [6]. In either case, the motivating criteria for constructing training classes are:

Self-determining - a change in the description of one training class should not change the value of another.

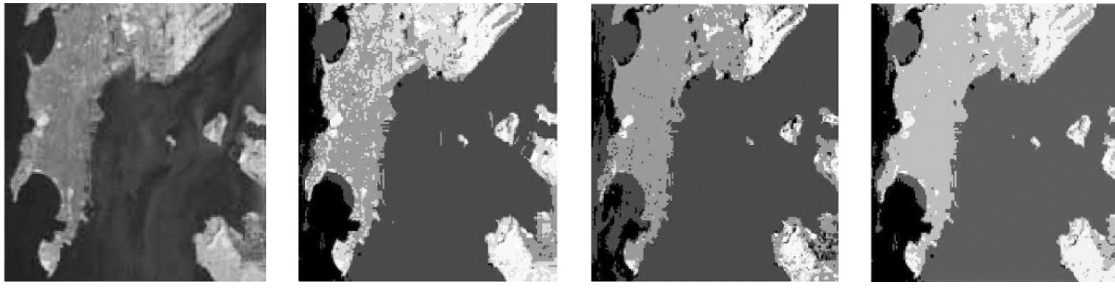
Biased - different image features should have significantly different descriptions.

Consistent - all image features within a training group should share the common definitive descriptions of that group.

5. Experimental Results

The multispectral remote sensing image data used in our experiment contains observations of the Indian Remote Sensing (IRS) satellite for the city of Mumbai, India (Gray Scale Image). The data contains images of four spectral bands namely blue, green, red and infrared. This image contains 377 * 372 pixels size. Here the method SVM is to segment the image into different land cover regions using four features (spectral bands). The image mainly consists of six classes e.g., clear water (ponds), turbid water (sea), concrete (buildings, roads, airport tarmacs), habitation (concrete structures but

less in density), vegetation (crop, forest areas) and open spaces (barren land, playgrounds). The complete process of SVM and the standards are summarized in subsequent figure 3.



(a) (b) (c) (d)

Fig. 3.a. Original Remote Sensing Image, b. Active SVM Based Classified image, c. Conventional SVM1 Based Classified Image, d. Conventional SVM2 Based Classified Image

5. Conclusion

Remotely sensed image classification has to progress some methodological factors such as the development and use of advanced classification algorithms, the use of multiple remote-sensing features and incorporation of ancillary data into classification procedures. The accuracy of SVM method is the ability to correctly determine the classification of randomly selected data instance. It may be expressed as the probability of correctly classifying unseen data. The optimistic predictions are often made regarding the accuracy of the classification method. Spectral and spatial features are important attribute for remote sensing image classification. Classification approaches may vary with different types of remote sensing datasets and images. Integration of remote sensing and GIS are significant in classification improvement, which varies in data format, accuracy, spatial resolution, and coordinate systems. The success of remote sensing image classification depends on many factors such as the availability of high-quality remotely sensed image and ancillary data, the design of a proper classification procedure, the analyst's skills and experiences are the most important. Moreover, the combinations of different classification approaches are helpful for improvement of classification accuracy. Especially SVM method of classifiers data by finding the best hyper plane that separates all data points of one class from those of the other class. Many researchers to prove the performances of SVM well in remote sensing image classification accuracy in order to boost the remote sensing applications.

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COMPLEMENTARY DISTANCE EQUITABLE DOMINATING SET

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Abstract

Let G=(V,E) be a simple graph. A subset D of V(G) is called a complementary distance equitable dominating set of G (cded-set of G) if V-D is a distance equitable set (ie. for any vertices u_1,u_2,u_3,u_4 in V-D, $|d(u_1,u_2)-d(u_3,u_4)| \leq 1$) and D is a dominating set of G. Since V(G) is a cded-set of G, the existence of cded-sets in any graph is guaranteed. The minimum cardinality of a cded-set of G is called the complementary distance equitable domination number of G and is denoted by $\gamma_{cded}(G)$. The property of complementary distance equitable domination is super hereditary. Hence a cded-set is minimal iff it is 1-minimal. Characterization of minimal cded-sets is derived. The values of γ_{cded} for many classes of graphs have been found. It is established that there is no relationship between γ_{cded} and β_0.The inequality chains involving γ,γ_{cded} and their upper parameters are presented with strict inequality in certain graphs. A new parameter called i_{cded} is also introduced. Interesting results are proved with respect to the new parameters.

Keywords: Dominating set, Complementary distance equitable dominating set.

Introduction 1.1 The concept of equitability in graph theory is nearly 40 years old. Walter Meyer introduced equitable coloring in 1973. In this coloring, the color classes are independent and any two color classes differ in cardinality by at most one. Several types of equitability were suggested by Prof. E.Sampathkumar. One such is distance equitability. This paper uses his concept and combines it with domination.

Definition 1.1.1: Let G=(V,E) be a simple graph. Let D be a subset of V(G). D is said to be distance equitable if for any two pairs $(u_1,v_1),(u_2,v_2)$ in D, $|d_G(u_1,v_1)-d_G(u_2,v_2)| \leq 1$.

Definition 1.1.2: A subset D of V(G) is called a complementary distance equitable dominating set of G (cded-set of G) if V-D is a distance equitable set and D is a dominating set of G.

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Definition 1.1.3: The minimum cardinality of a minimal cded-set of G is called the cded number of G and is denoted by $\tilde{a}_{cded}(G)$. The maximum cardinality of a minimal cded-set of G is called the upper cded number of G and is denoted by $\Gamma_{cded}(G)$.

Since V(G) is a complementary distance equitable dominating set of G, the existence of complementary distance equitable dominating set is guaranteed in any graph.

$\tilde{a}_{cded}$(G) for standard graphs

i) $\tilde{a}_{cded}(K_n)=1$

ii) $\tilde{a}_{cded}(K_{1,n})=1$

iii) $\tilde{a}_{cded}(K_{m,n})=\min\{m,n\}$

iv) $\tilde{a}_{cded}(D_{r,s})=2$

Lemma 1.1.4: Let $G=P_n$ ($ne\geq 4$). Then any three non consecutive vertices constitute a non distance equitable set of G.

Proof: Let x_1,x_2 and x_3 be non consecutive vertices. (x_1 and x_2 may be consecutive but x_2 and x_3 are not consecutive)

$d(x_1,x_2) \geq 1$, $d(x_2,x_3) \geq 2$

Therefore $d(x_1,x_3) \geq 3$.

Therefore $\{x_1,x_2,x_3\}$ is not a distance equitable set of G.

Theorem 1.1.5: $\tilde{a}_{cded}(P_n)=n-2$ $(n\geq 3)$

Proof: When n=3, $\tilde{a}_{cded}(P_3)=1=$"n-2"

Let $n \geq 4$. Let D be a complementary distance equitable dominating set of P_n. Then V-D is a distance equitable set of P_n. The complement of any three consecutive vertices of P_n is not a dominating set of P_n.

By above lemma, $|V-D| \leq 2$.

Therefore, $|D| \geq n-2$.

Since any two vertices of P_n constitute a distance equitable set of P_n, any dominating set with n-2 elements is a complementary distance equitable dominating set of P_n.

Therefore, $\tilde{a}_{cded}(P_n)=n-2$.

Theorem 1.1.6: $\tilde{a}_{cded}(C_n)= \begin{cases} n-2, n \neq 5 \\ 2, n = 5 \end{cases}$

Proof: $\tilde{a}_{cded}(C_3) =1$ $\tilde{a}_{cded}(C_4)=2$, $\tilde{a}_{cded}(C_5)=2$. Let $n\geq 6$.Let D be a complementary distance equitable dominating set of C_n. Then V-D is a distance equitable set of C_n and D is a dominating set of C_n. Let x_1,x_2 and x_3 be non consecutive vertices. (x_1,x_2 and x_3 be non consecutive vertices but x_2 and x_3 are not consecutive)

$d(x_1,x_2) \geq 1$, $d(x_2,x_3) \geq 2$.

Therefore $d(x_1,x_3) \geq 3$.

Therefore $\{x_1,x_2,x_3\}$is not a distance equitable set of C_n.

If x_1,x_2 and x_3 are consecutive vertices of C_n then $\{x_1,x_2,x_3\}$is a distance equitable set of C_n. If these three vertices are put in the complement, we get a set $\{V- \{x_1,x_2,x_3\}\}$ which is not dominating. If D is a complementary distance equitable dominating set of C_n, then $|V-D| \leq 2$. Therefore, $|D| \geq n-2$. Since any dominating set with n-2 elements is a complementary distance equitable dominating set of C_n. $\tilde{a}_{cded}(C_n) \leq n-2$. Therefore, $\tilde{a}_{cded}(C_n)=n-2$.

Theorem 1.1.7: $\tilde{a}_{cded}(W_n)=1$

Proof: Since $diam(W_n)=2$, the central vertex constitutes a complementary distance equitable dominating set of W_n. Hence the result.

Theorem 1.1.8: $\tilde{a}_{cded}(P)=3$ where P is the Petersen graph.

Proof:S=$\{1,3,7\}$ is a complementary distance equitable dominating set of P (Since in V-S, the distance between any two vertices is either 1 or 2). Therefore, $\tilde{a}_{cded}(P) \leq 3$.

But $\tilde{a}_{cded}(P) \geq \tilde{a}(P)=3$.

Therefore, $\tilde{a}_{cded}(P)=3$.

Remark 1.1.9: Let G be a simple graph. Let D be a complementary distance equitable dominating set of G. Then any super set of D is clearly a dominating set and its complement in V(G) is distance equitable. Therefore, complementary distance equitable property is super hereditary.

Theorem 1.1.10: Let G be a simple graph. A cded-set D of G is minimal if and only if for every $u \in D$, either u is an isolate of D or u has a private neighbor in V-D with respect to D or there exist x,y,z in V-D such that either $|d(u,x)-d(u,y)| \geq 2$ or $|d(u,x)-d(y,z)| \geq 2$

Proof: Suppose D is a cded-set of G. Since cded property is super hereditary, D is minimal if and only if D is 1-minimal. Suppose D is minimal. Let $u \in D$. Then D-{u} is not a cded-set of G. Therefore, D-{u} is either not dominating or (V-D-{u}) is not distance equitable. If D-{u} is not dominating then either u is an isolate of D or u has a private neighbor in V-D. If (V-D-{u}) is not distance equitable then there exist x,y,z in V-D such that either $|d(u,x)-d(u,y)| \geq 2$ or $|d(u,x)-d(y,z)| \geq 2$. Conversely, Suppose D is a cded-set of G satisfying the given property. Let $u \in D$. Then u is an isolate of D or u has a private neighbor in V-D with respect to D or there exist x,y,z in V-D such that either $|d(u,x)-d(u,y)| \geq 2$ or $|d(u,x)-d(y,z)| \geq 2$. In the first two cases, D-{u} is not dominating and in the third case, (V-D-{u}) is not distance equitable. Therefore, D-{u} is not a cded-set of G for any $u \in D$. Therefore, D is a minimal cded-set of G.

Remark 1.1.11: $\tilde{a}_{cded}(G) \leq \Gamma_{cded}(G)$

Example 1.1.12: $\tilde{a}_{cded}(K_{1,n})=1$. $\Gamma_{cded}(K_{1,n})=n$

$\tilde{a}_{cded}(C_5)=2=\Gamma_{cded}(C_5)$

Remark 1.1.13: A cded-set need not be distance equitable.

For: Let $G=P_6$. Let $D=\{u_1,u_2,u_3,u_5\}$ where $V(P_6)=\{u_1,u_2,u_3,u_4,u_5,u_6\}$

D is a cded-set of P_6. But D is not a distance equitable set.

Remark 1.1.14: There are graphs in which a cded-set is distance equitable.

For example, in $K_{1,n}$ the central vertex constitutes a cded-set and it is also distance equitable set.

Remark 1.1.15: The complement of a cded-set need not be dominating.

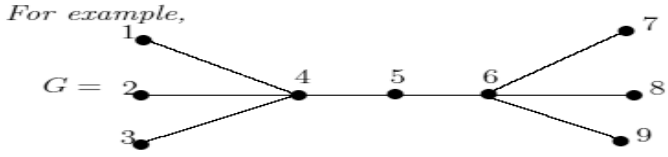
For example, in P_6, $D=\{u_1,u_2,u_3,u_5\}$ where $V(P_6)=\{u_1,u_2,u_3,u_4,u_5,u_6\}$ is a cded-set. But $V-D=\{u_4,u_6\}$ is not dominating.

Theorem 1.1.16: Let G be a simple graph without isolates. Let D be a cded-set of G. Suppose D is a minimal dominating set of G. Then V-D is a distance equitable dominating set of G.

Proof: Since D is a minimal dominating set of G and G has no isolates, V-D is a dominating set of G. Hence V-D is a distance equitable dominating set of G.

Illustration 1.1.17: $D=\{1,2,3\}$ is a cded-set of $K_{3,4}$. D is also minimal dominating set of $K_{3,4}$. Therefore, V-D is a distance equitable dominating set of $K_{3,4}$.

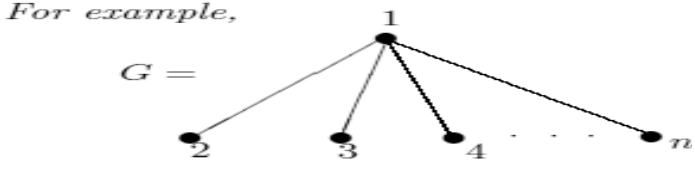
Remark 1.1.18: There are graphs G for which $\tilde{a}_{cded}(G) > \tilde{a}(G)$



$\tilde{a}(G) = 2$, $\tilde{a}_{cded}(G) = 5$.

Therefore $\tilde{a}_{cded}(G) > \tilde{a}(G)$

Remark 1.1.19: There are graphs G for which $\tilde{a}_{cded}(G) = \tilde{a}(G)$



$\tilde{a}(G) = 1$, $\tilde{a}_{cded}(G) = 1$.

Definition 1.2.1: A subset S of G is called independent cded-set if S is an independent set and S is a cded-set. The minimum cardinality of a minimal independent cded-set of G is called independent cded number of G and is denoted by $i_{cded}(G)$.The maximum cardinality of a minimal independent cded-set of G is called the upper cded number of G and is denoted by $\hat{a}_{cded}(G)$.

Remark 1.2.2:

(i) If G is a star then G has an independent cded-set.

(ii) K_n has an independent cded-set.

(iii) The Complement of K_n has an independent cded-set.

(iv) W_n has an independent cded-set.

(v) C_3, C_4, C_5, C_6 and C_7 have independent cded-set.

(vi) C_n ($n \geq 8$) has no independent cded-set.

(vii) If diam $G \leq 2$ then G has an independent cded-set.(Any maximal independent set of G is a cded-set of G)

For example, Peterson graph P has an independent cded-set since diam P=2.

(viii) If $\hat{a}_o(G) \geq n-2$ then G has an independent cded-set.

For example, $K_{m,n}$ has an independent cded-set.

Observation 1.2.3: There is no relationship between $\tilde{a}_{cded}(G)$ and $\hat{a}_o(G)$.

For: (i) $\tilde{a}_{cded}(C_8)=6$ $\hat{a}_o(C_8)=4$

$\tilde{a}_{cded}(C_8)>\hat{a}_o(C_8)$

(ii) $\tilde{a}_{cded}(K_{1,n})=1$ $\hat{a}_o(K_{1,n})=n$

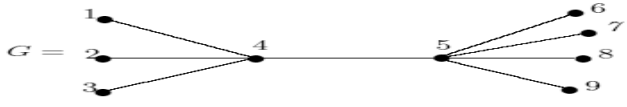
$\tilde{a}_{cded}(K_{1,n})<\hat{a}_o(K_{1,n})$ if $n>1$

(iii) $\tilde{a}_{cded}(K_n)=1=\hat{a}_o(K_n)$

Remark 1.2.4: $\tilde{a}(G)\leq \tilde{a}_{cded}(G)\leq \Gamma(G)$d" $\Gamma_{cded}(G)$

Remark 1.2.5: If G has independent cded-sets, then $\tilde{a}_{cded}(G)\leq i_{cded}(G)\leq \hat{a}_{cded}(G)\leq \hat{a}_o(G)$

Illustration 1.2.6: For example,



$\tilde{a}_{cded}(G)=2$ $i_{cded}(G)=4$ $\hat{a}_{cded}(G)=5$ $\hat{a}_o(G)=7$

$\tilde{a}_{cded}(G)< i_{cded}(G)<\hat{a}_{cded}(G)<\hat{a}_o(G)$

Remark 1.2.7: There is no relationship between $\Gamma_{cded}(G)$ and $\hat{a}_o(G)$.

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ABOUT END VERTEX ADJACENCY MATRIX AND END VERTEX INCIDENCE MATRIX OF SEMIGRAPHS

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Abstract

E.Sampathkumar introduced a new approach in Graph Theory called Semigraphs. A semigraph G = (V, X) on the nonempty set of vertices V and the set of edges X consists of n-tuples $(u_1,u_2,...,u_n)$ of distinct elements belonging to the set V for various $n \geq 2$, with the following conditions:

(i) Any n-tuple $(u_1,u_2,...,u_n) = (u_n,u_{n-1},...,u_1)$ and

(ii) Any two such tuples have at most one element in common.

The aim of the paper is to define the end vertex adjacency and end vertex incidence matrices of a semigraph. We have defined e-spectrum of a semigraph. We have also analyzed rank of an end vertex adjacency matrix. Using these parameters, we have calculated bounds for the e-chromatic number χ_e of certain semigraphs.

Keywords: *Semigraph, end vertex adjacency matrix A_e, end vertex Incidence matrix B_e, e-eigen value, e-spectrum, e-chromatic number.*

AMS Subject Classification Code: 05C99.

1. Introduction

Semigraphs introduced by E.Sampathkumar [4] is a new type of generalization of the concept of graph. In this structure an edge is connected by several points. A matrix is convenient and useful way of representing a semigraph and is important for applications in computer.

In section 2, we give some preliminary definitions and in section 3, we define end vertex adjacency and end vertex incidence matrices. Properties of these matrices are compared with those of a given semigraph. Finally in section 4, we give bounds for the e-chromatic number in terms of eigen values of end vertex adjacency matrix of a semigraph.

2. Preliminaries

We give definitions as in [4].

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Definition 2.1 A semigraph G = (V, X) on the nonempty set of vertices V and the set of edges X consists of n – tuples $(u_1, u_2,\ldots\ldots, u_n)$ of distinct elements belonging to the set V for various $n \geq 2$, satisfying the following conditions.

(SG1) Any two edges have at most one vertex in common.

(SG2) Two edges $(u_1, u_2,\ldots\ldots, u_n)$ and $(v_1, v_2,\ldots\ldots, v_m)$ are considered

to be equal if and only if

(i) m = n and

(ii) Either $u_i = v_i$ for $1 \leq i \leq n$ or $u_i = v_{n-i+1}$ for $1 \leq i \leq n$.

Thus the edge $(u_1, u_2,\ldots\ldots, u_n)$ is the same as $(u_n, u_{n-1},\ldots\ldots, u_1)$.

Definition 2.2 For the edge $E = (u_1, u_2,\ldots\ldots, u_n)$, u_1 and u_n are said to be the end vertices of the edge E while $u_2, u_3,\ldots\ldots, u_{n-1}$ are said to be the middle vertices of E.

Definition 2.3 Two vertices in a semigraph are said to be adjacent if they belong to the same edge and they are said to be consecutive adjacent if in addition they are consecutive in order as well.

Definition 2.4 Two edges are adjacent if they have a common vertex.

Definition 2.5 ([3]) Let G = (V, X) be a semigraph. Two vertices u and v are e – adjacent, if they are the end vertices of an edge in G.

Definition 2.6 For a vertex in a semigraph G = (V,X) we define various types of degrees as follows:

Degree: deg (v) is the number of edges having v as an end vertex.

Edge Degree: $\deg_e(v)$ is the number of edges containing v.

Adjacent Degree: $\deg_a(v)$ is the number of vertices adjacent to v.

Consecutive Adjacent Degree: $\deg_{ca}(v)$ is the number of vertices which are consecutive adjacent to v.

Definition 2.7 A semigraph G is complete if any two vertices in G are adjacent.

3. END VERTEX ADJACENCY AND END VERTEX INCIDENCE MATRICES

Definition 3.1 Let G = (V,X) be a semigraph with $V = \{v_1, v_2,\ldots, v_p\}$ and $X = \{e_1, e_2,\ldots, e_q\}$. The end vertex adjacency matrix $A_e = (a_{ij})$ of semigraph G with p points is the p x p matrix in which

$$a_{ij} = \begin{cases} 1, & \text{if } v_i \text{ is } e-\text{adjacent with } v_j \\ 0, & \text{Otherwise} \end{cases}.$$

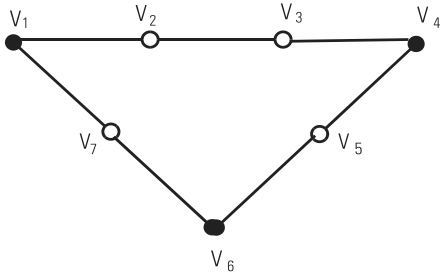

Fig (1)

For example the end vertex adjacency matrix of the semigraph G in fig(1) is

$$A_e = \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Definition 3.2 Let G = (V, X) be a (p, q) semigraph. The second matrix associated with a semigraph G in which points and lines are labeled is the end vertex incidence matrix $B_e = (b_{ij})$. This p x q matrix has

$$b_{ij} = \begin{cases} 1, & \text{if } \textit{end vertex } v_i \textit{ is incident with } e_j \\ 0, & \text{Otherwise} \end{cases}.$$

For example the end vertex incidence matrix of the semigraph G in fig (1) is given by

$$B_e = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

Definition 3.3 ([1]) Let $A_e(G)$ denote the end vertex adjacency matrix of a semigraph G. The characteristic polynomial of G is define to be det $(\lambda I - A_e(G))$. Where I stands for the identity matrix of the same order of A_e. the roots of the characteristic polynomial must be real and they are called eigen values of $A_e(G)$ or e – eigen values of G. The sequence of e – eigen values of G is called the e – spectrum of G.

We make the following observations regarding the end vertex adjacency and end vertex incidence matrices of a semigraph

1. The end vertex adjacency matrix A_e is symmetric.
2. The sum of the i^{th} row of A_e is equal to the sum of the i^{th} column of A_e is equal to the degree of v_i.
3. The entries along the leading diagonal of A_e are zero.
4. If one row or one column of the end vertex adjacency matrix A_e of a semigraph G has all its entries 0, then the corresponding vertex is a middle vertex.
5. If sum of the i^{th} row or i^{th} column of A_e is one, then v_i is either a pendent vertex or a middle end vertex.
6. Since each edge has exactly two end vertices, each column of the end vertex incidence matrix B_e contains exactly two 1's.
7. The sum of i^{th} row of B_e is equal to degree of v_i.
8. A_e has both positive, and negative real eigen values.
9. The nature of the quadratic form of A_e is indefinite.

For any graph G, $A(L(G)) = B^T B - 2I_q$ where A the adjacency matrix of the line graph of G and B the incidence matrix of G, was given by Harary [2]. We present the following similar result with example for semigraphs which relates the end vertex adjacency matrix to the end vertex incidence matrix of semigraph G.

Theorem 3.4 (Harary [2]) For any (p, q) semigraph G = (V, X) with end vertex incidence matrix B_e, the end vertex adjacency matrix A_e can be obtained from the following relation: $A_e(G) = B_e B_e^T - D$. Where B_e^T is the transpose of the end vertex incidence matrix and D is the diagonal matrix whose diagonal entries are the degree of the vertices.

Example 3.5 Consider the semigraph S in figure(2)

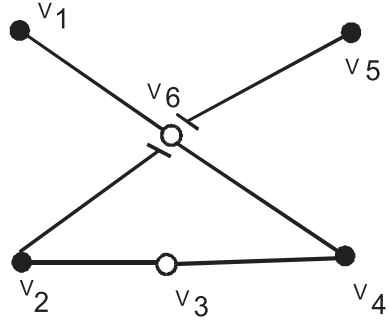

Fig 2

$$A_e = \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 \end{bmatrix} \quad B_e = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \end{bmatrix} \text{ and } \quad D = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2 \end{bmatrix}$$

where D is a 6 × 6 diagonal matrix whose diagonal entries are the degrees of the vertices of S.

$$B_e B_e^T - D = \begin{bmatrix} 1 & 0 & 0 & 0 & & \\ 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & & \end{bmatrix} \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} - \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 \end{bmatrix} = A_e(S).$$

4. BOUNDS ON e – CHROMATIC NUMBER

Sampathkumar [4] introduced coloring numbers of a semigraph as follows:

Definition 4.1 An e – coloring of semigraph G is a coloring of vertices so that no two end vertices of an edge are colored the same. The e – chromatic number χ_e is the minimum number of colors needed to colour end vertices of edges of semigraph G. For more details refer [4].

The following theorem presents bound involving the e – chromatic number and the rank of A_e of semigraphs.

Theorem 4.2 If A_e be the end vertex adjacency matrix of a semigraph G and χ_e is the e – chromatic number of G, then $\chi_e \leq$ Rank of the matrix A_e.

Lemma 4.3 If A_e be the end vertex adjacency matrix of a complete semigraph G with no middle end vertex and χ_e is the e – chromatic number of G, then χ_e = Rank of the matrix A_e.

Example 4.4 Consider a complete semigraph H with no middle end vertex in figure(3).

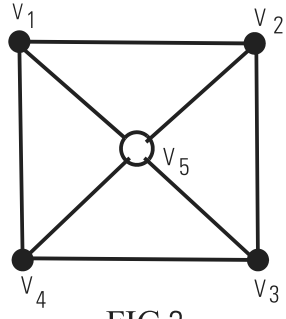

FIG 3

$$A_e = \begin{bmatrix} 0 & 1 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

χ_e = Rank of $A_e(H) = 4$.

The following theorem gives bounds for the e – chromatic number in terms of e – eigen values. Refer [1] page 135.

Theorem 4.5 ([1]) If G is a connected semigraph with largest e – eigen value λ and smallest e – eigen value μ, then $(1 - \lambda)\ \mu \leq \chi_e\ (G) \leq 1 + \lambda$.

Example 4.6 Consider the semigraph H given in figure(3).

The eigen values of A_e are 3, – 1, – 1, and – 1.

$\lambda = 3$, $\mu = -1$ and $\chi_e = 4$

$(1 - \lambda)\ \mu = 2$ and $1 + \lambda = 4$

$(1 - \lambda)\ \mu \leq \chi_e \leq 1 + \lambda$. Thus the inequalities in theorem 4.5 is true for H.

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STRUCTURE HARMONIOUS INDEX OF COMPLETE GRAPHS

R. B. Gnanajothi* and R. Ezhil Mary**

Abstract

Harmonious graphs naturally arose in the study of Graham and Sloane of modular versions of additive bases problems stemming from error-correcting codes. They defined a graph G with q edges to be harmonious if there is an injection f from the vertices of G to the group of integers modulo q such that when each edge xy is assigned the label f(x) + f(y) (mod q), the resulting edge labels are distinct. When G is a tree, exactly one label may be used on two vertices. The complete graph K_n is not harmonious for n > 4. Rosa's concept of decomposing the complete graph into isomorphic subgraphs motivated us to define the structure harmonious index of graphs. The structure harmonious index of a graph G is defined as the minimum k for which G is k-structure harmonious. Let us denote it by SHI(G). In this paper, we proved that the SHI of K_n is $\leq$ m+2, when n is of form 5+3m or 6+3m or 7+3m, n>4. Some more results regarding SHI of graphs have been dealt with.

Keywords:

Graph structure, Harmonious labeling, Harmonious graph structure, SHI of a graph, complete graph.

AMS Subject Classification Code: 05C

1. Introduction

Most graph labeling methods trace their origin to one introduced by Rosa in 1967 or one given by Graham and Sloane in 1980. Rosa introduced β – valuations as well as a number of other labeling as tools for decomposing the complete graph into isomorphic subgraphs.

Harmonic graphs naturally arose in the study by Graham and Sloane of modular versions of additive bases problems stemming from error-correcting codes. They defined a graph G with q edges to be harmonious if there is an injection f from the vertices of G to the group of integers modulo q

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such that when each edge xy is assigned the label (f(x) + f(y))(mod q), the resulting edge labels are distinct. When G is a tree, exactly one label may be used on two vertices. Lice and Zhang have proved that every graph is a subgraph of a harmonious graph.

In our previous paper, we proved the SGI of complete graphs for $4<n<11$. This motivated us to find the SHI of complete graphs. The structure harmonious index of a graph G is the minimum k for which G is k – structure harmonious. In this paper, we define a new graph H_n and prove that H_n is harmonious for all $n > 4$ and also we prove that the SHI of complete graphs for $n > 4$ is $\leq m + 2$, n is any one of the following form $5 + 3m$, $6 + 3m$ and $7 + 3m$.

1.1 Definition: A graph G with q edges is said to be harmonious if there is an injection

f: $V(G) \rightarrow Z_q$ such that when each edge xy is assigned the label $f(x) + f(y) \pmod q$, the resulting edge labels are distinct.

1.2 Definition: A graph structure $G = (V, E_1, E_2, \ldots, E_k)$ is said to be harmonious if there exists an injective function $f:V(G) \rightarrow Z_q^k$ such that $f_i : V(G(E_i) \rightarrow Z_q$ defined by $f_i(v) = (f(v))_i$, $1 \leq i \leq k$ is a harmonious numbering on $G[E_i]$.

Note 1: For k = 1, it is the usual harmonious numbering.

1.4 Example: Consider the graph structure $G = (V, E_1, E_2)$ with

$V(G) = \{v_1, v_2, \ldots, v_5\}$ $E_1 = E(K_5) \setminus v_4v_5$ $E_2 = \{v_4v_5\}$.

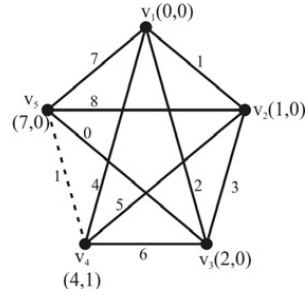

Fig. 1

$f(v_1) = (0, 0)$ $f(v_2) = (1, 0)$ $f(v_3) = (2, 0)$ $f(v_4) = (4, 1)$ $f(v_5) = (7, 0)$

Note 2: Any graph can be viewed as a harmonious graph structure for some k.

Let E(G) = $\{e_1, e_2, \ldots, e_q\}$. Take $E_i = \{e_i\}$ for i = 1, 2, …, q. Then we can assign a harmonious numbering to $G[E_i]$, $1 \leq i \leq q$, the sub graph induced by E_i. Then $\{V(G), E_1, E_2, \ldots, E_q\}$ is a graph structure which is harmonious.

For example, we consider K_3: Let V(G) = $\{v_1, v_2, v_3\}$ and $E_1 = \{v_1v_2\}$, $E_2 = \{v_2v_3\}$, $E_3 = \{v_1v_3\}$

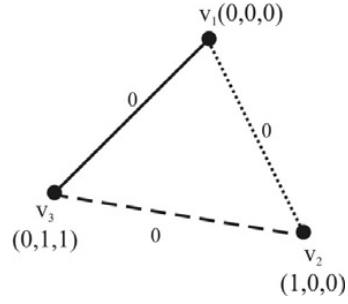

Fig. 2

1.5 Definition : A graph G = (V, E) is said to be k – structure harmonious if E can be partitioned into k disjoint subsets $E_1, E_2, \ldots, E_k$ such that the graph structure $(V(G), E_1, E_2, \ldots, E_k)$ is harmonious.

1.6 Example: We consider C_5

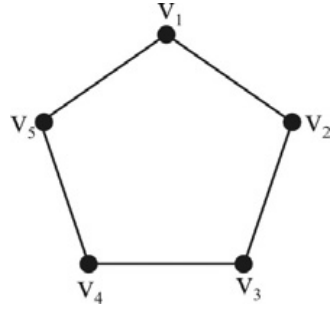

Fig. 3

Let $V(C_5) = \{v_1, v_2, \ldots, v_5\}$ and $E(C_5) = \{v_1v_2, v_2v_3, v_3v_4, v_4v_5, v_5v_1\}$. Also let $E_1 = \{v_1v_2, v_2v_3\}$, $E_2 = \{v_3v_4, v_4v_5\}$, $E_3 = \{v_1v_5\}$

As a harmonious structure, it is

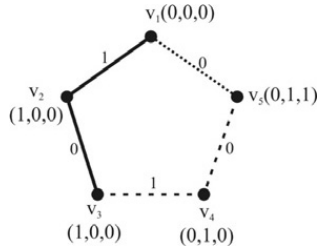

Fig. 4

Note that the induced sub graphs $G[E_1]$, $G[E_2]$ and $G[E_3]$ are harmonious under the labeling induced by the above labeling.

$G[E_1]$

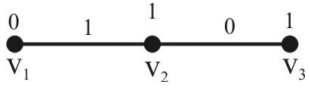

Fig. 5

$G[E_2]$

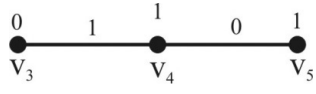

Fig. 6

$G[E_3]$

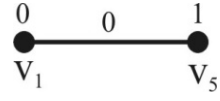

Fig. 7

$E(C_5)$ can also be written as $E = F_1 \cup F_2$ where $F_1 = E(C_5) \setminus v_5v_1$

and $F_2 = \{v_5v_1\}$.

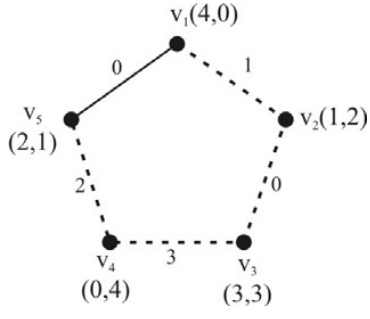

Fig. 8

$(V(G), F_1, F_2)$ is also a harmonious graph structure. Hence C_5 is 2 – structure harmonious.

Note 3: If G is k – structure harmonious then G is m – structure harmonious for any $m \geq k$.

1.7 Definition: The structure harmonious index of a graph G is defined as the minimum k for which G is k – structure harmonious. Let us denote it by SHI(G).

Note 4: SHI (G) = 1, for any harmonious graph G.

1.8 Result 1: $SHI(C_n) = \begin{cases} 1, \text{if } n \equiv 1, 3 \pmod 4 \\ 2, \text{if } n \equiv 0, 2 \pmod 4 \end{cases}$

Proof: When $n \equiv 1, 3 \pmod 4$, C_n is harmonious and hence $SHI(C_n) = 1$ in this case.

When $n \equiv 0, 2 \pmod 4$, partition the edge set of C_n as $E(C_n) = F_1 \cup F_2$ where $F_1 = \{v_i v_{i+1} / 1 \leq i \leq \frac{n}{2}\}$ and $F_2 = \{v_i v_{i+1} / \frac{n}{2} + 1 \leq i < n\} \ \{v_n v_1\}$. Each F_i contains $\frac{|E(C_n)|}{2}$ edges, i = 1, 2.

Now, $C_n[F_1]$ and $C_2[F_2]$ are paths. Since paths are harmonious, $C_n[F_1]$ and $C_n[F_2]$ are harmonious.

Let $f_i = V(C_n[F_i]) \rightarrow Z_{\frac{n}{2}}$ be the harmonious labeling for $C_n[F_i]$, i = 1, 2. Then f: $V(C_n) \rightarrow Z_n^2$ is an injective function such that the induced functions are harmonious labeling of $C_n[F_i]$, i = 1,2 respectively. Therefore SHI of C_n is 2 when $n \equiv 0, 2 \pmod 4$.

1.9 Definition: Let L_n be the ladder graph $P_n \times P_2$ with vertex set $V(L_n) = \{v_1, v_2, \ldots, v_{2n}\}$ and $E(L_n)| = 3n - 2$.

1.10 Result 2: $SHI(L_2) = 2$.

Proof: Let $V(L_2) = \{v_1, v_2, v_3, v_4\}$ and $E(L_2) = \{v_1v_2, v_2v_3, v_3v_4, v_4v_1\}$. Ladders $P_m \times P_2$, are harmonious when m > 2. ie) All ladders except L_2 are harmonious. L_2 is nothing but C_4 and by result 1, $SHI(C_4) = 2 \ \therefore SHI(L_2) = 2$.

1.11 Definition: $F_n (n \geq 1)$ is a friendship graph consists of n triangles with a common vertex.

1.12 Result 3: $SHI(F_n) = \begin{cases} 1, & \text{if } n \equiv 0, 1, 3 \pmod 4 \\ 2, & \text{if } n \equiv 2 \pmod 4 \end{cases}$

Proof: F_n is harmonious except when $n \equiv 2 \pmod 4$. So, when $n \equiv 0, 1, 3 \pmod 4$, F_n is harmonious and hence $SHI(F_n) = 1$ in this case.

When $n \equiv 2 \pmod 4$, partition the edge set of F_n as $E(F_n) = F_{\frac{n}{2}}^{(1)} \cup F_{\frac{n}{2}}^{(2)}$ where $F_{\frac{n}{2}}^{(i)}$ is one point union of $\frac{n}{2}$ triangles, i = 1, 2. Since $n \equiv 2 \pmod 4$ is an even number, $F_{\frac{n}{2}}^{(i)}$ contains an odd number of triangles, i = 1,2. ie) $\frac{n}{2} \equiv 1$ or $3 \pmod 4$. Hence $F_{\frac{n}{2}}^{(i)}$; harmonious for i = 1, 2.

Let $f_i : V(F_n)\left[F_{\frac{n}{2}}^{(i)}\right] \to Z_{\left|E(F_{\frac{n}{2}}^{(i)})\right|}$ be the harmonious labeling for $F_n\left[F_{\frac{n}{2}}^{(i)}\right]$, i = 1, 2. Then $Z : V(F_n) \to Z_{|E(F_n)|}^2$ is an injective function such that the induced functions are harmonious labeling of $F_n\left[F_{\frac{n}{2}}^{(i)}\right]$, i = 1, 2 respectively. Therefore SHI(F_n) = 2, if $n \equiv 2 \pmod 4$.

1.13 Result 4: The six connected graphs with less than or equal to 5 nodes that are not harmonious have SHI 2.

Proof: The harmonious labeling of the six connected graphs with less than or equal to 5 nodes are given below.

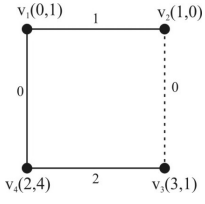

Fig. 9

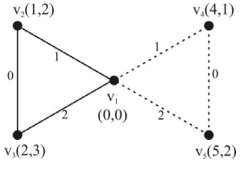

Fig. 10

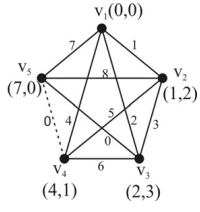

Fig. 11

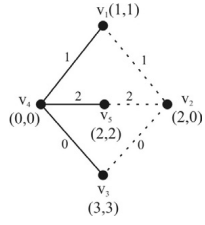

Fig. 12

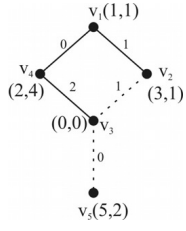

Fig. 13

1.14 Result 5: If G is harmonious, then one – point union of an even number of copies of G using the vertex labeled zero as the shared point has SHI ≤ 2.

Proof: Let G be a graph with p vertices and q edges, which is harmonious. Let G^1 be the one – point union of an even number of copies of G using the vertex labeled zero as the shared point. Suppose G^1 is harmonious, then SHI(G^1) = 1. If G^1 is not harmonious, partition the edge set of G^1 as $E(G^1) = F_1 \cup F_2$ where F_1 = edges in one – point union of an odd number of copies of G using the vertex labeled zero as the shared point and $F_2 = E(G^1) \setminus E(F_1)$. Now, $G^1[F_1]$ and $G^1[F_2]$ are both one – point union of an odd number of copies of G using the vertex labeled zero as the shared point. But if G is harmonious then the one – point union of an odd number of copies of G using the vertex labeled 0 as the shared point is harmonious. So, $G^1[F_i]$ are harmonious for i = 1,2. Let $f_1: V(G^1[F_1]) \to Z_{|F_1|}$ and $f_2: V(G^1[F_2]) \to Z_{|F_2|}$ are the harmonious labeling for $G^1[F_1]$ and $G^1[F_2]$ respectively. Then $f: V(G^1) \to Z_q^2$ is an injective function such that the induced functions are harmonious labeling of $G^1[F_1]$ and $G^1[F_2]$ respectively. $\therefore$ SHI(G^1) = 2. Hence SHI(G^1) ≤ 2, in general.

1.15 Definition: A triangular cactus is a connected graph all of whose blocks are triangles. A triangular snake is a triangular cactus whose block - cutpoint - graph is a path (a triangular snake is obtained from a path $v_1, v_2, \ldots, v_n$ by joining v_i and v_{i+1} to a new vertex w_i for i = 1, 2, …, n – 1.

1.16 Result 6: Triangular snakes Δ_n with number of triangle congruent to 2(mod 4) has SHI 2.

Proof: Let Δ_n be a triangular snake with number of triangles congruent to 2(mod 4). Δ_n has 3n edges. It is not harmonious. Partition the edge set of Δ_n as $E(\Delta_n) = F_1 \cup F_2$ where F_1 = edges in the triangular snake Δ_n with number of triangles congruent to 1(mod 4) and $F_2 = E(\Delta_n) \setminus E(F_1)$. Since $\Delta_n[F_1]$ has number of triangles congruent to 1(mod 4), and we are considering n ≡ 2(mod 4), $\Delta_n[F_2]$ also has number of triangles congruent to 1(mod 4). Triangular snakes are harmonious iff the number of triangles is not congruent to 2(mod 4). So $\Delta_n[F_1]$ and $\Delta_n[F_2]$ are harmonious.

Let f_i: $V(\Delta_n[F_i]) \rightarrow$ $Z_{|F_i|}$ be the harmonious labeling of $\Delta_n[F_i]$, i = 1,2. Then f: $V(\Delta_n)$ Z_{3n}^2 is an injective function such that the induced functions are harmonious labeling of $\Delta_n[F_i]$, i =1, 2 respectively. Hence $SHI(\Delta_n) = 2$, when n ≡ 2 (mod 4).

1.17 Definition: Prisms are graphs of the form $C_m \times P_n$.

1.18 Result 7: $SHI(C_m \times P_n)$ d" 2.

Proof: Let $G = C_m \times P_n$. If G is harmonious, then SHI = 1. If not, partition E(G) into $F_1 \cup F_2$, where $F_1 = E(G) \setminus \{e\}$ and $F_2 = E(G) \setminus E(F_1) = \{e\}$.

All prisms $C_m \times P_2$ with a single vertex deleted or single edge deleted are harmonious.

Therefore $G[F_1]$ is harmonious. $G[F_2]$ has only one edge, which is harmonious.

Let f_1: $V(G[F_1]) \rightarrow Z_{mn-1}$ and f_2: $V(G[F_2]) \rightarrow Z_1$ be the harmonious labeling of $G[F_1]$ and $G[F_2]$ respectively. Then f: $V(G) \rightarrow$ Z_{mn}^2 is an injective function such that the induced functions are harmonious labeling of $G[F_1]$ and $G[F_2]$ respectively. ∴ SHI(G) =2 in this case. Hence $SHI(G) \leq 2$.

1.19 Definition : Let H_n be a graph with $V(H_n) = \{v_1, v_2, \ldots, v_n\}$ and $E(H_n) = \{v_1v_i / i > 1\} \cup \{v_2v_i / i > 2\} \cup \{v_3v_i / i > 3\}$, for n > 4.

1.20 Example: Consider a graph

H_9

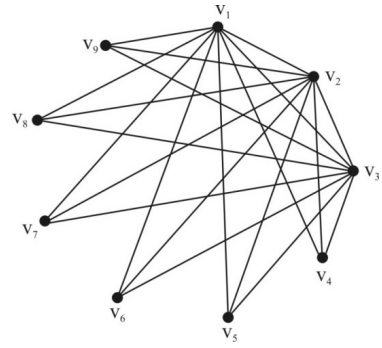

Fig. 14

1.21 Result 8: H_n graph is harmonious for $n > 4$.

Proof: The H_n graph has n vertices and 3n – 6 edges. Let $V(H_n) = \{v_1, v_2, \ldots, v_n\}$ and $E(H_n) = \{v_1v_i / i > 1\} \cup \{v_2v_i / i > 2\} \cup \{v_3v_i / i > 3\}$ and $|E(H_n)| = 3n - 6$.

Define $f(v_i) =$

$$\begin{cases} 0, & i = 1 \\ 1, & i = 2 \\ 2, & i = 3 \\ 4, & i = 4 \\ 7 + 3\,(i - 5), & 5 \le i \le n \end{cases}$$

f is injective:

$f(v_1) \neq f(v_i)$, since $f(v_1)$ is 0 and $f(v_i)$ is a positive integer for $i > 2$. ..... (1)

Clearly, $f(v_i) \neq f(v_j)$ for $0 \le i \neq j \le 4$

Suppose $5 \le i \le n$ & $1 \le j \le 4$ then $f(v_i) = 7 + 3(i - 5) \ge 7$, which is $> f(v_j)$.

Let $5 \le l,k \le n$. $f(v_k) = f(v\ \ ) \Rightarrow 7 + 3\,(k - 5) = 7 + 3(l - 5)$

$\Rightarrow 3(k - 5) = 3(l - 5)$

$\Rightarrow k - 5 = -5$

$\Rightarrow k = l$

$\therefore f(v_k) \neq f(v)$ for $k \neq l$. ..... (2)

From (1) and (2), $f(v_i) \neq f(v_j)$, $i \neq j$, $1 \leq i, j \leq n$.

Let A1 = $\{\ell(v_1v_i) / i > 1\} = \{\ell(v_1) + \ell(v_i) (\text{mod } q) / i > 1\}$

$= \{\ell((v_1) + \ell(v_2)) (\text{mod } q), (\ell(v_1) + \ell(v_3)) (\text{mod } q), \ldots, (\ell(v_1) + \ell(v_n)) (\text{mod } q)\}$

$= \{(0 + 1) (\text{mod } q), (0 + 2) (\text{mod } q), (0 + 4) (\text{mod } q), (0 + 7) (\text{mod } q), \ldots,$

$(0 + \overline{7 + 3(n-5)}) (\text{mod } q)\}$

$= \{1, 2, 4, 7, \ldots, 7 + 3(n - 5)\}$ ..... (3)

$A_2 = \{\ell(v_2v_i) / i > 2\} = \{\ell(v_2) + \ell(v_i) (\text{mod } q) / i > 2\}$

$= \{\ell((v_2) + \ell(v_3)) (\text{mod } q), (\ell(v_2) + \ell(v_4)) (\text{mod } q), \ldots, (\ell(v_2) + \ell(v_n)) (\text{mod } q)\}$

$= \{(1 + 2) (\text{mod } q), (1 + 4) (\text{mod } q), (1 + 7) (\text{mod } q), \ldots, (1 + \overline{7 + 3(n-5)}) (\text{mod } q)\}$

$= \{3, 5, 8, \ldots, 8 + 3(n - 5)\}$ ..... (4)

$A_3 = \{\ell(v_3v_i) / i > 3\} = \{(\ell(v_3) + \ell(v_4)) (\text{mod } q), (\ell(v_3) + \ell(v_5)) (\text{mod } q), \ldots,$

$(\ell(v_3) + \ell(v_n)) (\text{mod } q)\}$

$= \{(2 + 4) (\text{mod } q), (2 + 7) (\text{mod } q), (2 + 10) (\text{mod } q), \ldots, (2 + \overline{7 + 3(n-5)}) (\text{mod } q)\}$

$= \{6, 9, 12, 15, \ldots, (9 + 3(n - 5)) (\text{mod } q)\}$

$= \{6, 9, 12, 15, \ldots, (9 + 3n - 15) (\text{mod } q)\}$

$= \{6, 9, 12, 15, \ldots, (3n - 6) (\text{mod } q)\}$

$= \{6, 9, 12, 15, \ldots, 0\}$ ..... (5)

From (3), (4) & (5)

$$A_1 \cup A_2 \cup A_3 = \{ 1, 2, 3, \ldots, 3n - 5, 0\}$$

$$= \{0, 1, 2, \ldots, 3n - 15\} = \{ 0, 1, 2, \ldots, q - 1\}.$$

Thus f: $V(H_n) \rightarrow Z_{3n-6}$ is an injective function and the edges receive the labels from 0 to 3n–5. ie) from 0 to q – 1. Therefore f is a harmonious labeling of H_n. Hence H_n is harmonious.

1.22 Illustration:

Harmonious labeling of H_9

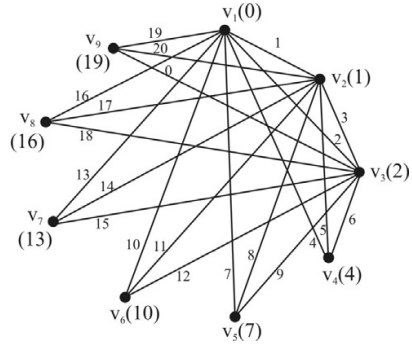

Fig. 15

1.23 Result 9: $SHI(K_n) \leq m + 2$, n is of any form 5 + 3m, 6 + 3m and 7 + 3m, n > 4.

Proof : Partition the edges of K_n ie) $E(K_n)$ into two sets namely, $E(H_n)$ and $E(K_n \setminus H_n)$, then $E(K_n \setminus H_n)$ into $E(H_{n-3})$ and $E(\overline{K_n \setminus H_n} \setminus H_{n-3})$, then $E(K_n \setminus H_n \setminus H_{n-3})$ into $E(H_{n-6})$ and $(E(\overline{K_n \setminus H_n \setminus H_{n-3}} \setminus H_{n-6})$ and so on.

From this partition, in the last step we have arrived the following cases:

(i) $E(K_2)$, when n is of the form 5 + 3m.

(ii) $E(K_3)$, when n is of the form 6 + 3m.

(iii) $E(K_4)$, when n is of the form 7 + 3m.

(i) When n is of the form 5 + 3m

We have sub graphs which contain the edges of H_n, H_{n-3}, H_{n-6}, …, H_5 and K_2.

Let $H_n^{(j)} = < A_j >$, j = 1, 2, …, m + 2.

Where $< A_1 >$ is the sub graph of K_n induced by the edges in H_n.

$< A_2 >$ is the sub graph of $K_n \setminus H_n$ induced by the edges in H_{n-3}.

$< A_{m+1} >$ is the sub graph of $K_n \setminus H_n \setminus H_{n-3} \setminus \ldots \setminus H_8$ induced by the edges in H_5 and

$< A_{m+2} >$ is the sub graph of $K_n \setminus H_n \setminus H_{n-3} \setminus \ldots \setminus H_8$ induced by the edges in K_2.

We have already proved that the graph H_n is harmonious for n > 4. Therefore $H_n^{(j)}$, j = 1, 2, …, m – 1 is harmonious. Since K_n is harmonious for n < 5, $H_n^{(j)}$, j = m + 2 is also harmonious. Totally we have m + 2 harmonious sub graphs. ∴ SHI(K_n) is ≤ m + 2.

(ii) When n is of the form 6 + 3m

We have subgraphs, which contain the edges of H_n, H_{n-3}, …, H_5 and K_3.

Let $H_n^{(j)} = < A_j >$, j = 1, 2, …, m + 2, where $< A_j >$'s are as above for j = 1, 2, …, m and $< A_{m+1} >$ is the sub graph of $K_n \setminus H_n \setminus H_{n-3} \setminus \ldots \setminus H_9$ induced by the edges in H_6 and $< A_{m+2} >$ is the sub graph of $K_n \setminus H_n \setminus H_{n-3} \setminus H_9$ induced by the edges in K_3. Again $H_n^{(j)}$, j = 1, 2, …, m + 2 are harmonious. ∴ SHI(K_n) ≤ m + 2.

(iii) When n is of the form 7 + 3m

We have sub graphs, which contain the edges of $H_n \setminus H_{n-3} \setminus H_{n-6} \setminus \ldots \setminus H_{10}$ and K_4.

Let $= < A_j >$, j = 1, 2, …, m + 2, where $< A_j >$'s are sub graphs as in case (i) & case (ii) for j = 1, 2, …, m and $< A_{m+1} >$ is the sub graph of $K_n \setminus H_n \setminus H_{n-3} \setminus \ldots \setminus H_{10}$ induced by the edges in H_7 and $< A_{m+2} >$ is the sub graph of $K_n \setminus H_n \setminus H_{n-3} \setminus \ldots \setminus H_{10}$ induced by the edges in K_4. Here also $H_n^{(j)}$'s are harmonious for j = 1, 2, …, m + 2. ∴ SHI(K_n) ≤ m + 2.

Hence SHI(K_n) = m + 2, when n is of any form 5 + 3m, 6 + 3m and 7 + 3m.

1.24 Illustration: The 4–harmonious labeling of K_{13} is shown below.

We can write 13 as 13 = 7 + 3(2). ∴ n = 13 is of the form 7 + 3m where m = 2.

Hence by the above result, $SHI(K_{13}) = m + 2 = 2 + 2 = 4$.

For, partition the edges of K_{13} into $E(H_{13})$ and $E(K_{13} \setminus H_{13})$. Then we have

H_{13}

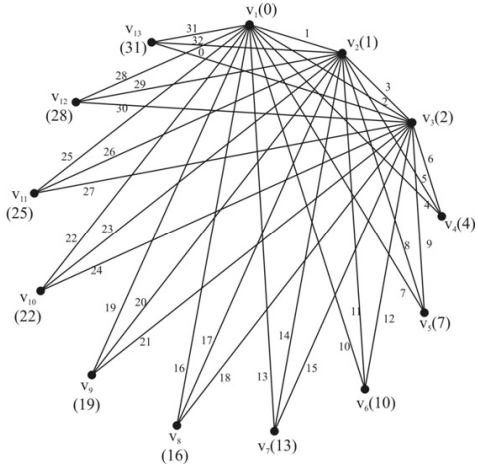

Fig. 16

$K_n \setminus H_n = K_{13} \setminus H_{13} = E(K_{10})$

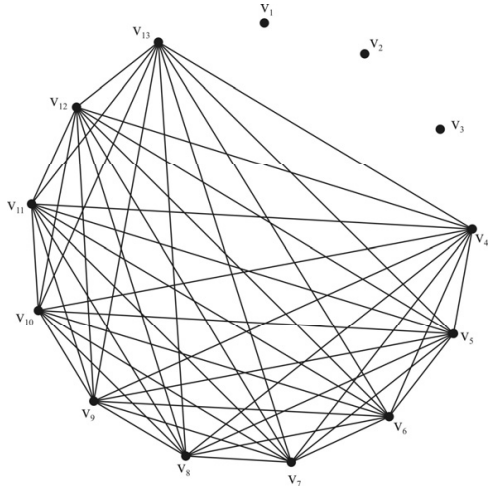

Fig. 17

Partition the edges of $K_{13} \setminus H_{13}$ into $E(H_{n-3} = H_{10})$ and $E(\overline{K_{13} \setminus H_{13}} \setminus H_{10})$

H_{10}

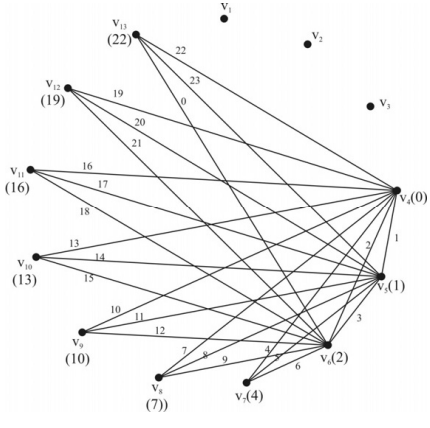

Fig. 18

$\overline{K_{13} \setminus H_{13}} \setminus H_{10} = K_7$

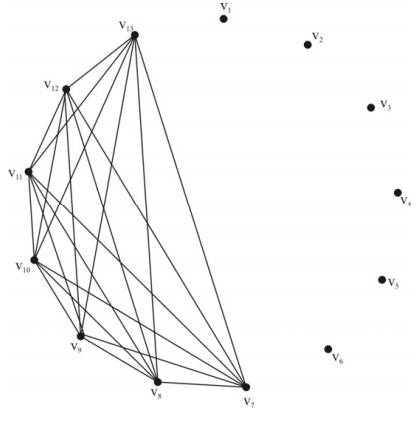

Fig. 19

Partition $E(K_{13} \setminus H_{13} \setminus H_{10})$ into $E(H_7)$ and $E(\overline{K_{13} \setminus H_{13} \setminus H_{10}} \setminus H_7) = K_4$.

H_7

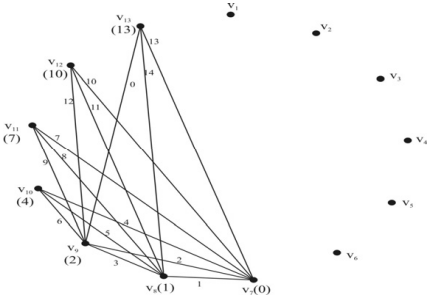

Fig. 20

K_4

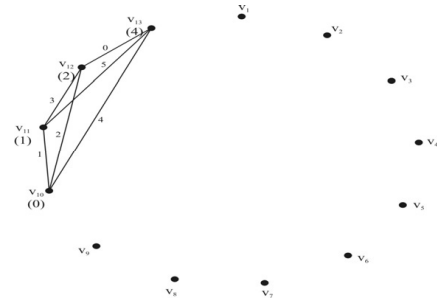

Fig. 21

Hence $SHI(K_{13}) = 4$.

4 – structure harmonious labeling of K_{13}

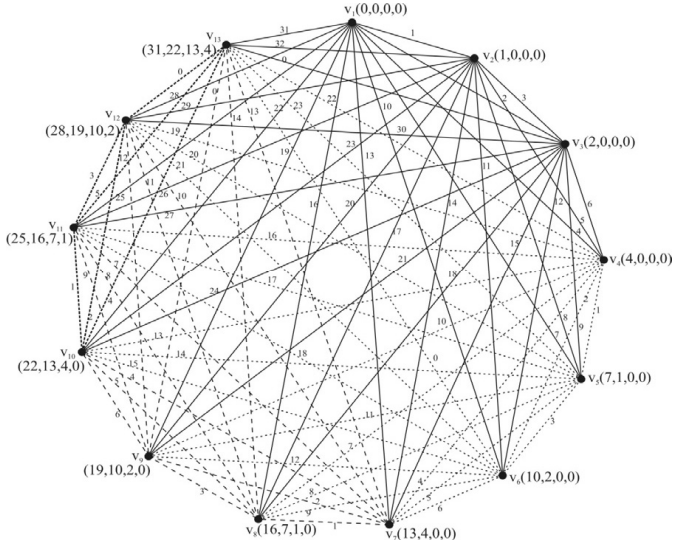

Fig. 22

Conclusion:

We have obtained an upper bound for SHI(K_n). It still remains open to seek for suitable answers for the following problems.

(i) Is this bound sharp?

(ii) Is it possible to extend the result to other families?

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ESTIMATION OF PLASMA DRIFT USING AIR GLOW IMAGING

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Present study uses airglow imaging data of 630.0 nm O (^{1}D) emissions to detect the plasma depletions which occurs at ionospheric altitudes over Gadanki (13.5^o N, 79.2^o E), a low latitude Indian station. We analyze 66 nights of data collected during 2012 and 2013. We have calculated the drift velocity of plasma depletions which are indicative of ionospheric drifts at airglow emission altitudes. We have compared our values with a recently reported empirical model. We find that during March – May the agreement between model and our measurements are very good while, other months do not agree. Our investigation provides first systematic data on the ionospheric drifts using airglow emissions in the Indian sector and is deemed for the improvement in the understanding of upper atmosphere in order to improve the navigation capabilities relying on the trans-ionospheric communications.

Introduction

Earth's atmosphere is divided into different layers, viz., troposphere, stratosphere, mesosphere, thermosphere and exosphere. Within the thermosphere-exosphere system, there exist ionosphere and magnetosphere. The ionosphere is in a weakly ionised plasma state which is important for navigation and trans-ionospheric communication. This plasma undergoes drag forces under the influence of neutral winds. The aim of present project is to calculate the plasma drift velocity using "Air glow imaging technique". Irregularities in the plasma density give raise to the depletion regions of ionization. These depleted regions are often noted over the equatorial regions are known as Equatorial Spread-F (in radio terms) or Equatorial Plasma Bubbles (EPBs) (in optical terms).

These plasma density irregularities occur mainly due to Rayleigh-Taylor's (RT) instability (e.g., Kelley et al., 2011). By virtue of background winds, under normal conditions, these plasma depletions drift towards east. The drifting of plasma is an important parameter which is not easily

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obtained due to the lack of references in the sky. For this reason, there are reports that suggest that by considering the depletion in atmosphere as a reference point and tracking their movement (drifting) of the depletion, drift velocity of plasma can be calculated (e.g., Makela, 2011).This study is useful in finding out the occurrences and localisation of plasma bubbles which is important aspect to improve the navigation capability.

1. Methodology

The airglow imager monitors the 630 nm airglow emission which emanates from a peak altitude of ~250 km. This emission occurs due to the consequence of dissociative recombination process as following.

$$O_2^+ + e \longrightarrow O^*(^1S) + O^*(^1D)$$

$$O^*(^1D) \longrightarrow O + h\nu \quad (630nm)$$

As the changes of neutral densities at ionospheric altitudes are extremely small compared to the electron density variability, the variability noted in 630 nm airglow emissions represents the electron density variability.

We collect the 630 nm airglow images obtained through NARL Airglow Imager (NAI) (Taori et al., 2013). The collected image is then processed to the following steps.

Step1: Cropping the image to avoid low elevation effects in images.

Step2: Enhancing the contrast of images. (It includes the enhancement of Normalize, Equalising histograms, stack histograms).

Step3: Using Median filter of 4 pixels, filter all stars, to see the Clear Depletion.

Step4: At the edge of every depletions, the value of X (East-West plane) is noted for approximate value of Gadanki location (North-South plane, y ~90 ± 5). By using this reference position, plasma drift velocity will be calculated.

2. Instrumentation

The location of the NARL Airglow Imager (NAI) uses a circular medium format F/4 Mamiya fish eye lens with a focal length of 24mm. A set of plano-convex lens is used to make the collected optical ray path parallel before passing through the temperature controlled interference filter chamber. The filter chamber temperature is maintained at 25°C which has a filter-wheel inside with 10cm diameter interference filters (Of 50-90% transmission co-efficients) mounted on it to measure OH,

O(^{1}S) and O(^{1}D) emissions at peak wavelengths 840, 558 and 630nm respectively. The movement of filter wheel is controlled by a menu driven software synchronized with the CCD detector. After passing through interference filters, to coverage the optical rays to PIXIS camera system to Princeton Instruments, a camera lens is used. The CCD camera uses a back illuminated e2v CCD47-10 chip (Acton Pixis 1024B) with 1024X1024 square pixels of 13.3µm size, 100% fill factor and 16 bit depth. To reduce the dark counts, CCD is thermoelectrically cooled to -70°C before the operation. As the filter wheel moves, desired interference filter is brought into the optical path of the instrument with the help of magnetic position sensor and suitable stepper motor movement. This movement is given as trigger to the CCD camera and the intensity data is collected for the defined integration/ Exposure time of a particular interference filter. This motion is controlled through a menu driven software and different exposure times can be given to different interference filters for suitable data collection. The final image captured by the CCD Camera is stored in the computer hard disk for further analysis. In the present set-up, we bin the image for 2X2 pixels image on the chip to enhance the signal-to-noise ratio. Depending on the compromise among the background luminosity, interference filter transmission and actual airglow brightness, at present 16s exposure for OH and 95s exposure for both O (^{1}S) and O (^{1}D) emission monitoring are used.

3. Image analysis:

The NAI image processing method adopted in our study closely follows the methods elaborated by Garcia et al. (1997) and Kubota et al. (2001). After capturing, the images have to be corrected for (i) actual co-ordinates, (ii) flat fielding and background brightness and (iii) star brightness. The dark image (exposures with the lens cap on) removal from the observations is important. It takes care of readout counts and hot pixels in the observations. Although this remains nearly constant throughout the night, in our observations, we take dark image every hour. Further, the flat fielding and background intensity correction, in particular is not necessary for the estimation of spatial structures of the dynamical structure, but is important when deriving the exact power 'äI/I' of the structure. However, relative amplitude variation 'äI' may be estimated without doing this correction (Garcia et al., 1997). We do the background correction with the help of background image obtained which is subtracted from each image. In fact the removal of background from images takes care of dark image. Corrections also because it also contains the errors that need to b removed with the help of dark image. Note that flat fielding takes care of non-uniformities of pixels and also it is essential when Van Rhijin effect is large enough to alter the columnar intensity integration. In present study we have not done the flat fielding because the field of view of NAI used in this study is limited to 90° within which this effect is negligible (<8%) compared to the intensity variations caused by the dynamical features (e.g., gravity wave, tides or plasma depletions) (Kubota et al., 2001).

Conversion of obtained image to the real dimensions involves the calibration of direction and identifying the pixel correspondences to the spatial scales at the peak emission altitudes. The direction calibration in our case is done with the help of magnetic compass where identified directions were marked onto the boundaries of roof. Then, the roof was imaged to identify the actual CCD plane and direction. Usually, the spatial scales of the obtained images are obtained through the identification of different stars (Garcia et al., 1997) or by assuming the known peak emission altitude (Kubota et al., 2001). In our analysis, we use the later method, because of its simplicity. In this approach, the fish-eye lens coordinates 'è' and the geographic distance at the emission altitudes 'r' having the following relation:

$$r = C \times R_E$$

Where,

$$C = \theta - Sin^{-1}\left[\frac{R_E \times Sin\,\theta}{R_E + h}\right]$$

Where, R_E is the earth Radius and h is the altitude of airglow emission layer. This coordinate conversion provides scale to the image in terms of pixel positions.

Although, the brightness of the stars in images emphasis the clear sky conditions on a given night, the removal of stars is important aspect to enhance the signal-to-noise ratio of the image. We remove the stars with the help of median filter with 3X3 pixel width. In this filter, because of the sharp brightness of the stars, their corresponding intensity values are removed. After carrying out the above processes we enhance the contrast of the image with the help of histogram method in which, the image contrast is adjusted according to the lowest and high gray count values. On the importance is that, before doing the above image analysis procedures, the 512X 512 super pixel images were cropped to 256X256 sizes because of the limitation of existing building where the NAI is installed which corresponds to 90° circular field of view. In present analysis we cropped the images to 256X256 and enhanced the contrast as stated above. The scaling was done assuming the peak emission altitude of 630 nm emission to be ~250 km and using the above equations.

For calculation of drift velocities using plasma depletions, we note the pixel positions of depleted North-South aligned structures over Gadanki latitudes (zenith pixels) in image data and record their evolution with time. The longitudinal variation of these structures with time provides us information that it moved how much distance within a given time, which, in-turn provides an estimate of drift velocity. In case of multiple structures, we used similar process for every observed structure and finally determined an average drift value. Later, we average the drift velocity for 0.5 hr to get a uniform distribution of drift velocities against the duration of observations (i.e., time). To emphasis

the temporal structures of the plasma depletions, we also calculate the zenith intensity over Gadanki obtained by averaging 5x5 pixels at the centre of the image. Further, for a comparison with the empirical model of England & Immel (2012) we make a composite drift velocity representing a month by averaging the calculate plasma drift values on individual nights.

4. Results and Discussion:

A sample 630nm image obtained by NAI showing the occurrence of plasma depletion is shown in **figure 1**.

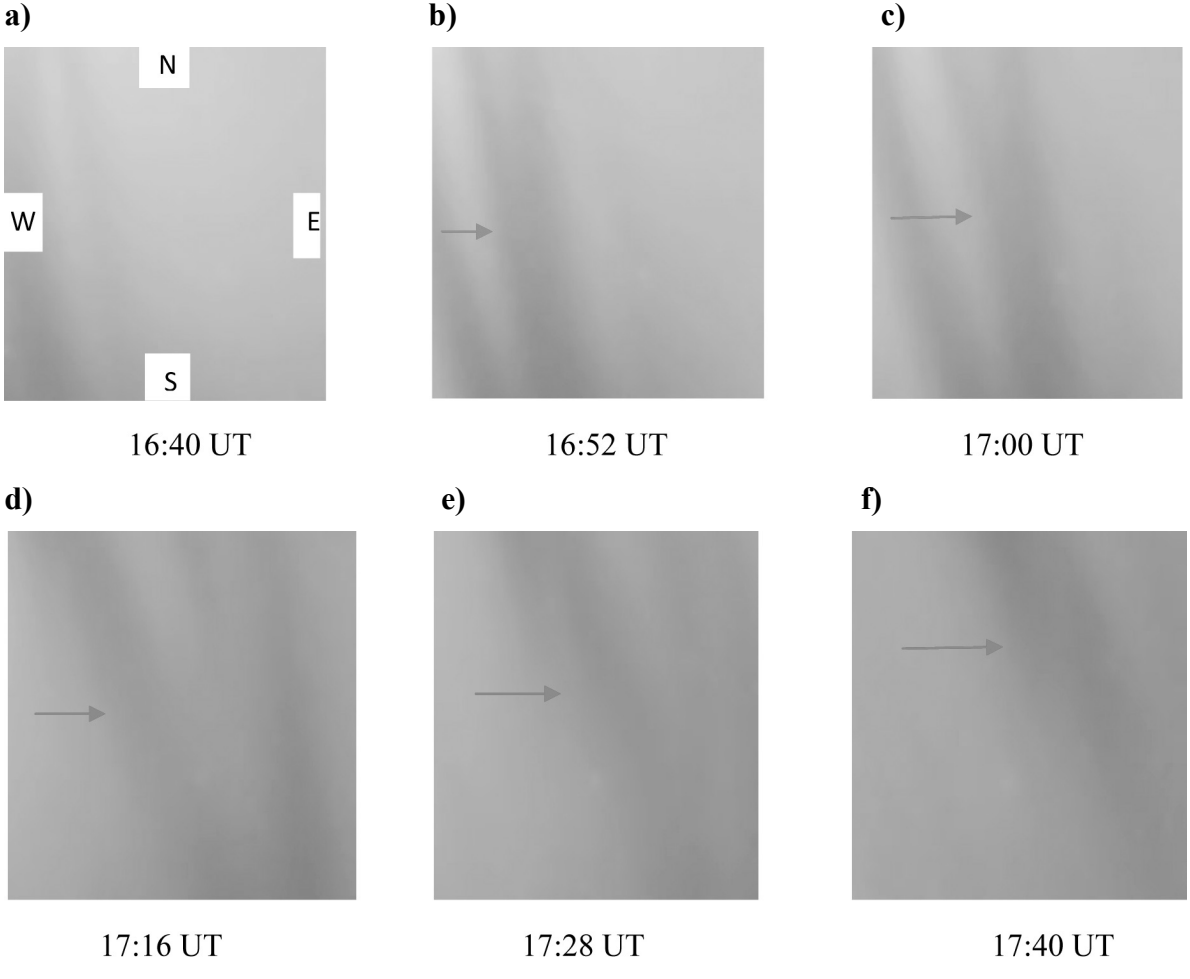

Figure 1. The above image sequence (a, b, c, d, e, f) shows the NAI observations of plasma depletions on 19 March 2012. It is clear from the above sequence that the plasma depletions are north-south aligned and drift eastward with respect to the time (UT in figure 1) (depleted region shown by red arrows).The right side of the image show East direction while the topside of the image represent North direction.

It is clear from the image that there exist some dark band structures extending from north to south exhibiting that they are aligned magnetically in the ionosphere. These structures are known as plasma bubbles / plasma depletions. The statistics of observations used for the above calculation is given in following tables.

Date-Month-Year	Day Number	Appearance of sky	Depletion
17 March 2012	77	Clear Sky	Good Depletion
19 March 2012	79	Clear Sky	Good Depletion
20 March 2012	80	Clear Sky	Good Depletion
21 March 2012	81	Clear Sky	Good Depletion
22 March 2012	82	Clear Sky	Weak Depletion
24 March 2012	84	Clear Sky	Good Depletion
26 March 2012	86	Clear Sky	Good Depletion
27 March 2012	87	Clear Sky	-
16 April 2012	107	Clear Sky	Good Depletion
08 November 2012	313	Clear Sky	Weak Depletion
09 November 2012	314	Clear Sky	Weak Depletion
10 November 2012	315	Clear Sky	Weak Depletion
12 November 2012	317	Clear Sky	Weak Depletion
16 November 2012	321	Clear Sky	Weak Depletion
10 December 2012	345	Clear Sky	Weak Depletion
11 December 2012	346	Clear Sky	Weak Depletion
13 December 2012	348	Clear Sky	Weak Depletion
15 December 2012	350	Clear Sky	Weak Depletion

The NAI observation statistics for the year 2012. The total observed and analyzed nights are 40 of which, 18 are clear nights in which 17 nights show the occurrence of depletions and 1 night show no depletions.

Date-Month-Year	Day Number	Appearance of sky	Depletion
07 January 2013	7	Clear Sky	Weak Depletion
09 January 2013	9	Partially cloudy sky	Weak Depletion
11 January 2013	11	Clear Sky	Good Depletion
08 February 2013	39	Clear Sky	Weak Depletion
09 February 2013	40	Clear Sky	Good Depletion
12 February 2013	43	Clear Sky	Weak Depletion
09 April 2013	99	Clear Sky	Good Depletion
10 April 2013	100	Clear Sky	Good Depletion
12 April 2013	102	Clear Sky	Good Depletion
13April 2013	103	Clear Sky	Good Depletion
07 May 2013	127	Clear Sky	Good Depletion
08 May 2013	128	Clear Sky	-
09 May 2013	129	Clear Sky	-

Table 2. The NAI observation statistics for the year 2013. The total observed and analyzed nights are 26 of which only 11 nights show depletions, 2 nights show no depletion occurrence while remaining 9 nights were cloudy and 4 nights were partially cloudy with no depletion occurrence.

The calculated monthly mean nightly drift velocity and its comparison with model estimates for month march 2012 and april 2013 are explained as follows.

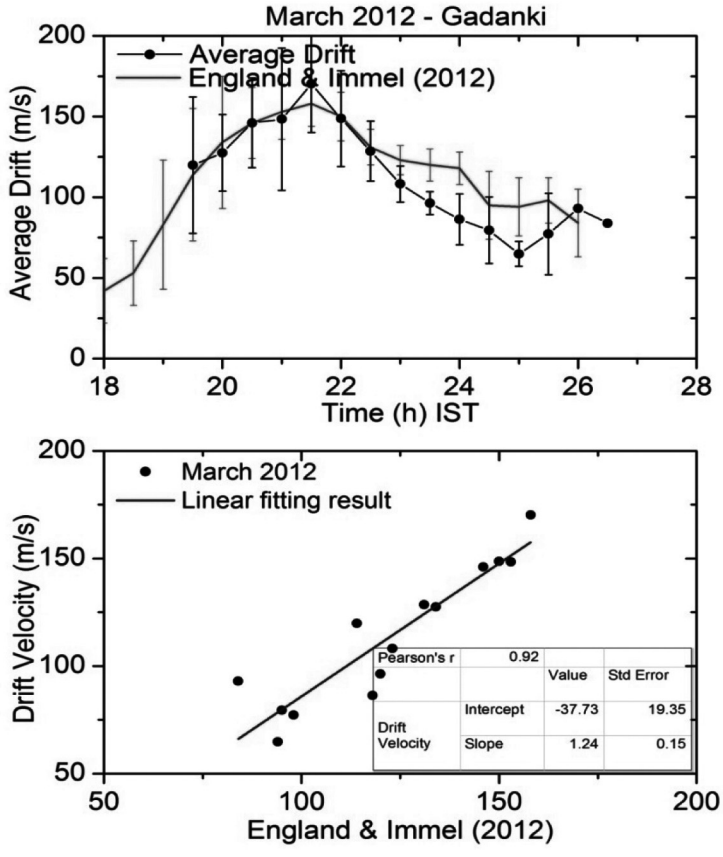

Figure 2. In the top panel, filled circles show average drift velocity obtained with night airglow data (composing 17-18March,19-20 March, 20-21 March, 21-22 March, 22-23 March, 24-25 March, 26-27 March nights) exhibiting the plasma depletions during March 2012. The red line curve shows the estimates of England and Immel (2012) plasma drifts. The bottom panel quantifies the agreement between our measurements and model estimates.

In **Figure 2**, the top panel shows the average plasma drift values derived from the movement of plasma depletion as noted in the 630 nm airglow images during March 2012 (filled circles with connecting lines). We have used night data corresponding to 17-18 March, 19-20 March, 20-21 March, 21-22 March, 22-23 March, 24-25 March, 26-27 March, data to make this plot. We estimated the plasma drift values for individual nights and average drift values were obtained by composing them. In general, we note that plasma drift to be positive, i.e., the depletions were moving to east throughout the night. It is clear that after 1900 IST the drift show an increase in the drift velocity till 2200 IST. After 2200 IST, drift velocity show a decreasing trend till 0100 (in figure, 2500) IST. The empirical model given by England and Immel (2012) (red line curve) also reveal a similar trend

to exist. Bottom panel plots our results on the plasma drift velocity (y-axis) against the model estimates (x-axis). It is clear that there is very good agreement between our measurements and model estimates. This is emphasized with the correlation coefficient between them, which is estimated to be 0.92.

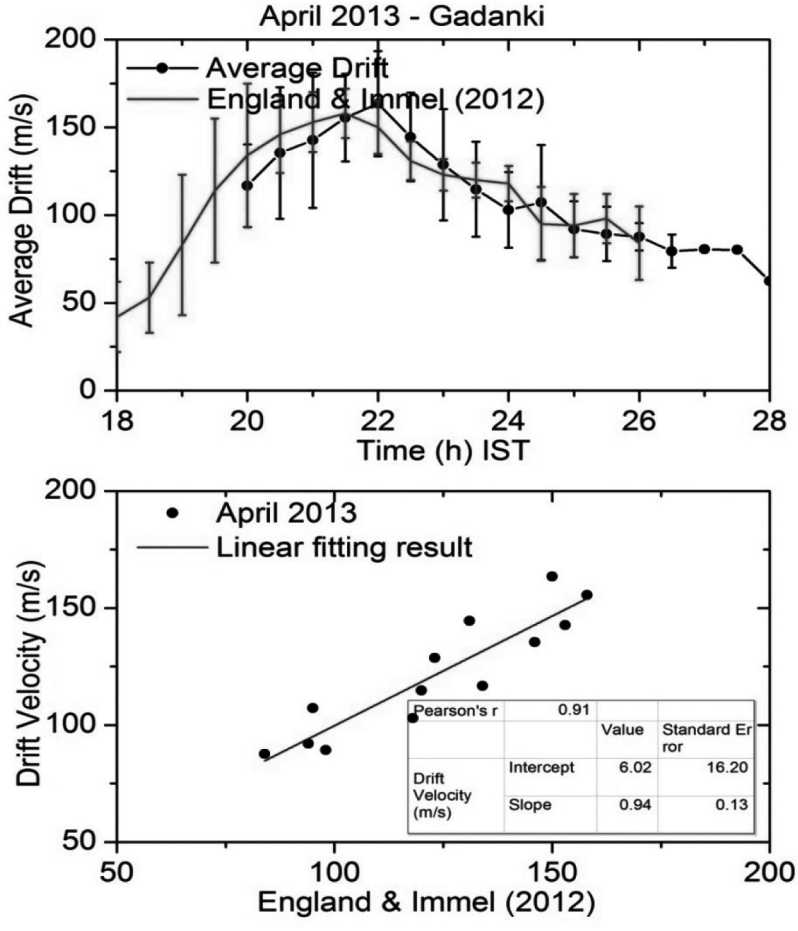

Figure 3: In the top panel, filled circles show average drift velocity obtained with night airglow data (composing 9-10 April, 10-11 April, 12-13 April, 13-14 April nights) exhibiting the plasma depletion during April 2013. The red line curve shows the estimates of England & Immel (2012) plasma drifts. The bottom panel qualifies the agreement between our measurements and model estimates.

Plotted in **figure 3** are the average drift value estimates corresponding to the NAI data obtained during April 2013 (filled circles with connecting lines). Important to state here is that 9-10 April, 10-11 April, 12-13 April, 13-14 April data are used to estimate the values depicted in this plot. In general, we note that plasma drift to be positive, i.e., the depletions were moving to east throughout the night. It is clear that after 2000 IST the drift show an increase in the drift velocity till 2200 IST. After 2200 IST, drift velocity shows a decreasing trend till 0400 (in figure 2800) IST. The empirical

model given by England & Immel (2012) (red line curve) also reveals a similar trend to exist. Bottom panel plots our results on the plasma drift velocity (y-axis) against the model estimates (x-axis). It is clear that there is very good agreement between our measurements and model estimates. This linear relationship is emphasized with the correlation coefficient being 0.91 between them.

5. Summary

Throughout the measurements we note that plasma drifts towards East during night time irrespective of season. The drift velocities increase till 2100 – 2200 IST, after which they decrease gradually. We note that the comparison of our measured drift values and the empirical model values given by England and Immel (2012) agree well during March, April and May months while, there is a gross in-agreement during other months. This may be because the data base used by England and Immel (2012) is during March - June months. Even if there is a very good agreement (correlation coefficient > 0.9) there exists some bias with intercept of linear fit varying from -37 to 6 (which ideally should be 0). This may arise due to the fact that model uses space borne measurements carried out by Global Ultraviolet Imager (GUVI) onboard the Thermosphere Ionosphere Mesosphere Energetic and Diagnosis (TIMED) mission which may represent more towards the topside of ionosphere while, ground based images taken by NAI represent 250 km with a layer thickness of ~50 km. The present data set is ***'first'*** to report systematic drift measurements using airglow imaging and to compare them with model values. These provide important information to the upper atmospheric community and future studies based on larger database may give useful insight into the genesis of plasma bubbles and in-turn to the understanding of processes associated with the ionospheric irregularities.

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TRIPLE CONNECTIVITY OF A GRAPH

Selvam Avadayappan* and M. Bhuvaneshwari*

Abstract

A graph G is said to be triple connected if any three vertices of G lie on a path in G. In this paper, we introduce the concept of triple connectivity and triple edge connectivity of a graph G. Also we characterize triple cut vertices and triple cut edges in G. Moreover, we establish a relationship between (edge) connectivity and triple (edge) connectivity.

Keywords

Connected graph, connectivity, triple connected graph, triple cut vertex, triple cut edge, triple connectivity, triple edge connectivity.

AMS Subject Classification code (2000): 05C (Primary)

1. Introduction

Throughout this paper, by a graph we mean a finite, simple, undirected graph. For notations and terminology we follow [2]. A graph G is said to be *connected*, if any two vertices of G are joined by a path in G; otherwise G is said to be *disconnected*. A maximal connected subgraph of a graph G is called a *component* of G. The number of components of a graph G is denoted by $\omega(G)$. A vertex v of a connected graph G is a *cut vertex* if G – v is disconnected. An edge e of a connected graph G is a *cut edge* if G – e is disconnected. A connected subgraph H of a connected graph G is called a *H – cut,* if $\omega(G - H) \geq 2$ where G – H is the subgraph obtained from G by deleting all vertices of H. A connected graph with no cut vertices is called a *block*. A *block of a graph* is a maximal subgraph with respect to this property. *Block graph* B(G) of a graph G is a graph with each vertex corresponding to a block in G and two vertices in B(G) are adjacent if and only if the corresponding blocks in G have a vertex in common. *Vertex Connectivity* of a graph G is the minimum number of vertices whose removal results in a disconnected graph or in a trivial graph and is denoted by κ. *Edge*

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Connectivity of a graph G is the minimum number of edges whose removal results in a disconnected graph or in a trivial graph and it is denoted by λ. G is said to be a *k – (edge) connected graph,* if the (edge) connectivity of G is greater than or equal to k. $\alpha(G)$ denotes the independence number of a graph G. A *full vertex* of a graph G is a vertex which is adjacent to all other vertices in G. For any vertex $v \in V(G)$, the *open neighbourhood* N(v) of v is the set of all vertices adjacent to v. That is, $N(v) = \{u \in V(G) / uv \in E(G)\}$. The *closed neighbourhood* of v is defined by $N[v] = N(v) \cup \{v\}$. For any subset S of V, $N(S) = \bigcup_{v \in S} N(v)$. For any subgraph H of G, we take N(H) = N(V(H)).

The distance between two vertices u and v in G is denoted by $d_G(u,v)$ or simply d(u,v) and is defined as the length of a shortest (u,v) – path. The *eccentricity* e(v) of a vertex v is defined to be the distance of a farthest vertex from v. The *diameter,* diam(G), of a graph G is the maximum eccentricity and the *radius*, r(G), of G is the minimum eccentricity in G. A vertex v is said to be a *central vertex* if e(v) = r(G). The subgraph induced by the set of all central vertices of G is called the center of G and is denoted by cen(G).

Let G_1 and G_2 be two graphs. The Cartesian product of G_1 and G_2 is denoted by $G_1 \times G_2$, whereas, the join of G_1 and G_2 is denoted by $G_1 \vee G_2$. The graph $G_1^{\circ} G_2$ obtained from one copy of G_1 and $|V(G_1)|$ copies of G_2 by joining each vertex in the i^{th} copy of G_{2-} to the i^{th} vertex of G_1 by means of an edge is called the *corona* of G_1 and G_2.

The concept of triple connected graphs has been recently introduced by Paulraj Joseph et al. [3]. A graph G is said to be *triple connected* if any three vertices of G lie on a path in G. For example, paths, cycles, complete graphs, wheels, $K_{m,n}$, where $m, n \geq 2$, are triple connected graphs. Note that a triple connected graph may or may not contain cut vertices. For example, the triple connected graph C_n has no cut vertex where as the triple connected graph shown in Figure 1 has a cut vertex as well as a cut edge.

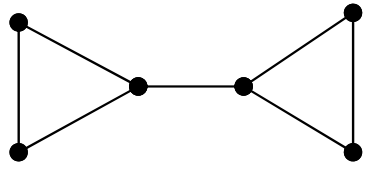

Figure 1

The following results have been obtained in [3]:

Result 1 Every 2 – connected graph is triple connected.

The above result means that a non triple connected graph always contains a cut vertex.

Result 2 A tree is triple connected if and only if it is a path.

Result 3 A graph G is triple connected if and only if its block graph B(G) is a path.

Result 4 A connected graph G is not triple connected if and only if there exists a H – cut with $\omega(G - H) \geq 3$, such that $| V(H) \cap N(G_i) | = 1$ for at least three components G_1, G_2 and G_3 of G – H.

Result 5 Let G and H be any two graphs. Then G + H is not triple connected if and only if $G \cong K_1$ and $\omega(H) \geq 3$.

Result 6 Let G_1 be a connected graph and G_2 be a disconnected graph. Then $G_1 \circ G_2$ is triple connected if and only if $G_1 \cong K_1$ and $\omega(G_2) = 2$.

The existence of a triple connected graph G with $\alpha(G) = a$ and $| V(G) | = b$, for any two integers a and b such that $b \geq 2a - 1 \geq 1$, has been established in [3].

In [1], the minimum possibility of such b has been proved to be a + 2. Also, it has been proved in [1] that any graph G can be made as a center of a triple connected graph and $G_1 \times G_2$ is always triple connected for any two connected graphs G_1 and G_2.

Now we define triple cut vertex and triple cut edge as follows:

A subset V' of V(G) of a triple connected graph G is called a *triple vertex cut* if G – V' is not a triple connected graph. V' is said to be a *k - triple vertex cut* of G if |V'| = k. A vertex v is a *triple cut vertex* or simply a *t – cut vertex* of G, if {v} is a triple vertex cut of G.

Note that every cut vertex is a triple cut vertex but not the converse. For example, in the graph shown in Figure 2, v_1 is a triple cut vertex which is not a cut vertex while v_2 is a triple cut vertex as well as a cut vertex.

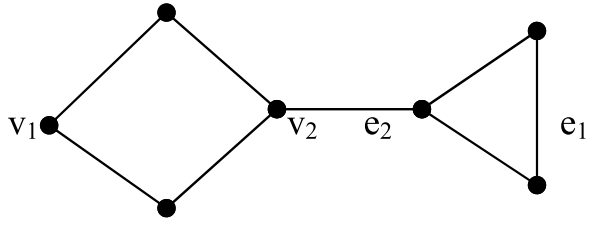

Figure 2

A subset E' of E(G) of a triple connected graph G is called a *triple edge cut* if G – E' is not a triple connected graph. It is said to be a *k - triple edge cut* of G if |E'| = k. An edge e of G is a *triple cut edge* or simply a *t – cut edge* of G, if {e} is a triple edge cut of G.

It is clear to observe that every cut edge is a triple cut edge but not the converse. For example, in the graph shown in Figure 2, e_1 is a triple cut edge which is not a cut edge while e_2 is a triple cut edge as well as a cut edge.

The minimum k for which there exists a k – triple vertex cut is called the *triple connectivity* of a connected graph G and it is denoted by *tc(G)*. The *triple edge connectivity tc'(G)* of a connected graph G is the smallest k for which there exists a k – triple edge cut. It is clear that tc(G) = tc'(G) = 0 if and only if G is a trivial graph or a non triple connected graph. A graph G is said to be a *k – triple (edge) connected graph,* if the triple (edge) connectivity of G is greater than or equal to k. Throughout this paper, by (x, y, z) – path, we mean a path containing the vertices x, y and z.

In this paper, we obtain some results regarding triple (edge) connectivity of a graph G. We give characterization for a vertex to be a t – cut vertex and an edge to be a t – cut edge of a graph. We construct triple connected graphs with given tc(G) and tc'(G).

2. Main Results

The following theorem characterizes the triple cut vertices in a triple connected graph.

Theorem 1 A vertex v of a triple connected graph G with at least 4 vertices is a t – cut vertex if and only if there exist vertices x, y and z of G, distinct from v, such that v is in every (x, y, z) – path of G.

Proof Let v be a t – cut vertex of a triple connected graph G. Then G – v is disconnected or G – v is not triple connected.

Case 1 Suppose G – v is disconnected. Then v is a cut vertex. Since G is triple connected, B(G) is a path and so G – v has exactly two components G_1 and G_2. Without loss of generality, let G_2 contain at least two vertices. Take $x \in V(G_1)$ and $y, z \in V(G_2)$. Then every (x, y) – path in G contains v. This forces that v is in every (x, y, z) – path.

Case 2 Suppose G – v is not triple connected. Then by Result 4, there exists a H – cut in G – v with $\omega(G - H) \geq 3$ and there are at least three components G_1, G_2 and G_3 of G – H with the property that $|V(H) \cap N(G_i)| = 1$ for i = 1, 2, 3. Let x, y, z be any three vertices from such G_1, G_2 and G_3 respectively. Then there will be no (x, y, z) – path in G – v. That is, v is in every (x, y, z) – path.

Conversely, suppose there are vertices x, y and z in G, distinct from v, such that v is in every (x, y, z) – path of G. Then the deletion of v disconnects every (x, y, z) – path in G – v. This means that there is no (x, y, z) – path in G – v. Therefore, G – v is not triple connected and hence v is a t – cut vertex.

In a similar way, one can prove that

Theorem 2 An edge e of a graph G is a t – cut edge of a triple connected graph if and only if there exist vertices x, y and z such that e belongs to every (x, y, z) – path in G.

From the definition of tc(G), one can clearly note the following:

1. For any graph G of order n, $0 \leq tc(G) \leq n - 1$ and $tc(G) = n - 1$, if and only if G is complete.

In fact, there do exist graphs of order n with $tc(G) = k$, $0 \leq k \leq n - 1$, the existence of which is proved in Theorem 3.

2. For any graph G, $tc(G) \leq \kappa(G)$. Also the inequality is strict.

For example, the graph shown in Figure 3, has v as a t – cut vertex and so tc(G) =1. Also $\kappa(G) = 2$.

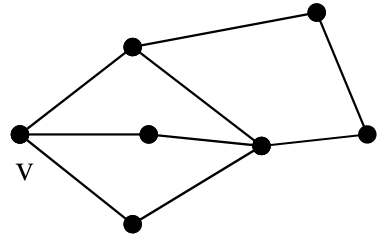

Figure 3

Theorem 3 For any two positive integers n and k,

(i) there exists a graph G of order n with $tc(G) = k$ and $tc(G) \neq \kappa(G)$ for $k < n - 2$.

(ii) there exists a graph G of order n with $tc(G) = k$ and $tc(G) = \kappa(G)$ for $k < n$.

Proof Let n and k be any two positive integers. For any $k < n - 2$, consider the graph $G = K_k \vee K_{1,n-k-1}$. Clearly G is of order n with $tc(G) = k$ and $\kappa(G) = k + 1$. This proves (i). If we consider the graph $G = K_k \vee (K_1 \cup K_{1,n-k-2})$ of order n, then $tc(G) = \kappa(G) = k$, for any $k < n - 1$. For $k = n - 1$, K_n is the graph with $tc(G) = \kappa(G) = k$. Hence (ii).

The following theorem proves that connectivity of a graph differs from its triple connectivity by at most one.

Theorem 4 For any graph G, $tc(G) \leq \kappa(G) \leq tc(G) + 1$.

Proof For trivial and any disconnected graph G, $\kappa(G) = tc(G) = 0$ and so there is nothing to prove. Let G be any connected graph. Let $tc(G) = m$ and let $\{v_1, v_2, \ldots, v_m\}$ be a t – vertex cut in G. If $G_1 = G - \{v_1, v_2, \ldots, v_m\}$ is trivial or disconnected, then we get $\kappa(G) = m$. When G_1 is a non triple connected graph, it contains a cut vertex. This forces that $\kappa(G) = m + 1$.

It is easy to observe that if a graph G contains m full vertices, then $\kappa(G) \geq m$ and hence $tc(G) \geq m - 1$.

If there is a graph G with $tc(G) = n - 2$ and $tc(G) \neq \kappa(G)$, then by the above theorem $\kappa(G) = n - 1$ and so $G \cong K_n$, which is a contradiction since $tc(K_n) = n - 1$. Thus we can state that,

Corollary 5 There does not exist a graph G with $tc(G) = n - 2$ and $tc(G) \neq \kappa(G)$.

Corollary 6 Any graph G for which $tc(G) \neq \kappa(G)$ must contain at least $\kappa(G) + 3$ vertices.

Proof Let G be any graph with $tc(G) \neq \kappa(G)$. Therefore, G is a connected graph. Let $tc(G) = m$ and hence by the previous theorem $\kappa(G) = m + 1$. Then the removal of m vertices from G results in a non triple connected graph which contains at least 4 vertices. Therefore G must contain at least $\kappa(G) + 3$ vertices.

Note that the converse of the above statement is not true. For instance, P_4 contains 4 vertices with $tc(P_4) = \kappa(P_4) = 1$.

If there is a graph G with $tc(G) = n - 3 \neq \kappa(G)$, then by Theorem 4, $\kappa(G) = n - 2$ and so by the above corollary G contains at least n + 1 vertices, which is a contradiction. Thus we can state that

Corollary 7 There does not exist a graph G of order n with $tc(G) = n - 3$ and $tc(G) \neq \kappa(G)$.

The following theorem gives the characterisation for a t – cut vertex in a graph with a single block.

Theorem 8 Let G be a 2 – connected graph. Then a vertex v in G is a t – cut vertex if and only if N(v) contains at least three vertices such that every path connecting them in G contains v.

Proof Let G be any 2 – connected graph. Suppose v is a t – cut vertex in G, then G – v is not triple connected and so by Result 4, there exists a H – cut in G – v such that $\omega(G - \{H \cup \{v\}\}) \geq 3$

such that $| V(H) \cap N(G_i) | = 1$ for at least three components G_1, G_2 and G_3 of $G - \{H \cup \{v\}\}$. Since $B(G) \cong K_1$, v has at least one neighbour in each of these three components. Let them be v_1, v_2 and v_3 respectively. Then there is no (v_1, v_2, v_3) – path in G – v. Therefore N(v) contains at least three vertices such that v lies on every path connecting them in G.

Conversely, assume that G contains a vertex v such that N(v) contains at least three vertices such that every path connecting them contains v. Then there is no path in G – v connecting these three vertices. Hence G – v is not triple connected which implies that v is a t – cut vertex of G.

Again from the definition of tc'(G), we can obviously note the following:

1. For any graph G of order n, $0 \leq tc'(G) \leq n - 1$ and $tc'(G) = n - 1$, if and only if G is complete.

2. For any graph G, $tc'(G) \leq \lambda(G)$ and the inequality is strict.

For example, the graph shown in Figure 4, has e as a t – cut edge and so tc(G) =1. Also $\lambda(G) = 2$.

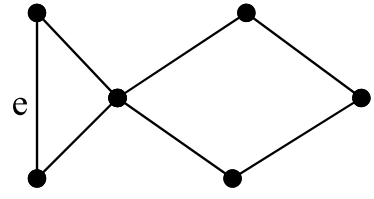

Figure 4

It has been proved in Theorem 4 that $\kappa(G)$ differs from tc(G) by at most one but this is not the case when we compare $\lambda(G)$ and tc'(G). The difference can be any positive integer which is established in the following theorem.

Theorem 9 For n, $m \geq 1$, there exists a graph G which is n + m – edge connected and m – triple edge connected.

Proof Let n and m be any two positive integers. Consider the graph $K_1 \vee 3K_{n+m,}$ where $3K_{n+m}$ denotes the disjoint union of 3 copies of K_{n+m}. In this graph, add new edges $e_1, e_2, \ldots, e_m$ between any m pairs of vertices. Let the resultant graph be denoted by G. Clearly $\{e_1, e_2, \ldots, e_m\}$ is a t – edge cut. Therefore tc'(G) = m. Also, $\lambda(G) = n + m$. Hence G is the required graph.

For example, the graph G constructed for n = 3 and m = 2 is shown in Figure 5.

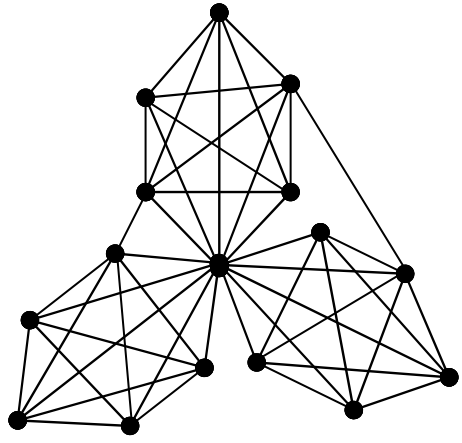

Figure 5

Theorem 10 Every 2 – connected graph G is 2 – edge triple connected.

Proof Let G be a 2 – connected graph. Then $B(G) \cong K_1$. We claim that $tc'(G) \neq 1$. Suppose $tc'(G) = 1$. Then there exists an edge e in G whose removal results in a non triple connected graph. Then by Result 4, G – e contains at least three components each having a unique neighbour in a H – cut of G – e. The removed edge e has its end points in at most two of these components. This forces that $B(G) \not\cong K_1$, which is a contradiction to the fact that G is a single block graph.

The converse of the above theorem need not be true. For example a 2 – edge triple connected graph shown in Figure 6 contains a cut vertex.

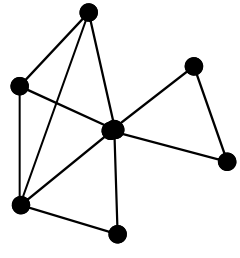

Figure 6

Theorem 11 For a 2 – edge connected graph $tc'(G) = 1$ if and only if there exists an edge e in G such that G – e contains at least three vertices such that any path connecting them contains e.

Proof Let G be a 2 – edge connected graph. Suppose tc'(G) = 1, then G is a triple connected graph with a t – cut edge e = uv in G such that G – e is not triple connected. Then by Result 4, there exists a H – cut in G – e such that $| V(H) \cap N(G_i) | = 1$ for at least three components G_1, G_2 and G_3 of $G – \{H \cup \{e\}\}$. Since $B(G) \cong P_n$, u and v must belong to any two of these three components. Let v_1, v_2 and v_3 be any three vertices in G_1, G_2 and G_3 respectively. Then there is no (v_1, v_2, v_3) – path in G – e. But such a path exists in G implies that G – e contains at least three vertices such that e lies on every path in G connecting them.

Conversely, if there exists an edge e in G such that G – e contains at least three vertices such that any path connecting them contains e, then e is obviously a t – cut edge of G. And hence tc' (G) = 1.

For any graph G regarding connectivity, we already know that $\kappa \leq \lambda \leq \delta$. Here we prove an analogue result for triple connectivity.

Theorem 12 For any graph G, $tc(G) \leq tc'(G) \leq \lambda(G) \leq \delta(G)$.

Proof Let G be any graph. If G is trivial, then $tc(G) = tc'(G) = \lambda(G) = \delta(G) = 0$ and hence the result is obvious. For a non trivial graph G, if tc(G) = 0, then G is non triple connected or disconnected which forces that tc'(G) = 0 and so the result is true.

Now we assume that G is triple connected for which tc(G), tc'(G) and $\delta(G)$ are all positive. Then there exists a non empty triple edge cut E with tc'(G) edges. Fix an edge uv in G. For all edges other than uv in E, remove an end vertex that is different from u and v. Since E contains tc'(G) edges including uv, at most tc'(G) - 1 vertices have been removed. If the resulting graph is not triple connected, then $tc(G) \leq tc'(G) - 1$. Otherwise, further removal of u or v results in a trivial or non triple connected graph and so $tc(G) \leq tc'(G)$. But we know that $tc'(G) \leq \lambda(G) \leq \delta(G)$. Thus we have $tc(G) \leq tc'(G) \leq \lambda(G) \leq \delta(G)$.

Note that for a disconnected graph G, $tc(G) = \kappa(G) = tc'(G) = 0$. But for a non triple connected graph G, $tc(G) = tc'(G) = 0$ and $\kappa(G) = 1$. The following theorem proves that for a triple connected graph G, $\kappa(G)$ d" tc'(G).

Theorem 13 Let G be any triple connected graph. Then $tc(G) \leq \kappa(G) \leq tc'(G)$.

Proof Let G be a triple connected graph. We have already proved that $\kappa(G) = tc(G)$ or $tc(G) + 1$ and $tc(G) \leq tc'(G)$. The result is obvious when $tc(G) = \kappa(G)$. Therefore assume that $tc(G) \neq \kappa(G)$. This forces that $B(G) \cong K_1$. Let tc(G) = m. Then $\kappa(G) = m + 1$.

We claim that tc'(G) > m. On contrary assume that tc'(G) = m. Let E = $\{e_1, e_2, \dots, e_m\}$ be a t – edge cut of G. By Theorem 10, every 2 – connected graph is 2 – triple edge connected. Hence $G_1 = G - \{e_1, e_2, \dots, e_j\}$, $1 \leq j \leq m - 2$ is a 2 – connected graph. This means that $G_1 - e_{j+1}$ contains a cut vertex. Then one end point of each of these j+1 removed edges together with that cut vertex form a j+2 – vertex cut for G which is a contradiction since $\kappa(G) = m + 1$. Hence we conclude that for a triple connected graph G, $tc(G) \leq \kappa(G) \leq tc'(G)$.

Combining Theorem 11, 12 and 13 we have the following result.

Corollary 14 If G is disconnected or triple connected, then $tc(G) \leq \kappa(G) \leq tc'(G) \leq \lambda(G) \leq \delta(G)$.

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ISOLATION, IDENTIFICATION AND ANTIBIOTIC SENSITIVITY OF MICROBES FROM BIOMEDICAL WASTES

Dr. (Mrs) Usha.S* and Suguna.V*

Abstract

In the present investigation the microbial flora in the biomedical wastes which includes soil and cotton sample were taken the isolated bacteria from the biomedical waste were identified as Streptococcus pyogenes, Staphylococcus aureus*,* Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa *and* Salmonella typhi *and the isolated fungal colonies were* Aspergillus niger, Aspergillus flavus, Candida albicans *and* Penicillum chrysogenum *respectively using standard protocols. The antibiotic sensitivity of isolated bacteria and fungi strain were further analyzed. The commercially available antibiotic disc such as Erythromycin, Nitrofuration, Ceftrazidime, Ofloxacin Gentamicin, Streptomycin, Clindamycin and Ceftriaxone were used in present study, and Amphotericin B, Clotrimazone, Ketoconazole, Fluconazole and Nystatin were used for fungal sensitivity. Result revealed in bacteria the maximum zone of inhibition was observed in Norfloxacin and Ofloxacin, and in fungal strains maximum zone of inhibition was observed in Clotrimazole and Ketaconazole.*

Keywords

Biomedical waste, Microbes, Bacteria, Fungi, Antibiotics.

Introduction

Biomedical wastes generated in the hospital falls under two major categories – non hazardous and bio hazardous. Constituents of non hazardous waste are non-infected plastic, cardboard, packaging material, paper etc. Bio hazardous waste again falls into two Infectious waste are sharps, non sharps, plastics disposables, liquid waste, etc, and non infectious waste are radioactive waste, discarded glass, chemical waste, cytotoxic waste, incinerated waste etc. Approximately 75-90% of the biomedical

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waste is non-hazardous and as harmless as any other municipal waste. The remaining 10-25% is hazardous and can be injurious to humans or animals and deleterious to environment. It is important to realize that if both these types are mixed together then the whole waste becomes harmful (Singh *et al.,* 2007). Hospital infections, a severe public health issue, are widespread and have high economic and social impact (Blanc., 2004). Several bacteria are associated to nosocomial infections, mainly representatives of gram negative and gram positive cocci (Sader et al., 2001). Hence in the present study soil sample and bio-waste sample (cotton) of hospital dump sites were examined and assayed for the presence of pathogenic microorganisms.

Materials and Methods

Collection of Soil Sample

The soil and hospital bio waste samples were collected from Raja Mirasdar Government Hospital, Thanjavur. The samples were stored in a sterile container for further studies.

Isolation and Identification of Microbes

The nutrient agar medium was poured and the content was mixed well in clockwise and anticlockwise direction. The plates were allowed to solidify and incubated at 37^{o}C for 24 hours for bacterial observation. The PDA medium is prepared for fungal observation. The plates were incubated at 28 ± 2^{o}C for 3 to 4 days for fungal isolation. The isolated bacterial strains were identified based on their cultural, morphological and biochemical characteristics.

Assay of Antibiotic Sensitivity

Antibiotic Disc Used

The commercially available antibiotic disc such as Erythromycin, Nitrofuration, Ceftrazidime, Ofloxacin Gentamicin, Streptomycin, Clindamycin and Ceftriaxone were used for bacterial culture. Amphotericin B, Clotrimazone, Ketoconazole, Fluconazole and Nystatin used for fungal culture. The antibiotic disc was purchased from High media chemical Pvt. Ltd, Mumbai, India. The antibiotic sensitivity of isolated bacteria species against commercial antibiotic tests was analyzed by disc diffusion (Kirby-Bauer) method. Antibiotic sensitivity test was carried out following the modification of the method described by Bauer et al., (1996).

Statistical Analysis

The results obtained in the present investigation were subject to statistical analysis like Mean $(\bar{x})$ and Standard Deviation (SD) by Zar (1984).

Result and Duscussion

In the present study, contaminated hospital waste was collected and microbial strains were isolated and identified from the contaminated hospital waste sample. The antimicrobial activity of isolated bacteria and fungi strain for their antibiotic sensitivity were analyzed.

The results were compared with Bergey's Manual of systemic bacteriology. Based on is isolated bacterial strains such as HWB_1, HWB_2, HWB_3, HWB_4, HWB_5, HWB_6 and HWB_7 were confirmed as, *Streptococcus pyogenes, Staphylococcus aureus*, *Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Salmonella typhi* respectively. Among the study all the bacterial isolated were more sensitive to Norfloxacin and Ofloxacin compared with other antibiotics. At the same time the maximum inhibition (32 mm) was noted in Streptomycin against *Bacillus subtilis* and *Salmonella typhi* compared to other organisms. The entire test organisms have more resistance to Ceftrazidime and Ceftriaxone (Table-1, Fig-1).

Table – 1

ASSAY OF ANTIBACTERIAL ACTIVITY AGAINST COMMERCIAL ANTIBIOTIC DISCS

S. No.	Bacteria	Zone of Inhibition (mm in diameter) (M±SD) (n=3)							
		Streptomycin	Nitrofuration	Ceftrazidime	Erythromycin	Ofloxacin	Gentamicin	Clindamycin	Ceftriaxone
1	*Streptococcus pyogenes*	-	19±0.42	-	28±0.39	24±0.42	23±0.25	-	-
2	*Staphylococcus aureus*	26±0.08	18±0.18	-	20±0.25	18±0.47	20±0.72	-	-
3	*Bacillus subtilis*	32±0.22	24±0.29	-	19±0.26	24±0.31	23±0.62	26±0.36	-
4	*Escherichia coli*	29±0.21	24±0.32	-	20±0.30	24±0.37	22±0.42	23±0.47	-
5	*Klebsiella pneumoniae*	26±0.28	18±0.26	-	-	28±0.22	21±0.57	-	-
6	*Pseudomonas aeruginosa*	30±0.32	23±0.33	-	20±0.62	24±0.82	22±0.20	22±0.26	-
7	*Salmonella typhi*	32±0.24	24±0.27	-	-	24±0.19	-	22±0.18	-

Mean ± Stranded Deviation

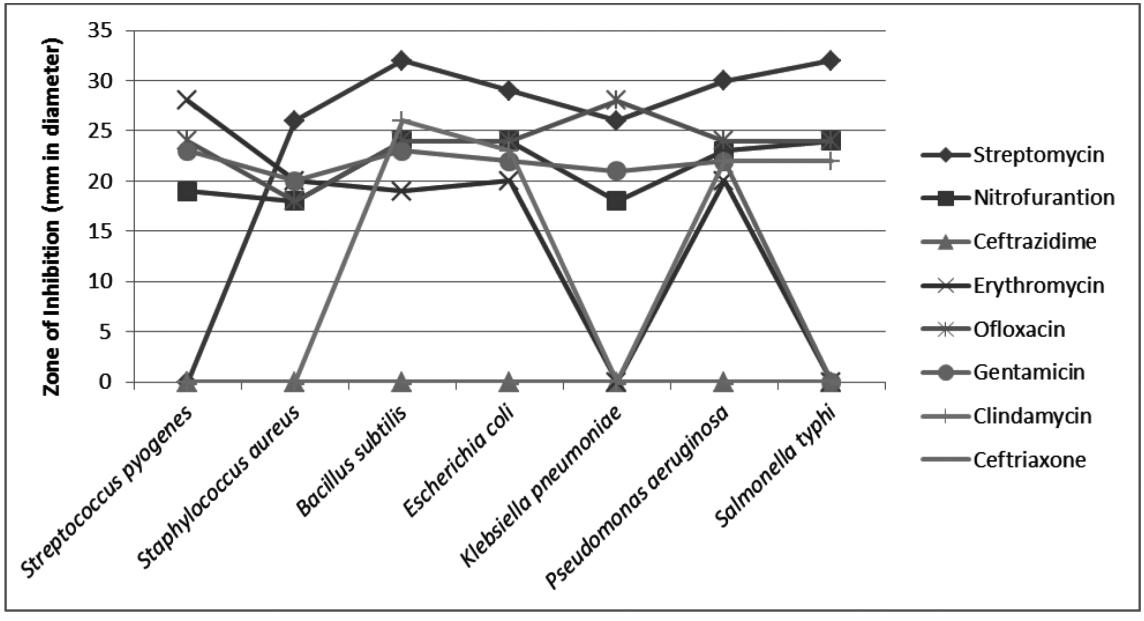

Fig – 1

Assay of Antibacterial Activity Against Commercial Antibiotic Discs

The four different fungal strains were identified by Lacto phenol cotton blue staining. The staining results of each fungus were compared with standard fungal identification manual (Bergey's Manual of systemic bacteriology) and the isolated fungal strain HWF1, HWF2, HWF3 and HWF4 were confirmed as *Aspergillus niger, Aspergillus flavus, Candida albicans* and *Penicillum chrysogenum* respectively. All the test organisms were more sensitive to Clotrimazole and Ketaconazole antibiotic compared to other antibiotics. Ketaconazole inhibit the growth of *Aspergillus flavus* (18mm), *Aspergillus niger* (17mm), *Candida albicans* (18mm) and *Pencillium sp* (15mm). Clotrimazole antibiotic highly inhibit the growth of *Aspergillus niger* and *Aspergillus flavus* (19mm) and *Penicillium chrysogenum* (16mm) and Amphotericin have moderate inhibition noted against all isolated fungi (Table-2, Fig-2).

Kapoor and Aggarwal, (1997) illustrated more than 50% of *Escherichia coli* shows sensitivity to Amikacin, Ciprofloxacin and Gantamicin. In this present study *E.coli* shows sensitivity to Gentamicin, Streptomycin, Nitrofuration and Ofloxacin. Nagno et al (2004) suggest that ketaconazole is an effective antibiotic against *Aspergillus niger* isolated from CKD patients where as in this study Nystatin is very effective against the isolates. *Bacillus, Staphylococcus* and *Streptococcus* species were examined bacteria frequently encountered in hospital wastewater, varying between 5 to 10%.

Table – 2

ASSAY OF ANTIFUNGAL ACTIVITY AGAINST COMMERCIAL ANTIBIOTIC DISCS

S. No.	Fungi	Zone of Inhibition (mm in diameter) (M±SD) (n=3)				
		Amphotericin	Clotrimazole	Nystatin	Fluconazole	Ketaconazole
1	*Aspergillus flavus*	**10±0.17**	**19±0.28**	**11±0.42**	**-**	**18±0.23**
2	*Aspergillus niger*	**-**	**11±0.24**	**-**	**15±0.61**	**17±0.28**
3	*Candida albicans*	**10±0.22**	**19±0.30**	**14±0.72**	**-**	**18±0.31**
4	*Penicillium chrysogenum*	**13±0.21**	**16±0.22**	**13±0.77**	**11±0.28**	**15±0.92**

Mean ± Stranded Deviation

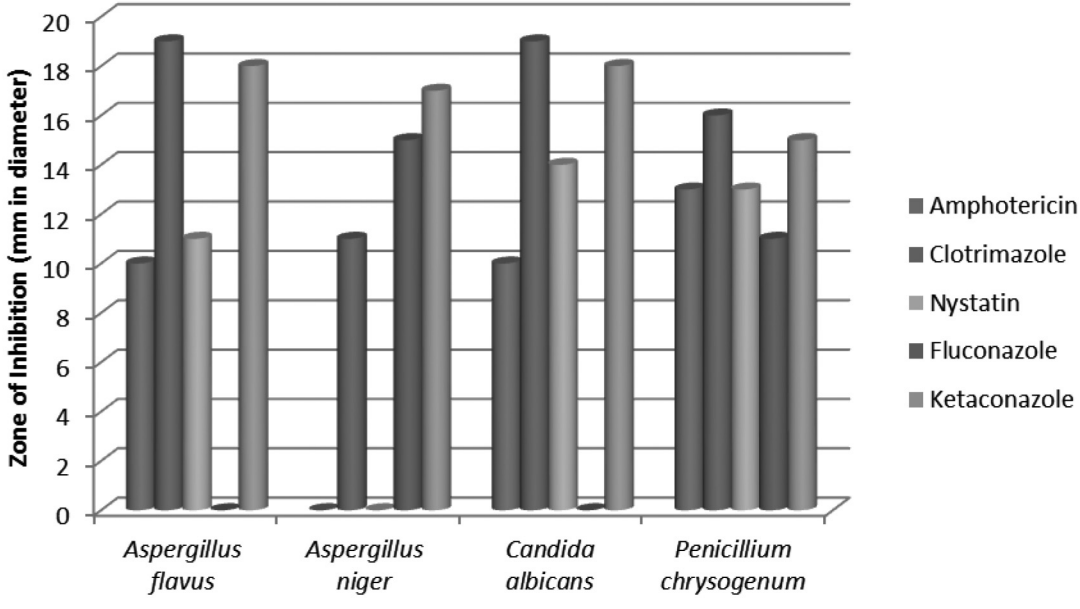

Fig – 2

Assay of Antifungal Activity against Commercial Antibiotic Discs

Several researchers have reported that the environmental surfaces of hospitals are contaminated by various kinds of microbes (Schaal, 1991; Kitashima et al, 1996). In the present study microbes isolate hospital wastes revealed presence *Escherichia coli, Pseudomonas aeruginosa, Bacillus subtilis, Klebsiella pneumoniae,* and fungal species like *Aspergillus niger* and *Candida albicans* which also caused the nosocomial infection.

Conclusion

Thus in the present study isolated bacterial colonies from biomedical wastes were confirmed as*, Streptococcus pyogenes, Staphylococcus aureus*, *Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Salmonella typhi.* The identified fungal colonies were *Aspergillus niger, Aspergillus flavus, Candida albicans* and *Penicillum chrysogenum*. Antimicrobial activities of commercial antibiotics were assayed against the bacterial and fungal isolates by the methods of disc diffusion. In bacteria, maximum zone of inhibition was noted in Nitrofuration and Ofloxacin and in fungi the maximum zone of inhibition was noted in Clotrimazole and Ketaconazole.

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A STUDY ON USAGE OF INTERNET RESOURCES AMONG THE ENGINEERING STUDENTS IN MADURAI DISTRICT

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Abstract

The purpose of the study was examining the internet usage among the Engineering students in Madurai district. In particular, the study aims at studying the effect of certain variables such as gender, level of satisfaction and facilities, utilization of process. The study was conducted using questionnaire method with a sample of 480 respondents to determine the usage of internet. The empirical research design and random sampling technique was applied to select the sample. The data collected was analyzed and inferences made based on standard statistical methods. (ANOVA-Two-way model). The study reveals that (51.25%) Google is a standard search engine to access information resources. Majority of the respondents are familiar with IEEE online database information through internet. It is suggested that the facilities should concentrate on proving orientation programme for all students studying in their institutions to motivate them and familiar with online resources available in the internet. Internet has become a vital instrument for reaching, research and learning process of these respondents. Some suggestions are set forth to make the service more beneficial for the academic community of the engineering colleges under study.

Keywords

Internet, internet resources, search engines, engineering students.

Introduction

In the era of network information, Internet and large worldwide of networks, has emerged as powerful educational tool for an instant access to information. It has made a tremendous impact on the academic activities of the teachers and students. Information is just a "finger touch" away from the user and it would not be inappropriate to say that the internet has become the biggest global

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digital information library, which provides the fastest access to the right kind of information in nano-seconds to end user at any time and at any place in the world.

According to Wikipedia, the free encyclopedia, the internet is global system of interconnected computer networks that the standard internet protocol suite (TCP/IP) to serve several billions of private, public, academic, business and government networks of local to global scope, that are linked by a broad array of electronic, wireless and optical networking technologies. The internet carries an extensive range of information resources and services such as inter- links hypertext documents of the World Wide Web (WWW) and the infrastructure to support email.

A good search engine has to be available for the users to utilize effectively to find the relevant documents by using keyword search. Desktop access can be provided by designing a suitable website with easier hyper links and can be published over the network environment using web technology. A resource is any physical or virtual entity of limited availability that needs to be consumed to obtain a benefit from it. In most cases, commercial or even non- commercial factors require resources allocation through resource management. There are two types of resources: renewable and non- renewable. Resources have three main characteristics: utility, quantity (often in terms of availability) and consumption.

Need of the Study

This Study identifies the utilization of Information resources in the Internet, retrieval of Information, purpose of gathering of information, usage of search engines and preference of web site, search methods and opinion about the Internet resources.

Objectives of the Study

The specific objectives are framed for the Study:

1. To identify the internet users according to the method of internet browsing.
2. To identify the internet users according to the availability of online database related to subjects.
3. To identify the internet users according to the use of search engine.
4. To identify the internet users according to purpose of browsing.
5. To identify the internet users with regard to the availability of OPAC services in their libraries.

6. To identify the internet users according to their knowledge of Collaborative activities available in their libraries.

Review of Literature

Review of literature related to information resources, services and facilities of academic libraries as well as internet centers. Indian and foreign publications, articles, books, reports, conference papers are reviewed. The review reveals that many studies have been conducted on e- resources in Libraries (Sami, Lalitha K. and Iffat, Rabia (2006), Nandi, SubodhGopal (2007) Natarajan, M (2007) Resnick, Taryn et al. (2008). Researchers have also been conducted on Digital libraries (Ramesh Babu, V.P., Ganesan, A and Maheswari, D.Uma (2006), Manducaca, Cathryn A., Fox, Sean and Iverson, Ellen R (2006), Das, A.K., C.Dutta and B.K.Sen (2007). Some researchers conducted studies on use of internet and services. Covi, L and Kling, R (1997), Daniel J.Barrett (1997), Kaminer, Noam (1997), Mary ,Beth Weber (1999), Zhang y (1999) Golian, Linda Marie (2000), Zhang Yin (2001), Banks, Dulie (2002), Mandal,M and Panda, K.C. (2005), Maheswarappa, B.S, Ebenezer Emmanuel (2003), Sudhambika, S.R and A. Lawrence Mary (2011). Only a few studies have been conducted on engineering libraries and very few studies on internet usage of engineering students.

Hence the present study focuses on the internet resources among the engineering students.

Methodology

Survey method was adopted in measuring the variables and other information required for this study. The data were collected from students of 10 engineering colleges located in and around Madurai city affiliated to Anna University.

The sample of this study consists of 480 engineering students in Madurai district. Among the total respondents 126 are male and 354 females. The empirical research design and random sampling technique was applied to the convenient sample. The Data were collected using the well-structured questionnaire prepared and standardized by the investigator keeping in mind the objectives of the study. The questionnaire was personally distributed to the sample of students selected for the study. 500 questionnaires were distributed to the population and 492 were received back. Among them 480 questionnaires were selected for the study as samples and the remaining 12 questionnaires were rejected due to incomplete responses.

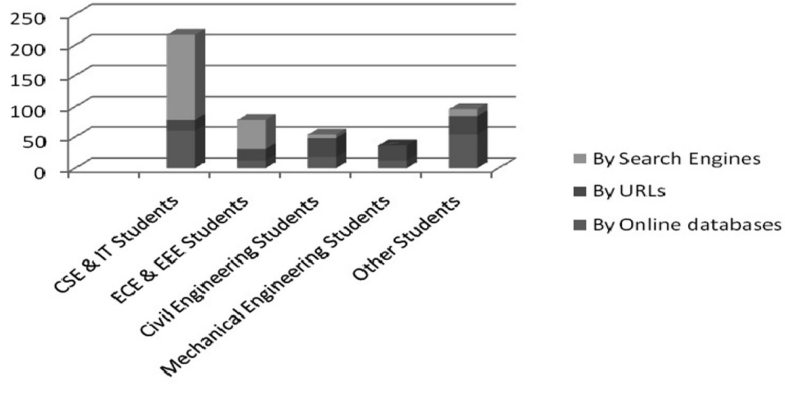
The Collected Data were classified and tabulated and analysis was carried out according to the objectives of the study, using ANOVA two way model tests. SPSS was used for analysis.

Analysis and Discussion

Table - 1 Distribution of engineering students according to the method of internet browsing

Users	Distribution of engineering students according to the method of internet browsing			Total
	By Online databases	By URLs	By Search Engines	
CSE & IT Students	60 (27.78)	18 (8.33)	138 (63.89)	216 (45)
ECE & EEE Students	12 (15.38)	18 (23.07)	48 (61.53)	78 (16.25)
Civil Engineering Students	18 (33.33)	30 (55.56)	6 (11.11)	54 (11.25)
Mechanical Engineering Students	12 (33.33)	24 (66.67)	0	36 (7.5)
Other Students	54 (56.25)	30 (31.25)	12 (12.5)	96 (20)
Total	156 (32.5)	120 (25)	204 (42.5)	480 (100)

Data given within parentheses denote percentage



Data in Table 1 pointed out the distribution of Engineering Students according to the method of internet browsing. Out of all respondents, majority (42.5%) of them are using search engine for information retrieval. Followed by (32.5%) online databases. The rest (25%) of them is searching through definite URLs.

Table 1a ANOVA Summary Result

	Sum of square	Degrees of Freedom	Mean square	F	Table Value
Between Column	**710.4**	**2**	**355.2**	**0.32**	**4.46**
Between Rows	**6696**	**4**	**1674**	**1.5**	**3.84**
Residual	**8913.6**	**8**	**1114.2**	**-**	**-**

It is also clear from the above table that majority of them are CSE/IT students and most of the respondents are (63.89%) searching through search engines. In ECE/EEE students category also a majority of them (61.53%) are using search engines for information retrieval. It is noted that most of the Civil Engineering students are (55.56%) searching internet resources by URLs. It is noted that, there is no respondents in the category of Mechanical Engineering students is using search engines for information retrieval. Among the other students, a majority of them (56.25%) are using online databases for information retrieval.

It is clearly seen from the above discussion, most of them are using search engines for information retrieval.

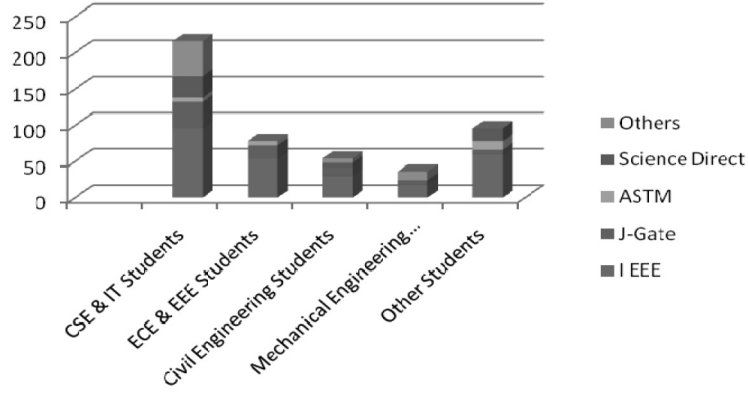
It could be seen from the ANOVA table 9a, the table value of F at 5% for v_1=2 and v_2=8 is 4.46. Since the calculated value is less than the table value, **the hypothesis holds true**. Hence the students according to the most frequently used browsing centers do not differ significantly. The table value of F for v_1=4 and v_2=8 at 5% level is 3.84. Since the calculated value is less than the table value, **the hypothesis holds true**. Hence browsing places with regard to branch wise distribution of students do not differ significantly.

It is clear from the above discussions that, there is no significant difference among the engineering students with regard to the most frequently visited place for internet browsing.

Table-2 Distribution of Engineering Students according to the availability of online database related to subjects

Users	Distribution of engineering students according to the availability of online databases related to their subjects					
	IEEE	J-GATE	ASTM	Science Direct	Others	Total
CSE & IT Students	96 (44.44)	36 (16.67)	6 (2.78)	30 (13.89)	48 (22.22)	216 (45)
ECE & EEE Students	54 (69.23)	18 (23.07)	6 (7.69)	-	-	78 (16.25)
Civil Engineering Students	30 (55.56)	12 (22.22)	-	6 (11.11)	6 (11.11)	54 (11.25)
Mechanical Engineering Students	18 (50)	6 (16.67)	-	-	12 (33.33)	36 (7.5)
Other Students	60 (62.5)	6(6.25)	12 (12.5)	18 (18.75)	-	96 (20)
Total	258(53.75)	78 (16.25)	24 (5)	54 (11.25)	66 (13.75)	480 (100)

Data given within parentheses denote percentage



Data in table 2 specifies the distribution of engineering students according to the availability of online databases related to their subjects. Out of all respondents, most of them (53.75%) are familiar with the IEEE online database, followed by (16.25%) J-gate online database, another (13.75%) on other online databases, few respondents (11.25%) the Science Direct online database, and a very few of them (5%) are browsing ASTM online database.

Table - 2A ANOVA Summary Result

	Sum of square	Degrees of Freedom	Mean square	F	Table Value
Between Column	**6883.2**	**4**	**1720.8**	**10.45**	**3.01**
Between Rows	**4017.6**	**4**	**1004.4**	**6.09**	**3.01**
Residual	**2635.2**	**16**	**164.7**		

It could be seen from the ANOVA table 10(a), the table value of F at 5% for v_1=4 and v_2=16 is 3.01. Since the calculated value is higher than the table value, **the hypothesis is rejected**. Hence distribution of engineering students according to the usage of online database is differing significantly. The table value of F at 5% for v_1=4 and v_2=16 is 3.01. Since the calculated value is higher than the table value, **the hypothesis is rejected**. Hence branch wise distribution of engineering students according to the usage of online database is also differing significantly.

It is clearly seen from the above discussion, most of the students are familiar with IEEE online database. It is also noted that the other databases are not much familiar with majority of the engineering students.

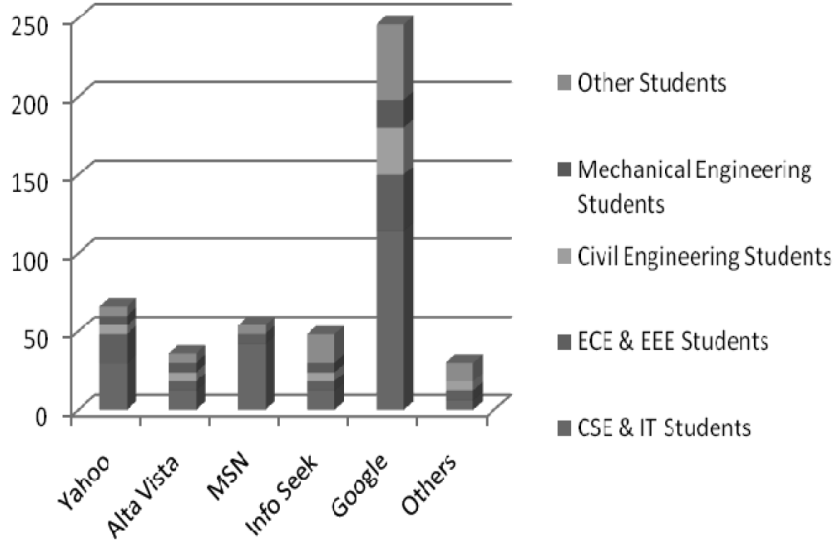
Table- 3 Distribution of engineering students according to the use of search engine

Users	**Distribution of engineering students according to the use of search engines**						
	Yahoo	**Alta Vista**	**MSN**	**Info Seek**	**Google**	**Others**	**Total**
CSE & IT Students	**30 (13.89)**	**12 (5.56)**	**42 (19.44)**	**12 (5.56)**	**114 (52.78)**	**6 (2.78)**	**216 (45)**
ECE & EEE Students	**18 (23.07)**	**6 (7.69)**	**6 (7.69)**	**6 (7.69)**	**36 (46.15)**	**6 (7.69)**	**78 (16.25)**
Civil Engineering Students	**6 (11.11)**	**6 (11.11)**	**-**	**6 (11.11)**	**30 (55.56)**	**6 (11.11)**	**54 (11.25)**

Mechanical Engineering Students	**6 (16.67)**	**6 (16.67)**	**-**	**6 (16.67)**	**18 (50)**	**-**	**36 (7.5)**
Other Students	**6 (6.25)**	**6(6.25)**	**6 (6.25)**	**18 (18.75)**	**48 (50)**	**12 (12.5)**	**96 (20)**
Total	**66 (13.75)**	**36 (7.75)**	**54 (11.25)**	**48(10)**	**246 (51.25)**	**6 (6.25)**	**480 (100)**

Data given within parentheses denote percentage

Data in table 3 reveals the distribution of engineering students according to the use of search engines. Among the respondents, majority of them (51.25%) are using Google, (13.75%) Yahoo (11.25%) MSN, (10%) Info Seek (7.5%) Alta Vista and (6.5%) are searching through other search engines



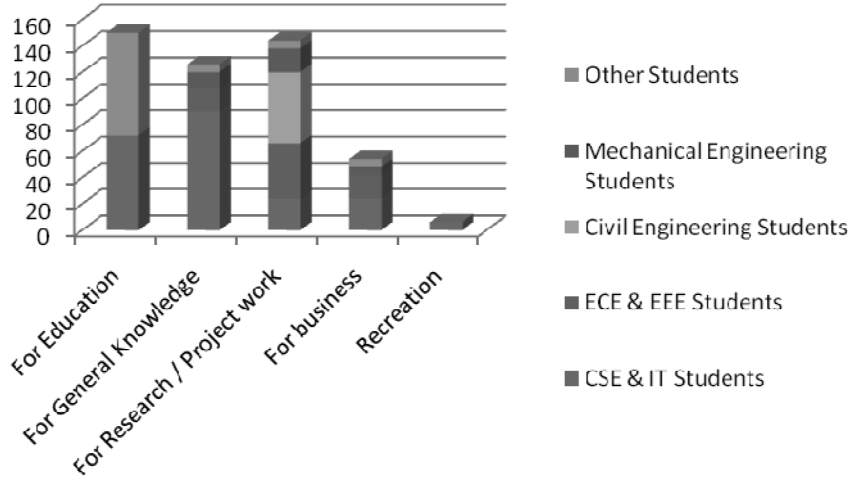
It is also seen from the above table that majority of the CSE/IT students, ECE/EEE students, Civil Engineering students Mechanical Engineering students and the other remaining students are using Google for searching purpose.

It is clearly seen from the above discussion that, most of the users are using Google for standard search.

Table- 4 Distribution of engineering students according to purpose of browsing

-Users	Distribution of engineering students according to purpose of browsing					
	For Education	For General Knowledge	For Research & Project Work	For Business	Recreation	Total
CSE & IT Students	72 (33.33)	90 (41.67)	24 (11.11)	24 (11.11)	6 (2.78)	216 (45)
ECE & EEE Students	-	18 (23.07)	42 (53.84)	18 (23.07)	-	78 (16.25)
Civil Engineering Students	-	-	54 (100)	-	-	54 (11.25)
Mechanical Engineering Students	-	12 (33.33)	18 (50)	6 (16.67)	-	36 (7.5)
Other Students	78 (81.25)	6(6.25)	6 (6.25)	6 (6.25)	-	96 (20)
Total	150 (31.25)	126 (26.25)	144 (30)	54 (11.25)	6 (1.25)	480 (100)

Data given within parentheses denote percentage



Data in table- 4 pointed out the distribution of engineering students according to purpose of using search engines. Out of total respondents, (31.25%) are browsing for education purpose, (30%) for research / project work, (26.25%) are browsing to gain general knowledge. (11.25%) business purpose and very few of them (1.25%) are browsing for recreation purpose

It is also seen from the above table that majority of the CSE/IT students (41.67%) are browsing to gain general knowledge. Majority of the ECE/EEE students (53.84%) are browsing for research / project work. All of the Civil Engineering students (100%) are browsing for research / project work. And also a majority of the Mechanical Engineering students (50%) are browsing for research / project work. It is noted that the majority of the remaining other students (81.25%) are browsing for education purpose.

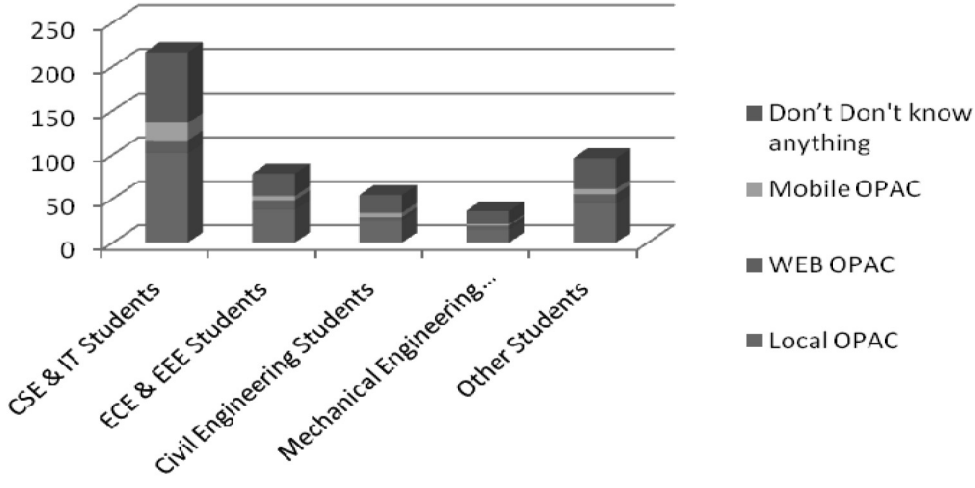
It is clearly seen from the above discussion most of the users are browsing for education purpose and project work

Table 5-Distribution of engineering students with regard to the availability of OPAC services in their libraries

Users	Distribution of engineering students according to the availability of OPAC services				Total
	Local OPAC	WEB OPAC	Mobile OPAC	Don't know anything	
CSE & IT Students	102 (47.22)	14 (6.48)	20 (9.26)	80 (37.04)	216 (45)
ECE & EEE Students	38 (48.72)	10 (12.82)	5 (6.41)	25 (32.05)	78 (16.25)
Civil Engineering Students	26 (48.15)	3 (5.56)	5 (9.26)	20 (37.04)	54 (11.25)
Mechanical Engineering Students	15 (41.67)	4 (11.11)	2 (5.56)	15 (41.67)	36 (7.5)
Other Students	45 (46.87)	10 (10.42)	6 (6.25)	35 (36.46)	96 (20)
Total	226 (47.08)	41 (8.45)	38 (7.92)	175 (36.46)	480 (100)

Data given within parentheses denote percentage

Out of total respondents, a majority of them are in the branch of CSE and IT. Their percentage is 45. Followed by 20% of them are other branch students. 16.25% of them are in the branch of ECE and EEE. 11.25% of them are belongs to Civil Engineering branch. And the final 7.5% of them are in the branch of Mechanical Engineering Students.



It is also clear from the above table that, a majority of them from all branches are having the knowledge of local OPAC, their percentage is 47.08. Followed by another majority of them (36.46%) are not having enough knowledge about OPAC services. And it is noted that, a little group of respondents only having the knowledge of Web OPAC and Mobile OPAC.

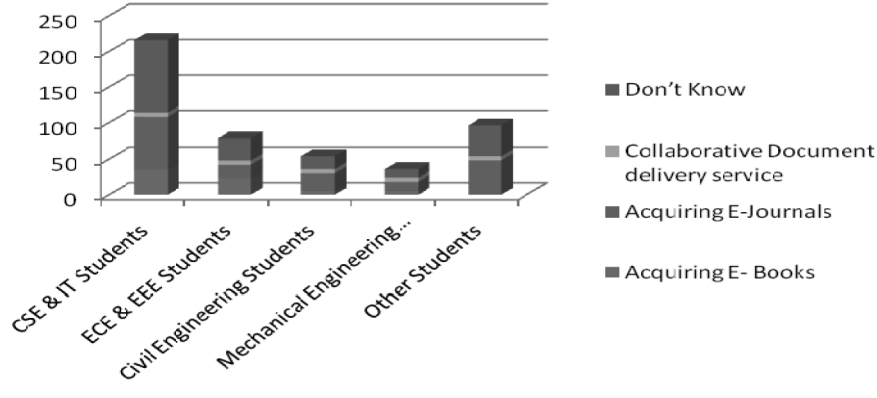
Table 6- Distribution of engineering students according to their knowledge of Collaborative activities available in their libraries

Users	Distribution engineering students according to their knowledge of Collaborative activities available in their libraries				Total
	Acquiring E- Books	Acquiring E-Journals	Collaborative Document delivery service	Don't Know	
CSE & IT Students	36 (16.67)	72 (33.33)	6 (2.78)	102 (47.22)	216 (45)

ECE & EEE Students	24 (30.76)	18 (23.07)	6 (7.69)	30 (38.46)	78 (16.25)
Civil Engineering Students	6 (11.11)	24 (44.44)	6 (11.11)	18 (33.33)	54 (11.25)
Mechanical Engineering Students	6 (16.67)	12 (33.33)	6 (16.67)	12 (33.33)	36 (7.5)
Other Students	0	48 (50)	6 (6.25)	42 (43.75)	96 (20)
Total	72 (15)	174 (36.25)	30 (6.25)	204 (42.5)	480 (100)

Data given within parentheses denote percentage

Among the total respondents, a majority of them are CSE/IT students. Their percentage is 45. Followed by the majority of the students from ECE/EEE students are 16.25 %. Civil Engineering students 11.25%, Mechanical Engineering students 7.5 % and the remaining other students are 20 %.



It is also seen from the above table that, the majority of the (47.22%) CSE/IT students and (38.46%) ECE/EEE students are unaware of collaborative activities. Among Civil Engineering Students, a majority of them (44.44%) are having the knowledge of acquiring e-journals through collaborative activities. It is noted that from the Mechanical Engineering students, there are equal number of respondents (33.33%) are having the knowledge of acquiring e-journals and the same time

the other group do not have any idea about collaborative activities. Among the group of other students, a majority of them (50%) are having the knowledge of acquiring e-journals through collaborative activities.

Findings

The Finding on distribution of engineering students according to the usage of inter resources reveal the following facts:

- Majority of the respondents are using search engine for information retrieval 42.5%.
- 53.75% of the students are familiar with IEEE online database.
- It is revealed from the Survey that most of the users are using Google for Standard search engine 51.25%.
- Majority of the students (81.25%) are browsing for education purpose.
- All branches are having the knowledge of local OPAC, their percentage is 47.08.
- 50% are having the knowledge of acquiring e-journals through collaborative activities.

Suggestions and Recommendations

In order to maintain and increase the usage of internet resources among the engineering students in Madurai district, the following suggestions may be useful:

- The timings of the internet services should be increased and if possible the service should be made available round the clock so that the users can maximum utilization of the internet facility.
- More computers with the latest specifications and multimedia kit should be installed so that the users can use internet telephony , video conferencing and other useful services of the internet
- More efficient technical staff should be appointed and they should always be present in the internet section for expert advice
- Websites providing only entertainment should be locked so that students should not unnecessarily sit on computers
- Some orientation training programs should be organized by the college at regular intervals so that the maximum users can improve their excellence or proficiency in the use of the internet for academic purposes.

- Information regarding popular & latest websites with their addresses should be displayed on the notice board in the computer centre.
- Capacity of servers should be increased and firewalls should be installed for protection from the viruses.
- The problem of slow connectivity should be overcome by increasing the bandwidth.

Limitations

This study is especially applicable to the internet users of engineering college students. The present study is being analyzed only by collecting the data from the user community. This study is being conducted only in the selected engineering colleges affiliated to Anna University in and around Madurai district.

Conclusion

Today engineering colleges are playing an important role in imparting technical education. The engineers, who are the outcomes of these colleges, require the latest and pin pointed information in their respective fields. Due to the high cost of engineering information resources, developing countries cannot provide these resources to their users. But the internet with its advantages makes the way for the developing countries to access information at a very low cost. The search process of internet will provide maximum access to the various sources to provider i.e. right information to the right user at the right time in a right manner. The effective use of internet in libraries in India has become a necessity with raising standard of education and competition. In the view of the present situation, it is the responsibility of the personnel of the library and information centre to create more awareness about the use of the internet among the students and to provide friendly environment so that the students can make better use of the facility.

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STRONG PRIME FILTERS IN LATTICE IMPLICATION ALGEBRAS

R. Punitha*

Abstract

In this paper, the notion of strong prime filters of Lattice implication algebras is introduced. The relation between strong prime filters and prime filters, between strong prime filters and maximal proper filters, between strong prime filters and the finite intersection property, and between Ultra LI-ideal and strong prime filters be investigated. Finally, we conclude that strong prime filters are equivalent to maximal proper filters.

Keywords

Lattice Implication Algebra, Prime Filter, Strong Prime Filter, Finite Intersection Property.

1. Introduction

In order to research the many-valued logical system whose propositional value is given in a lattice, in 1990 Xu [1] proposed the concept of lattice implication algebra. Since then this logical algebra has been extensively investigated by several researchers. In [5] Xu and Qin introduced the notions of filters and implicative filters in lattice implication algebras, and investigated their some properties. In lattice implication algebra, filters are important sub structures, they play a significant role in studying the structure and the properties of lattice implication algebras. In [3], Jun et al. defined the notion of LI-ideals in lattice implication algebras and investigated its some properties. In [4], Jun defined the notion of prime LI-ideals in lattice implication algebras and investigated its some properties. In this paper, as an extension of above-mention work we introduce the notions of strong prime filters in lattice implication algebras, and investigated its some properties. In section 2, we list some basic information on the lattice implication algebras. In section 3, we introduce the notion of the intersection property of lattice implication algebras. We give the sufficient and necessary condition that a proper filter to have the intersection property. In section 4, we introduce the notion of strong

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prime filters of lattice implication algebras, and talk about the relations between strong prime filters and prime filters, between strong prime filters and maximal proper filters, between Strong prime filters and the finite intersection property, and between ultra-LI ideal and Strong prime filter. We prove that Strong prime filters are equivalent to maximal proper filters.

2. Preliminaries

Definition 2.1[1] Let $(L,\vee, \wedge, O, I)$ be a bounded lattice with an order-reversing involution $'$, I and O the greatest and the smallest element of L respectively, and $\rightarrow: L \times L \rightarrow L$ be a mapping. $(L,\vee, \wedge, ', \rightarrow, O, I)$ is called a lattice implication algebra if the following conditions hold for any $x, y, z \in L$:

(L_1) $x \rightarrow (y \rightarrow z) = y \rightarrow (x \rightarrow z)$,

(L_2) $x \rightarrow x = I$,

(L_3) $x \rightarrow y = y' \rightarrow x'$,

(L_4) If $x \rightarrow y = y \rightarrow x = I$, then $x = y$.

(L_5) $(x \rightarrow y) \rightarrow y = (y \rightarrow x) \rightarrow x$,

(L_6) $(x \vee y) \rightarrow z = (x \rightarrow z) \wedge (y \rightarrow z)$,

(L_7) $(x \wedge y) \rightarrow z = (x \rightarrow z) \vee (y \rightarrow z)$.

Lattice implication algebra is called lattice H implication algebra if it satisfies

$$x \vee y \vee ((x \wedge y) \rightarrow z) = I$$

In a lattice implication algebra L, [3] defines two binary operations $\otimes$ and $\oplus$ as follows:

for any $x, y \in I$,

1) $x \otimes y = (x \rightarrow y')'$ and

2.) $x \oplus y = x' \rightarrow y$.

In a lattice implication algebra L, the following hold:

(L_8) $x \rightarrow (y \rightarrow z) = (x \otimes y) \rightarrow z$,

(L_9) $(x \oplus y)' = x' \otimes y'$,

(L_{10}) $(x \otimes y)' = x' \oplus y'$,

(L_{11}) $O \otimes x = O$, $I \otimes x = x$, $x \otimes x' = O$,

(L_{12}) $O \oplus x = x$, $I \oplus x = I$, $x \oplus x' = I$,

(L_{13}) $O \rightarrow x = I$, $x \rightarrow O = x'$,

(L_{14}) $I \rightarrow x = x$, $x \rightarrow I = I$,

(L_{15}) $x \leq y$ if and only if $x \rightarrow y = I$.

Definition 2.2 [2]

Let L be lattice implication algebra. An LI-ideal is a non-empty subset of L such that for any x, y ∈ L,

(I_1) O ∈ A,

(I_2) (x → y)' ∈ A and y ∈ A imply x ∈ A.

In lattice implication algebra, A⊆L, the least LI-ideal containing A is called the LI-ideal generated by A and denoted by <A>. Specially, if A = {a}, we write <{a}> as <a> .

Definition 2.3 [5] Let L be a lattice implication algebra, J⊆L is said to be a filter of L, if it satisfies the following conditions:

(J1) I ∈ J

(J2) For any x, y ∈ L, if x ∈ J and (x → y) ∈ J, then y ∈ J.

For any non-empty subset A of a lattice implication algebra, let A′ = {x′/x∈A}.

In lattice implication algebra, A⊆L, the least filter containing A is called the filter generated by A and denoted by <A>. Specially, if A = {a}, we write <{a}> as <a> .

Theorem 2.4 [2] Let A be a non-empty subset of a lattice implication algebra L. Then A is a filter of L if and only if A′ is an LI-ideal of L.

Definition 2.5 [6] Let L be a lattice implication algebra, a filter J of L is called an ultra-filter if for any x∈L, x∈J if and only if x′ ∉ J.

Definition 2.6 [4] Let L be a lattice implication algebra, p a proper LI-ideal of L. P is called a prime LI-ideal if x ∧ y ∈ P implies x ∈ P or y ∈ P.

Definition 2.7 [2] Let L_1 and L_2 be lattice implication algebras, f: L_1→ L_2 a mapping from L_1 to L_2, if f (x → y) = f (x) → f(y) holds for any x, y ∈ L_1, then f is called an implication homomorphism from L_1 to L_2. If f is an implication homomorphism and satisfies

$f(x \vee y) = f(x) \vee f(y)$,

$f(x \wedge y) = f(x) \wedge f(y)$,

$f(x') = (f(x))'$,

then f is called a lattice implication homomorphism from L_1 to L_2 .

3. The Intersection Property of Lattice Implication Algebras:

Definition 3.1 Let L be lattice implication algebra. $A \subseteq L$ is said to have the finite intersection property if for any $a_1, a_2, \ldots, a_n \in A$, $a_1 \otimes a_2 \otimes \ldots\ldots\ldots\ldots \otimes a_n \geq 0$.

Lemma 3.2 [8] If A is a non-empty subset of a lattice implication algebra L, then $\langle A \rangle = \{x \in L / [a_1, a_2, \ldots\ldots\ldots, a_n, x] = 1$ for some $a_1, a_2, \ldots\ldots a_n \in A\}$.

Theorem 3.3 Let L be a lattice implication algebra, $\phi \neq A \subset L$. Then

$\langle A \rangle = \{x / x \in L$, there exist $a_1, a_2, \ldots\ldots\ldots, a_n \in A$ such that, $a_1 \otimes a_2 \otimes \ldots \otimes a_n \leq x\}$.

Proof: $y \langle A \rangle = [a_1, a_2, \ldots\ldots\ldots, a_n, x] = 1$

$\Leftrightarrow a_1 \rightarrow (\ldots\ldots \rightarrow (a_n \rightarrow x) \ldots\ldots) = 1$

$\Leftrightarrow (a_1 \oplus \ldots\ldots\ldots\ldots \oplus a_n) \rightarrow x = 1$

$\Leftrightarrow x' \rightarrow (a_1 \oplus \ldots\ldots\ldots \oplus a_n)' = 1$

$\Leftrightarrow x' \leq (a_1 \oplus \ldots\ldots\ldots\ldots \oplus a_n)'$

$\Leftrightarrow a_1 \otimes \ldots\ldots\ldots \otimes a_n) \rightarrow x = 1$

$\Leftrightarrow x' \rightarrow (a_1 \otimes \ldots\ldots\ldots \otimes a_n)' = 1$

$\Leftrightarrow a_1 \otimes \ldots\ldots\ldots \otimes a_n \leq x$ and by lemma 3.2, we complete the proof.

Theorem3.4 Let L be lattice implication algebra. $A \subseteq L$, then $\langle A \rangle$ is a proper filter if and only if A has finite intersection property.

Proof: Suppose $\langle A \rangle$ is a proper filter and it doesn't have the finite intersection property. So there exist $a, a_2, \ldots\ldots\ldots, a_n \in A$ such that $a_1 \otimes a_2 \otimes \ldots\ldots\ldots\ldots \otimes a_n \leq 0$.

By Theorem 3.3, $0 \in \langle A \rangle$, contradiction.

Conversely, suppose that A has the finite intersection property, then for any $a_1,a_2,\ldots\ldots,a_n \in A$, $a_1 \otimes a_2 \otimes \ldots\ldots\ldots\ldots \otimes a_n \geq 0$, So $0 \notin A$ and $<A>$ is a proper filter.

Theorem 3.5 Let L be a lattice implication algebra, a', b', x' ∈ L.

(1) If $a' \leq b'$. Then $[a, x]^n \leq [b, x]^n$ for any $n \in N$,

(2) If $n, m \in N$, $n \leq m$, then $[a, x]^n \leq [a, x]^m$

(3) $[a, x]^n \leq x$ for any $n \in N$.

Proof: These conclusions are trivial when n=0 or m=0.

(1) We use induction over n to show

$[a, x]^n \leq [b, x]^n$. If n=1, then

$[a, x] = a \rightarrow x = x' \rightarrow a' \leq x' \rightarrow b' = b \rightarrow x = [b, x]$

Suppose now n>1, and $[a, x]^m \leq [b, x]^m$ for any m<n, then when n=m+1,

$[a, x]^{m+1} = a \rightarrow [a, x]^m \leq a \rightarrow [b,x]^m \leq b \rightarrow [b,x]^m = [b,x]^{m+1}$.

Since n = m+1

$[a, x]^n \leq [b, x]^n$.

(2) Suppose that n=m+p, it follows that p≥0. We use induction over p to show

$[a, x]^{m+p} \leq [a, x]^m$. If p=0, then $[a, x]^{m+p} \leq [a, x]^m$ holds.

Suppose now p=1, then

$[a, x]^{m+1} = a \rightarrow [a, x]^m \leq 1 \rightarrow [a, x]^m = [a, x]^m$

Suppose now p>1, and $[a,x]^{m+q} \leq [a,x]^m$ for any q>p. It follows that

$[a,x]^{m+p} = a \rightarrow [a,x]^{m+(p-1)} \leq [a,x]^m$.

(3) When n=1, then

$[a,x] = a \rightarrow x \leq 1 \rightarrow x = x$.

Suppose that n=m, and $[a,x]^m \leq x$ holds for any m∈ N. It follows that

$[a,x]^{m+1} = a \rightarrow [a,x]^m \leq 1 \rightarrow [a,x]^m \leq 1 \rightarrow x = x$ and the proof is complete.

4. Strong prime filters of Lattice implication algebras.

Definition 4.1 Let L be lattice implication algebra. A proper filter A is said to be a strong prime filter if

$(x^1 \longrightarrow v) \in A$

$(x \oplus y)$ $x \in A$ and $y \in A$ for any $x,y \in L$.

Example : The proper filter {a,c,1 } is the Strong prime filter of the Lattice implication Algebra L = {0,a,b,c,d,1}.

Theorem 4.2 A strong prime filter is a prime filter.

Proof: Let A be a strong prime filter. We need to prove that if $x \vee y \in A$ implies $x \in A$ and $y \in A$. In fact, by $x \oplus y \geq x \vee y \geq x \wedge y \geq x \otimes y$. We get $x \oplus y \in A$, because A is a strong prime filter, so $x \in A$ and $y \in A$.

Theorem: 4.3 Let L be lattice implication algebra, $A \subseteq L$. The following statements are equivalent:

(1) A is a strong prime filter

(2) A is a maximal proper filter.

Proof:

(1)$\Longrightarrow$(2) Suppose that A is a strong prime filter, So A is a proper filter, f $A \subset$ B and B is also a proper filte, We need to prove A=B. In fact, if there exist $x \in B$ such that $x \notin A$, then by $x \oplus x' = 1 \in A$, So $x' \in A \subset B$, (ie) $(1 \rightarrow x)$ B, it follows that $0 \in B$, and B=L, which is a contradiction.

(2)$\Longrightarrow$(1) Suppose A is a maximal proper filter. We need to prove that $x \oplus y \in A$ implies $x \in A$ and $y \in A$ for any $x,y \in L$. Otherwise, if $x \oplus y \in A$, but $x \notin A$ and $y \notin A$. Let $B = A \cap \{x\}$, $D = \langle B \rangle$, we shall prove that B has the intersection property, In fact, for any $y_1', y_2', \ldots\ldots y_n' \in B$.

(a) If $y_1', y_2' \ldots\ldots y_n' \in A$,

then $y_1' \otimes y_2' \otimes \ldots\ldots \otimes y_n' \in A$ by filters are closed with operation $\otimes$,

It follows that $y_1' \otimes y_2' \otimes \ldots\ldots \otimes y_n' > 0$ because A is a proper filter.

(b) If there exist i<n such that y_i '= x', Without losing generality, Suppose $y_1' = x'$.

If $y_1' \otimes y_2' \otimes \ldots\ldots\ldots\ldots \otimes y_n' = x' \otimes \ldots\ldots\ldots\ldots \otimes y_n'$

$= x' \rightarrow (y_2' \otimes \ldots\ldots\ldots\ldots \otimes y_n')$

$= 0$

then $x \geq y_2' \otimes \ldots\ldots\ldots\ldots \otimes y_n'$,So $x \in A$. By supposition, $x \oplus x' = 1 \in A$ implies $x \notin A$ and $x' \notin A$, a contradiction. By (a) and (b), We have proved that B has the finite intersection property, So <B> is a proper filter. it follows by $A \subset <B>$ that A= <B>, (ie) A= <A∩{x}>. (ie) $x \in A$, a contradiction.

Theorem: 4.4 Let L be a lattice implication algebra, $A \subseteq L$. If A has the finite intersection property, then there exist a strong prime filter B such that $A \supseteq B$.

Proof: Let E= {B, A ⊃B, B is a prime filter of L}.

It follows that $E \neq \phi$ because $<A> \in E$. Suppose that $B_i \in E$ for any i< k such that $B_1 \supseteq B_2 \supseteq \ldots.. \supseteq B_i \supseteq \ldots.$ Let $B = \cap_{i<k} B_i$, it follows that (1) $A \supset B$ (2) $0 \notin B$ because $0 \notin B_i$ for any i<k (3) $1 \in B$ (4) If y, $(x \rightarrow y) \quad B$, then there exists i<k such that y, $(x \rightarrow y) \in B_i$ it follows that $x \in B_i \subseteq B$. So, B is a proper filter and $B \in E$.

It follows by Zorn's lemma that E has a minimal element B. Thus B is a strong prime filter that $A \supseteq B$.

Corollary: 4.5 Any proper filter of L can be extended to a strong prime filter.

Theorem: 4.6 If A is a prime filter of lattice H implication algebra L, then A is a strong prime filter.

Proof. Suppose that A is not a strong prime filter of L. Then there exist a proper filter F of L such that $A \subset F$ and $A \neq F$. It follows that there exists an element $a \in F$ such that $a \notin A$

We get $a \vee a' = 1 \in A$, It follows that $a' \in A \subset F$, This implies that $a \wedge a' = 0 \in F$, Which contradicts the fact that F is a proper filter.

Corollary 4.7 In a lattice H implication algebra, the concept of prime filter and strong prime filter coincide.

Theorem: 4.8 Let L_1 and L_2 be lattice implication algebras, f: $L_1 \rightarrow L_2$ is a lattice implication homomorphism from L_1 to L_2. If A is a strong prime filter of L_2. Then $f^{-1}(A)$ is a strong prime filter of L_1.

Proof: For any $x,y \in L_1$, if $(x' \rightarrow y) \in f^{-1}(A)$ then $f(x' \rightarrow y) \in A$, By definition 2.7, we have $(f(x' \rightarrow y)) \in A$, (ie) $f(x') \rightarrow f(y) \in A$, and then $((f(x))' \rightarrow (f(y)) \in A$, for A is a strong prime filter of L_2, then $f(x) \in A$ and $f(y) \in A$, So $x \in f^{-1}(A)$ and $y \in f^{-1}(A)$. By definition 4.1, $f^{-1}(A)$ is a strong prime filter of L_1.

Lemma: 4.9 Let L be a lattice implication algebra, A a proper LI- ideal of L. A is an ultra LI-ideal if and only if $x \otimes y \in A$ implies $x \in A$ or $y \in A$ for any $x,y \in L$.

Proof: A is an Ultra LI-ideal and if $x \otimes y \in A$ then $x' \oplus y' = x \rightarrow y' = (x \otimes y)' \notin A$ and hence $x' \notin A$ and $b' \notin A$. Then $x \in A$ and $y \in A$.

Conversely we suppose that $x \otimes y \in A$ implies $x \in A$ and $y \in A$ for any $x, y \in L$.

Theorem: 4.10 Let L be a lattice implication algebra, A is a non-empty subset of L, let A= {x/ x A}, then A′ is an ultra LI- ideal if and only if A is a strong prime filter of L.

Proof. Suppose that A′ is an ultra LI- ideal. For any $x,y \in L$, if $x \oplus y \in A$,(ie) $(x \oplus y)' \in A'$ then $x' \otimes y' \in A'$. By lemma 4.9 We set $x' \in A'$ and $y' \in A'$ and hence $x \in A$ and $y \in A$. So by definition 4.1, A is a strong prime filter.

Conversely, Suppose that A is a strong prime filter, for any x', $y' \in L$, if $x' \otimes y' \in A'$ then $(x \oplus y) \in A'$, (ie) $x \oplus y \in A$, So $x \in A$ and $y \in A$. Hence $x' \in A'$ and $y' \in A'$,and A′ is an ultra LI-ideal.

5. Conclusion

In this paper, we proposed the notion of strong prime filters in lattice implication algebras, discussed the relations between strong prime filters and prime filters, between strong prime filters and maximal proper filters, and between ultra-L- ideal and Strong prime filter . We finally concluded

that Strong prime filters are equivalent to maximal proper filters. Actually, strong prime filters is the dual of ultra-LI-ideal. It hopes above work would serve as a foundation for further study the structure of lattice implications algebras and develop corresponding many-valued logical system.

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ANTIFUNGAL ACTIVITY OF *EUPHORBIA HIRTA* L. - A POSSIBLE MODE OF ACTION STUDY.

Gayathri A., Anitha E.M. and Vijaya Ramesh K*

Abstract:

Euphorbia hirta L., *a common garden weed belonging to the family* Euphorbiaceae *a herb having a multitude of medicinal properties. Scientific proof for antifungal activities of medicinal plants usually stagnates with the studies of the respective plant parts against many fungi. Very few reports go further into it and verify the mode of action of these antifungal agents. In our study, we have proved that the ethyl acetate extract of the inflorescence of* E. hirta L. *exhibits possible antifungal activity targeting the cell membrane which could result in leakage of cellular protein, we have chosen the minimum inhibitory concentration of the extract for this study.*

Keywords:

Euphorbia hirta L.*, inflorescence, antifungal, cell membrane, protein- leakage.*

Introduction

Euphorbia hirta L. is a pantropic herb found growing as a weed in tropical gardens. Commonly known as garden spurge (English) and Ammaan patcharisi (tamil), it has several clinical applications to its credit. It is proven as an antibacterial (Vijaya *et al*., 1995; Vijaya and Ananthan., 1997) and antifungal agent with a number of published reports asserting this fact. Nonetheless, the mode of action study of the inflorescence of *E. hirta* L. against mould growth is lacking which is the reason this study is being published.

E.hirta L. has been proven to have wide pharmacological activities like antifungal, antibacterial, larvicidal and so on (Lanhers *et al*., 1990; 1991). Suresh *et al*., (2008) has studied the antifungal potential of *E. hirta* L. ethanolic extract of leaves against *A. flavus*. Khan *et al*.,

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(2011) reported the antifungal activity of *E. hirta* L. (methanolic extract) on *A. flavus*. Ethanolic extract of *E.hirta* L. showed an antifungal activity against *A. niger* using paper disc diffusion method (Mohamed *et al*., 1996). Bhaskara Rao *et al*., (2010) have reported antifungal of *E.hirta* L. where they worked on the leaves. Yazdani *et al*., (2012) have screened plants from Malaysia against *A. flavus* where they used the shoots of *E. hirta* L. Lagnika *et al*., (2012) have studied the antifungal activity of some plant extracts on *A. flavus* sporulation. Poor antifungal activity has been reported by Pieme *et al*., (2008) for the methanol extract of *E. hirta* L.

Bakkiaraj and Pandiyaraj (2011) have evaluated the antimicrobial activity of *E. hirta* L. leaf on *C. albicans* using disc diffusion method. Basma *et al*., (2011) have reported TEM study on effect of *E. hirta* L. leaf extract on *C. albicans* cells. Jackson *et al*., (2009) evaluated the antimicrobial activity of methanol extract of leaves of *E. hirta* L. against *C. albicans* using the checker board method. Jyothirmayi and Prasad (2012) have reported the efficacy of methanol and chloroform extract of *E. hirta* L. against *C. albicans* using disc diffusion method. Momoh *et al*., (2011) have reported antifungal effect of *E. hirta* L. root, leaves, stem using alcohol, water and water mixed with 10% sodium chloride on *C. albicans* using agar plate method. Oluwayemi *et al*., (2012) have studied antifungal activity of *E. hirta* L. leaves using ethanol and n-hexane extracts by agar diffusion technique. Perumal *et al*., (2012) have reported their findings on determination of MIC of *E. hirta* L. against *Candida albicans* using the microdilution method.

They have used a combination of extracts from aerial parts of the plant using various solvents in order of increasing polarity. Rajeh *et al*., (2010) assessed the potential antimicrobial activity of *E. hirta* L. leaves, flower, stem and root extract using agar disc diffusion method.

Materials and Methods

Euphorbia hirta L. whole plant was collected from gardens in and around Chennai, Tamil Nadu, shade dried and the inflorescence part of the plant was separated and powdered before put to further use. A voucher specimen of the plant is deposited in the herbarium (Presidency College, Voucher No. 8413).

Preparation of extract

The powdered portion of the inflorescence (10g) was subjected to hexane treatment (to remove fats) followed by ethyl acetate (100 ml) for a day after which the solvent was evaporated and the residue weighed and solubilized in 50% of Di Methyl Sulfoxide (DMSO).

Preparation of inoculum

Aspergillus flavus strains were isolated from groundnuts and air and maintained in Potato Dextrose Agar (PDA). A spore load of 8.8 and 7.9 x 10^5 from food and air borne strains respectively was used as inoculum for further study. Briefly, 10 ml of sterile distilled water was poured in a plate covered with the strains. After one swirl, the broth was transferred to a sterile test tube. Tween 80 (0.01ml) was added to obtain uniform distribution of the spores. The suspension (0.1 ml) was loaded into Haemocytometer for performing spore count.

Candida albicans strain (NCIM 670) was procured from CMC Vellore, Tamil Nadu. Overnight culture in PDB was matched with the McFarland Standard No.1, (approximately106 cfu/ml) and put to further use.

Microbroth Dilution Assay

Microtitre plate (96 well) was used for this assay. The ethyl acetate extract dissolved in 50% DMSO having a concentration of 1.82mg/ml was used as a neat concentration. Ethanol extract residue of 1.07mg/ml was used as the neat concentration. Method of Perumal *et al*., (2012) was used to quantify the Minimum Inhibitory Concentration (MIC) of the extracts. Fluconazole and Amphotericin B were included as drug controls (10µg/ml). First three wells had the test sample in triplicate subsequently diluted from well B to well H, followed by Drug 1 (three wells) and Drug 2 (three wells). DMSO 50% (last three wells) was included as solvent control along with positive media control of PDB. Experiments were done separately for each of the fungal strains.

Protein Leakage Study

A spore load of 6.33 x 10^5 for air borne strain and 5.99 x 105 for the food borne strain was used for the assay. Spore suspension (50 ml) was mixed with equal volume of the MIC dilution of the plant extract and protein leakage estimated using the method of Lowry *et al*., (1953), at regular time intervals of 25 min (air borne strain) and 20 min (food borne strain) at 660 nm. Similar study was done for *Candida albicans* with an initial dose of 10^6 cfu/ml mixed with the plant extracts at their respected MICs.

Results

Microbroth Dilution Assay

The micro broth dilution assay revealed the MIC of the ethyl acetate extract as 606µg and ethanol extract as 535 µg for both mold and yeast strain. Drug 1 (Fluconazole) exhibited MIC of

3.33µg whereas Drug 2 (Amphotericin B) showed inhibition at 1.66µg (Plate 1). For the mold strains, the cultures from well C-H exhibited morphological variations as observed under the phase contrast microscope. Only vegetative growth was observed in the wells at C. The slide mount of plant extract treated wells showed hyphal growth with many chlamydospores. The presence of chlamydospores dwindled after wells F-H, only vegetative growth was seen. No reproductive bodies were observed even in DMSO control well which indicates that DMSO cannot be fully relied as inert solvent in such biological assays (Plates 2a – 2e). This indicates that the plant extract may play some, if not an insignificant role in affecting the hyphal morphology. There were no morphological changes observed in the cells of *Candida albicans* when mixed with the extracts.

Protein Leakage Study

The Lowry *et al.,* method of protein estimation of the (ethyl acetate, ethanol and drug controls) treated food borne and air borne *A. flavus* culture at regular time intervals of 25 min revealed some changes in the leakage pattern. For the ethyl acetate extract, maximum leakage was observed after 80 min of incubation with plant extract. Both the drug controls showed very less leakage of protein when compared with the test (ethyl acetate extract) but when compared with the control at 80 min incubation, drug 1 and 2 had some significant increase in OD values even if it was at the negative range (Fig.1). From the results of airborne fungal strain of *A. flavus* (Fig.2), significant amount of protein leakage is evident after 2 h 15 min of incubation with the plant extract (ethyl acetate).

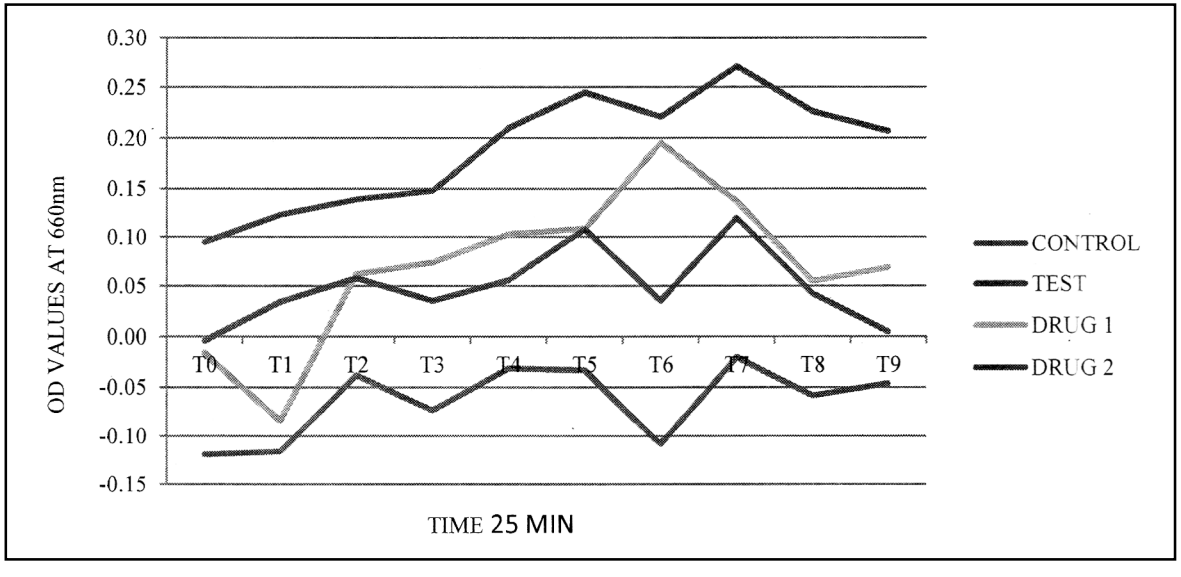


Fig.1 Protein leakage test for air borne *Aspergillus flavus* by ethyl acetate extract

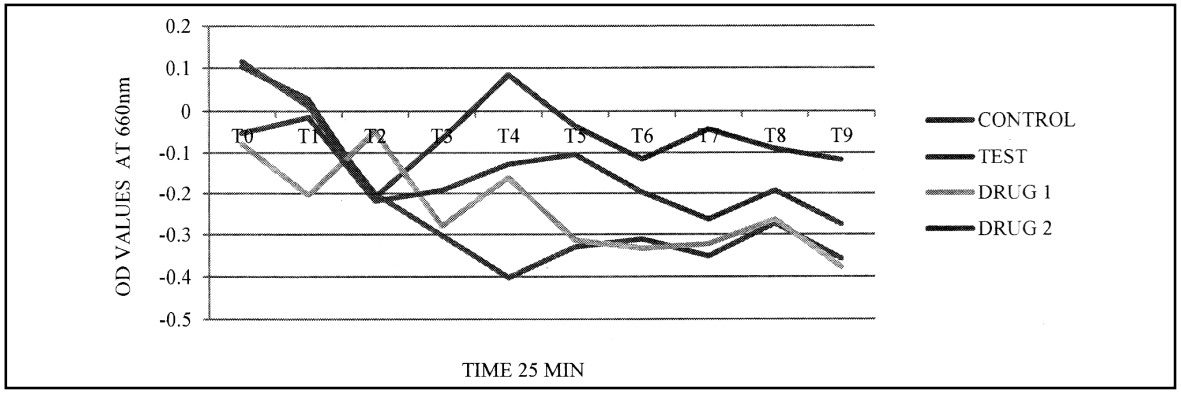


Fig.2 Protein leakage test for food borne *Aspergillus flavus* by ethyl acetate extract

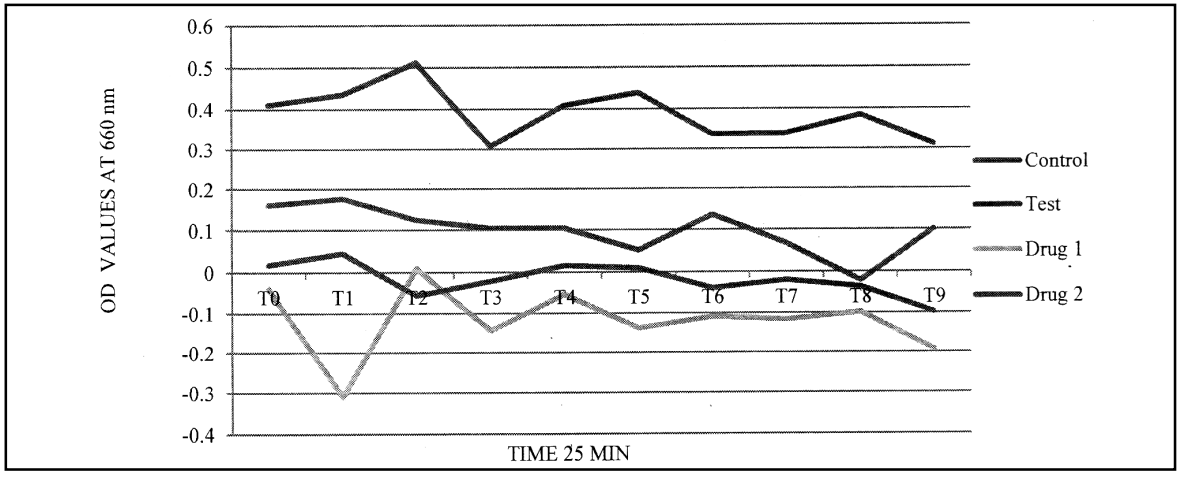


Fig.3 Protein leakage test for air borne *Aspergillus flavus* by ethanol extract

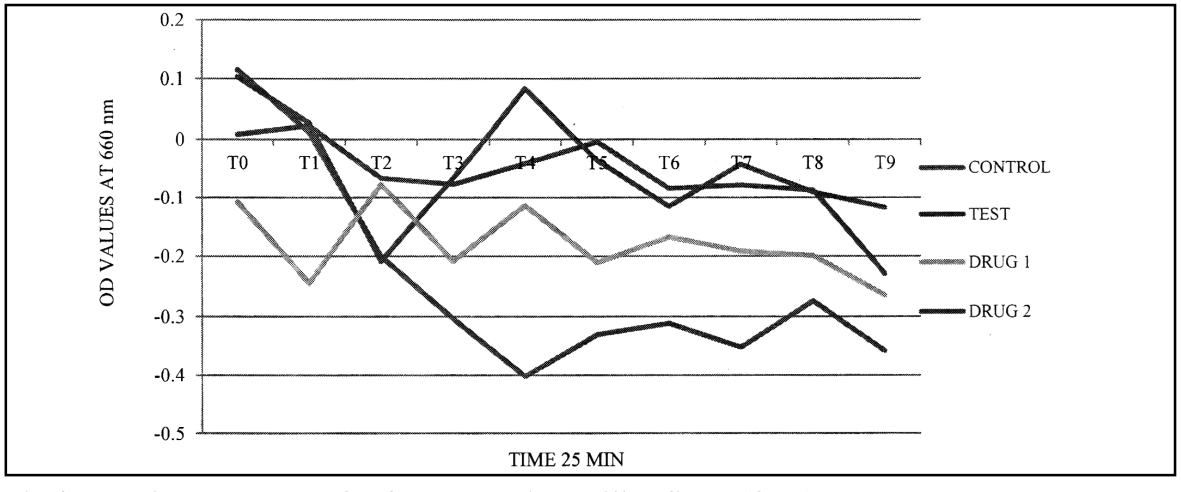


Fig.4 Protein leakage test for food born *Aspergillus flavus* (food) by ethanol extract

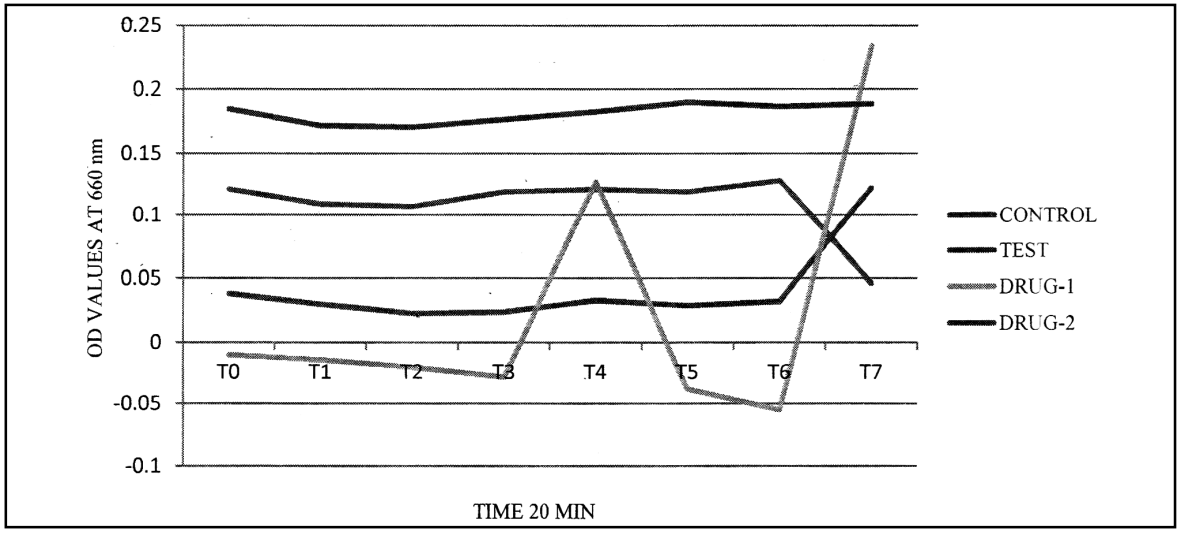


Fig. 5 Protein leakage test for *Candida albicans* by ethyl acetate extract

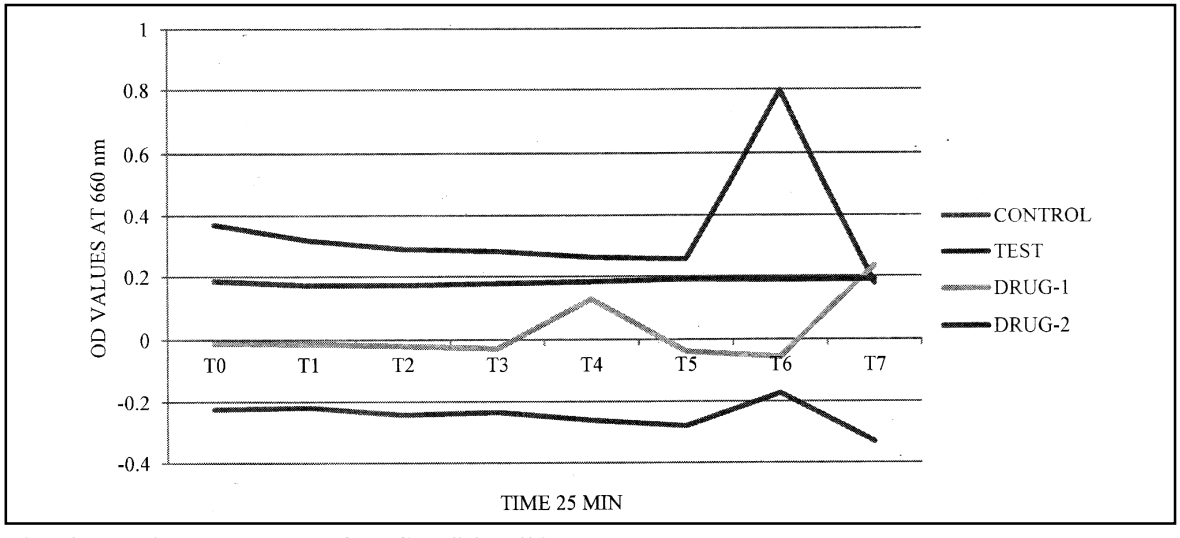


Fig. 6 Protein leakage test for *Candida albicans* by ethanol extract

Drug 1 showed its maximum release after 1 h 50 min that was considerably lesser than that of extract treated culture. Maximum leakage by Drug 2 was evident after 2 h 15 min of incubation with the OD value at a lower value than the test and Drug 1. The ethanol extract of the plant exhibited higher protein leakage after 50 min of incubation with the air borne *Aspergillus flavus* (Fig.3) as evident by the OD values taken at 660 nm. Food borne strain revealed uneven leakage patterns (Fig.4). Protein leakage pattern study on *Candida albicans* using the ethanol extract (Fig.5) showed gradual decrease in the OD values from T0 and exhibited uneven leakage patterns with ethyl acetate extract (Fig.6).

Discussion

The results of present study indicate that the ethanol extract of *E. hirta* L. exhibits a better antifungal activity when compared to the ethyl acetate extract. Even though the MIC of drug controls is significantly low, it is possible that the drugs used are in their purest form and the plant extract is in impure form which is why the MIC of the two extracts is higher than the drug controls. Nonetheless, our MIC values of extracts against *Aspergillus* species are much lower than the previous reported results that were in milligram levels, (Dhole *et al*., 2011; Bhaskara Rao *et al*., 2010; Sharma *et al*., 2010; Geeta Singh and Padma Kumar, 2011; Momoh *et al*., 2011). Though the effect of the extract and the drug controls did not reveal much by way of morphological changes, one cannot deny that DMSO (50%) has some, if not a profound effect on the morphology of the fungal strains. Therefore, its use for biological assays has to be reconsidered.

Perumal *et al*., (2012) had used 50 % DMSO for preparing the extract for antifungal testing. According to their study, ethanol and methanol extract of *E. hirta* L. aerial part revealed MIC of 250µg and 500µg/ml respectively against *Candida albicans*. Methanol extract of flowers revealed MIC of 1000 µg/ml. We have reported a lower MIC of 606 µg and 167µg for ethyl acetate and ethanol extracts of *E. hirta* L. inflorescence which is quite lower than that reported by Perumal *et al*., (2012).

Our results negate the study results of Bakkiaraj and Pandiyaraj (2011) who have reported poor antifungal activity of *E hirta* L. with methanolic extract of aerial parts of the plant. Basma *et al*., (2011) have reported the MIC value of 3.125 mg for methanolic extract which is very high when compared to the work of Perumal *et al.,* (2012). Our results are comparatively significant with lower MIC values. According to Oluwayeni *et al*., (2012) dried and fresh leaves of *E. hirta* L. ethanolic extracts have given definite antifungal activity against *Candida albicans* with dried portions revealing better results. The MIC values as reported by them is 25 mg - 50 mg/ml for the ethanolic extract. We are reporting much lower values for dried plant part extract of ethanol.

Results of studies of Jackson *et al*., (2012) on leaves of *E. hirta* L. (methanolic extract) indicated MIC values of 1.25 mg/ml which is higher than our results of ethanol/ethyl acetate *i.e*., 167µg and 606 µg respectively. Rajah *et al*., (2010) reported negative activity of methanolic extract of flowers of *E. hirta* L. against *Candida albicans* which is quite contradictory to many of the reported results including ours. They reported MIC of 3.13 mg against *Candida albicans* which is quite high when compared to our results.

Results of the protein leakage study does indicate some changes in the membrane integrity

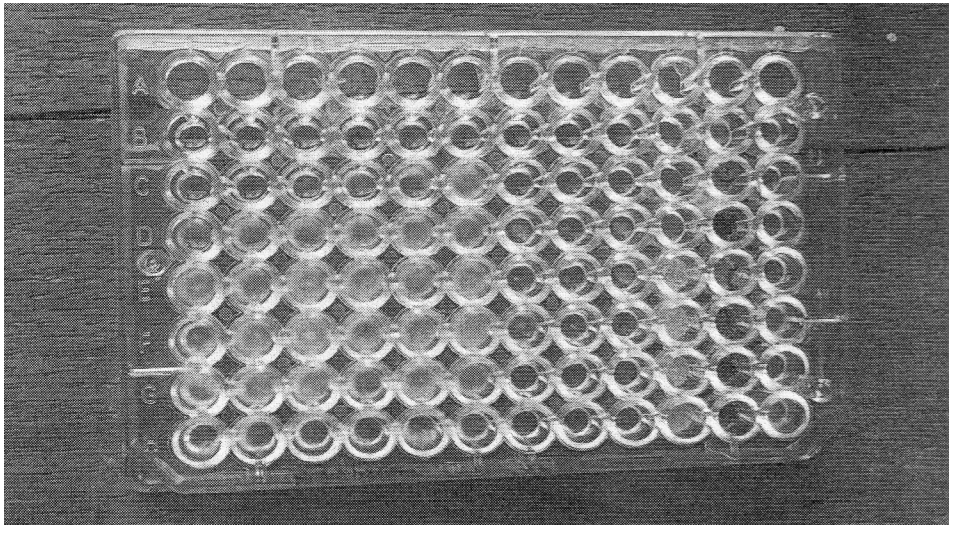


Plate 1a Microtiter plate showing the MIC results of ethyl acetate extract on *Aspergillus flavus*

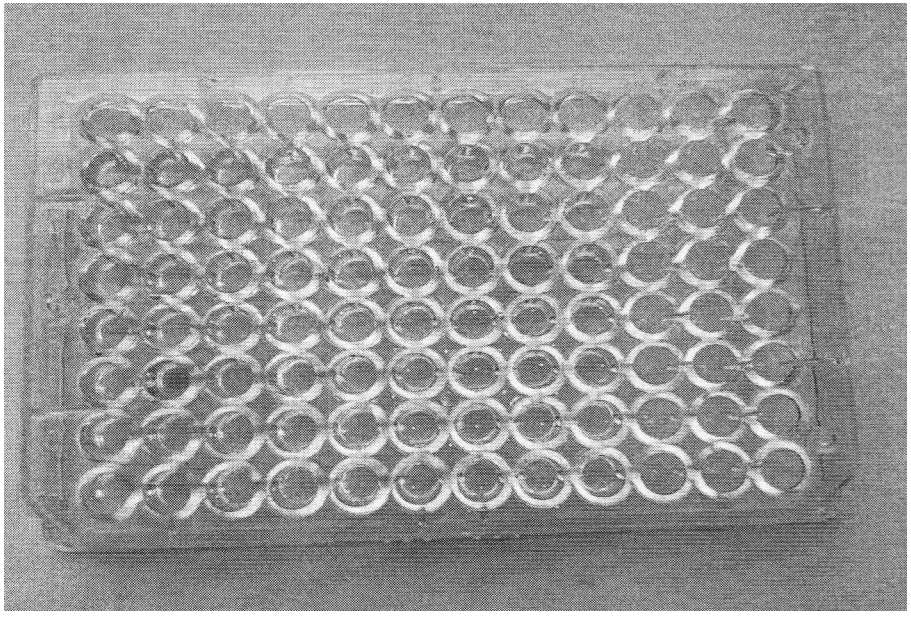
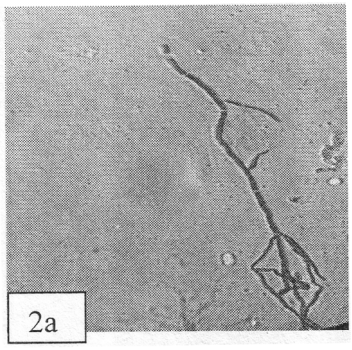
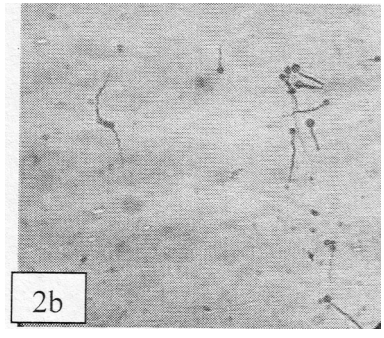


Plate 1b Microtiter plate showing the MIC results of extract on *Candida albicans*

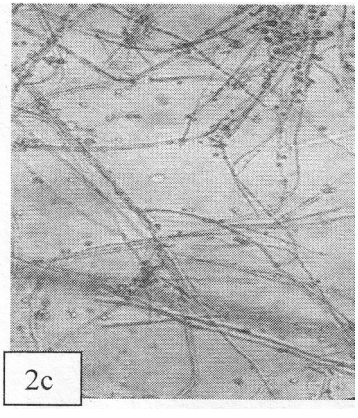
that could have led to the higher OD values for the test (plant extract treated fungal strain). The ethanol extract exhibited a higher leakage of protein than the ethyl acetate extract for both the air and food borne strains in general. Protein leakage from *A. flavus* isolated from air revealed a constant increase in the OD values from T0 to T7 where the value is at its highest for the test *i.e.,* ethyl acetate extract. Maximum levels of leakage was evident from the air borne strains with the

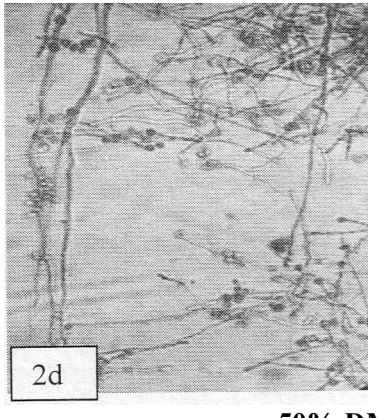
Control hyphal morphology **Plant extract treated hyphal morphology from well B**

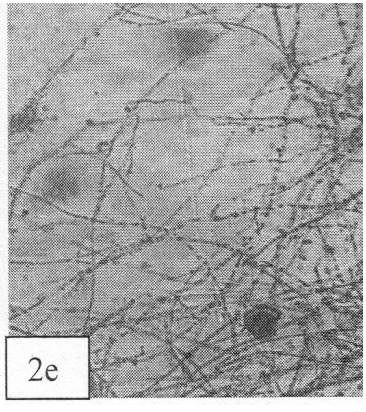




Fungal hyphal morphology of Drug 1 (2c) and Drug 2 (d) treated wells B and C respectively below MIC







50% DMSO treated hyphal morphology

Plate 2 Hyphal morphology at the MIC dosage – from well B (as observed in phase contrast microscope)

ethanol extract where the OD values reach more than double to that of the controls *i.e*., at time T2. Values for drug 1 and drug 2 show marginal increase and values for both are low when compared to extracts. This leads to the assumption that the extracts result in a higher leakage than the drug controls. Interestingly, the strain from food revealed lesser level of leakage when compared to that strain isolated from air for both the extracts. This could be due to cellular adaptations to the changing environment in the food based niche that may have led to a much integrated cellular membrane structure than that observed in the strain isolated form air.

There are quite a few electron microscopic studies to prove loss of cell membrane integrity as a possible mode of action for the observed antifungal activity against *Candida albicans* using *E.*

hirta L. (Rajeh *et al*., 2011; Kim *et al*., 2010). A simple estimation of protein release to relate the cause of activity against *Candida albicans* has been done in this study. Of the other parts of the plant, only flowers were used for the study since our previous reports (Vijaya *et al*., 1995;1997 and report of Rajeh *et al*., (2011) have revealed the least toxic nature of the flower extract against Vero cell line as well as Brine Shrimp Assay respectively.

Summary and Conclusion

The present work corroborates antifungal effect of *E. hirta* L. using ethanol and ethyl acetate extracts of the inflorescence part of the plant. After a thorough examination of the earlier results, we can conclude that inflorescence of *E. hirta* L. has a higher antifungal potential against the fungi used for our study than other parts of the plant and ethanol seems to be a better solvent than all other solvents used for extraction. One of the modes of antifungal activity has been ascertained as loss of cell membrane integrity by protein leakage study. This has been previously confirmed by TEM studies (Kim *et al*., 2010). This study can definitely be replicated with clinical isolates which are bound to give better results since they are more susceptible to antifungal agents than environmental isolates since it is possible that environmental strains have much higher adaptation strategies that make them survive better under harsh conditions.

Acknowledgements

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