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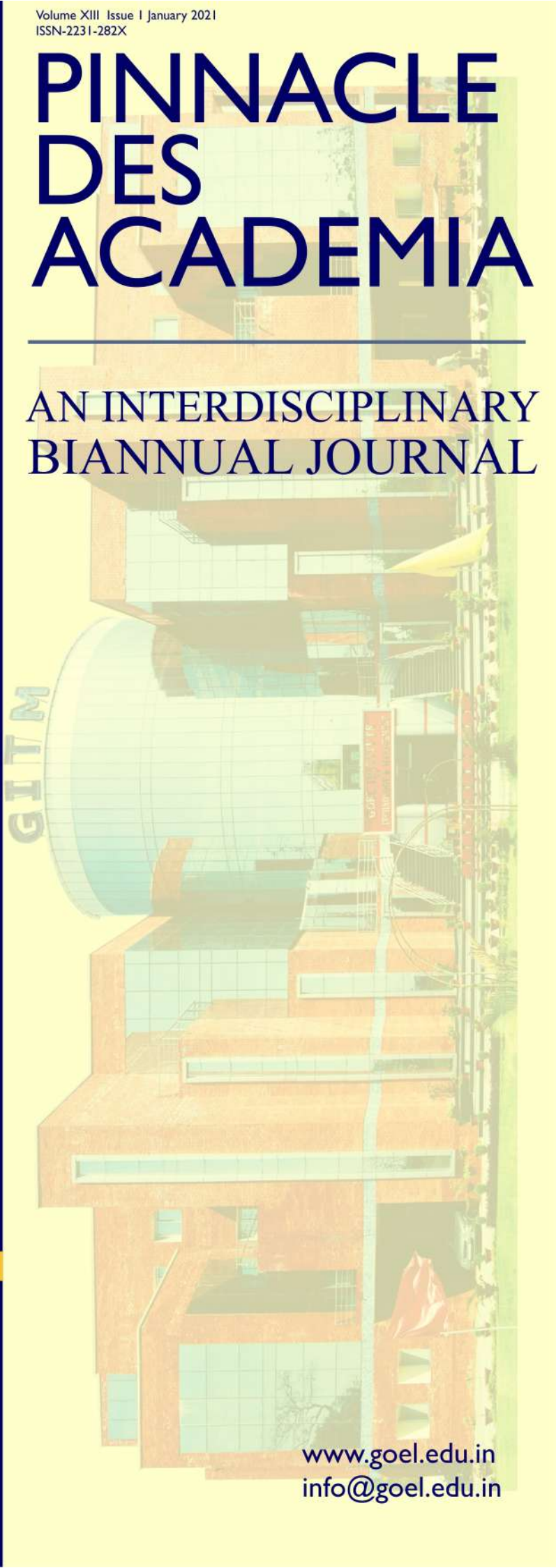
Editorial
Dr. Jyoti Agarwal, HoD, Department of M. B. A.



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ARTICLES

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Dr. Jyoti Agarwal
Ph. D, M. B. A, M. Com., B.Ed.
Head of Department
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Batches have passed out with excellent academic records and most of the students are working in various well known pharma industries in Quality control, Production and pharma marketing.

Students of the institute have formed a technical forum "Pharma Pharazers". The aim of the forum is to develop a sense of devotion towards their profession by organizing various blood donation camps, Hospital training, Industrial Visit, Industrial Training and rural visits for awareness of health etc.

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AKTU Code: 392
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B.B.A. | B.C.A. | B.Com. | B.Com. (H) | B.F.A. | B.V.A.

"Some Tagline.....".

Goel Institute of Pharmaceutical Sciences, Lucknow

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Goel Institute of Pharmaceutical Sciences was established by the Roop Chand Ramji Lai Education Trust. It is located near the heart of the city and far from hustle and bustle free environment. It has started its first academic session from year 2019 with four year Bachelors program in Pharmacy (B. Pharm) and two years Diploma program in Pharmacy (D. Pharm). Institute is affiliated to the Dr. A.P.J. Abdul Kalam Technical University (AKTU), Lucknow & approved by the AICTE, Pharmacy Council of India (PCI), New Delhi and Board of technical education (BTE), UP. The aim of the forum is to develop a sense of devotion towards their profession by organizing various blood donation camps, rural visits for awareness of health etc.

We are committed to the betterment of the students. We organize regular workshops, seminars, field work and industrial visits. The students are given
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AKTU Code: 960
BTE Code: 2119

B.Pharm. | D.Pharm.

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Affiliated to Central Board of Secondary Education, New Delhi

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Cyber Security Issues in Smart Grid System

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Abstract

The conventional electrical power grid with the use of modern technology is now evolving in to smart grid. Information and communication infrastructure with traditional approach of electrical power grid builds the smart grid. This type of integration enhances the electricity providers and commercial, industrial, residential end users, that guarantee the availability of the power grid system at real time situations efficiently. It is actually an internet of watts i.e. a huge autonomous network connected with many hardware devices and entities; controlled by complex software application. Due to the high degree of automation on the network may causes various cyber security concerns and vulnerabilities .Taking the above concern, this paper presents a survey on the latest smart grid security issues that highlighted the complexity, vulnerabilities of this huge heterogeneous smart grid network. This paper focuses on the latest security challenges that are facing due to the current technological advancement .The best optimal practices to secure the smart grid network and also discuss the changing attacking mechanism for which the current security solutions are not enough to secure it completely.

Keywords: Smart grid security, information and communications technologies, advanced metering infrastructure

1. Introduction

Smart grids provide electricity demand from the centralized and distributed generation stations to the customers through transmission and distribution systems. The grid is operated, controlled and monitored using information and communications technologies (ICT). These technologies enable energy companies to seamlessly control the power demand and allow for an efficient and reliable power delivery at reduced cost. Via digital two-way communications between consumers and electric power companies, the smart grid system provides the most efficient electric network operations based on the received consumer's information. Security remains to be one of the most important issues in smart grid systems given the danger and inconvenience residents and companies alike might encounter if the grid falls under attack.

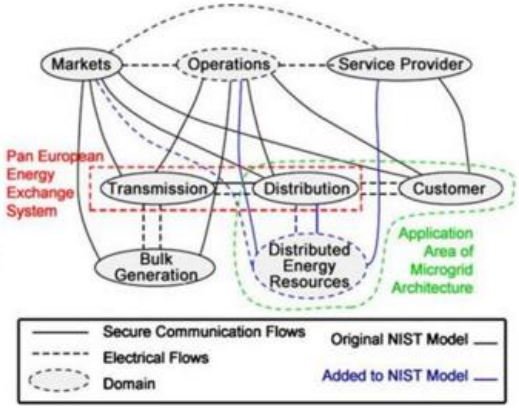
Three main security objectives must be incorporated in the smart grid system: 1) availability of uninterrupted power supply according to user requirements, 2) integrity of communicated information, and 3) confidentiality of user's data.

The remainder of this paper is organized as follows. Section 2 gives a brief background about smart grids. Section 3 addresses the grid's main vulnerabilities. Section 4 talks about the various attackers and the types of attacks they can conduct. Section 5 points out the major challenges in proposing smart grid security solutions. Section 6 details the current and needed security solutions, and Section 7 summarizes the paper contributions.

2. Background

The National Institute of Standards and Technology (NIST) proposed a Smart Grid architecture composed of seven domains as shown in Fig. 1. The grid can be viewed as having two main components, system and network.

Fig. 1. Domains of a smart grid [NIST].



2.1 System Component

The major system components in smart grid are Electrical Household Appliances, Renewable Energy resources, Smart Meter, Electric Utility Operation Center and Service Providers. *Electrical Household Appliances (*smart and legacy) are assumed to be able to communicate with smart meters via a Home Area Network (HAN) facilitating efficient power consumption management to all home devices. *Renewable Energy Resources* are solar and wind energy that supply home appliances with local generate electricity. *Smart Meter* is a stand-alone embedded system. Each smart meter contains a microcontroller that has non-volatile and volatile memory, analog/digital ports, timers, real-time clock and serial communication facilities. Smart meters register the power consumption periodically and transmit it to the utility server, connect or disconnect a customer power supply and send out alarms in case of abnormality. Some smart meters are equipped with relays that can be interfaced directly with smart home appliances to control them; for example, turn OFF the air conditioner during peak periods. Furthermore, the smart meter can be
used in demand side management. *Electric Utility Center* interacts with smart meters to regulate power consumption. It also sends consumption related instructions to smart meters and collects sub-hourly power usage reports and emergency/error notifications using General Packet Radio Service (GPRS) technology. *Service Providers* establish contracts with users to provide electricity for individual devices. Service providers interact with internal devices via messages relayed by the smart meter. To establish such interaction, service providers should register with the electric utility and obtain digital certificates for their identities and public keys. The certificates are then used to facilitate secure communications with users.

2.2 Network Component

Smart grid incorporates two types of communication: Home Area Network (HAN) and Wide Area Network (WAN). A HAN connects the in-house smart devices across the home with the smart meter. The HAN can communicate using Zigbee, wired or wireless Ethernet, or Bluetooth. A WAN, on the other hand, is a bigger network that connects the smart meters, service providers, and electric utility. The WAN can communicate using WiMAX, 3G/GSM/LTE, or fiber optics. The smart meter acts as a gateway between the in-house devices and the external parties to provide the needed information. The electric utility manages the power distribution within the smart grid, collects sub-hourly power usage from smart meters, and sends notifications to smart meters once required. The smart meter receives messages from devices within HAN and sends them to the appropriate service provider. Figure 2 illustrates the basic
architecture [1]. Note that while HANs are used in residential homes, Business Area Networks (BANs) and Industrial Area Networks (IANs) are used within business offices and industrial sites, respectively.

3. Vulnerabilities

Smart grid network introduces enhancements and improved capabilities to the conventional power network making it more complex and vulnerable to different types of attacks. These vulnerabilities might allow attackers to access the network, break the confidentiality and integrity of the transmitted data, and make the service unavailable. As proposed in [2],[3], the following vulnerabilities are the most serious in smart grids:

1) *Customer security*: Smart meters autonomously collect massive amounts of data and transport it to the utility company, consumer, and service providers. This data includes private consumer information that might be used to infer consumer's activities, devices being used, and times when the home is vacant.

2) *Greater number of intelligent devices*: A smart grid has several intelligent devices that are involved in managing both the electricity supply and network demand. These intelligent devices may act as attack entry points into the network. Moreover, the massiveness of the smart grid network (100 to 1000 times larger than the internet) makes network monitoring and management extremely difficult.

3) *Physical security*: Unlike the traditional power system, smart grid network includes many components and most of them are out of the utility's premises. This fact increases the number of insecure physical locations and makes them vulnerable to physical access.

4) *The lifetime of power systems*: Since power systems coexist with the relatively short lived IT systems, it is inevitable that outdated equipments are still in service. This equipment might act as weak security points and might very well be incompatible with the current power system devices.

5) *Implicit trust between traditional power devices*: Device-to-device communication in control systems is vulnerable to data spoofing where the state of one device affects the actions of another. For instance, a device sending a false state makes other devices behave in an unwanted way.
6) *Different Team's backgrounds*: Inefficient and unorganized communication between teams might cause a lot of bad decisions leading to much vulnerability.
7) *Using Internet Protocol (IP) and commercial off-the- shelf hardware and software*: Using IP standards in smart grids offer a big advantage as it provides compatibility between the various components. However, devices using IP are inherently vulnerable to many IP-based network attacks such as IP spoofing, Tear Drop, Denial of Service, and others.
8) *More stakeholders*: Having many stakeholders might give raise to a very dangerous kind of attack: insider attacks.

4. Attackers and Types of Attacks

The just mentioned vulnerabilities can be exploited by attackers with different motives and expertise and could cause different levels of damage to the network. Attackers could be script kiddies, elite hackers, terrorists, employees, competitors, or customers. The authors in [4] group attackers into:
1) Nonmalicious attackers who view the security and operation of the system as a puzzle to be cracked. Those attackers are normally driven by intellectual challenge and curiosity.
2) Consumers driven by vengeance and vindictiveness towards other consumers making them figure out ways to shut down their home's power.
3) Terrorists who view the smart grid as an attractive target as it affects millions of people making the terrorists' cause more visible.
4) Employees disgruntled on the utility/customers or ill-trained employees causing unintentional errors.
5) Competitors attacking each other for the sake of financial gain.

Those attackers can cause a wide variety of attacks, classified into three main categories [5],[6]: Component-wise, protocol-wise, and topology-wise. Component-wise attacks target the field components that include Remote Terminal Unit (RTU). RTUs are traditionally used by engineers to remotely configure and troubleshoot the smart grid devices. This remote access feature can be subject to an attack that enables malicious users to take control over the devices and issue faulty states such as shutting down the devices. Protocol-wise attacks target the communication protocol itself using methods such as reverse engineering and false data injections. Topology-wise attacks target the topology of the smart grid by launching a Denial-of-Service (DoS) attack that prevents operators from having a full view of the power system causing inappropriate decision making. More attacks were discussed in [7]-[10] including:
1) *Malware spreading:* An attacker can develop malware and spread it to infect smart meters or company servers. Malware can be used to replace or add any function to a device or a system such as sending sensitive information.
2) *Access through database links:* Control systems record their activities in a database on the control system network then mirror the logs into the business network. If the underneath database management systems are not properly configured, a skilled attacker can gain access to the business network database, and then use his skills to exploit the control system network.
3) *Compromising communication equipment:* An attacker may compromise some of the communication equipment such as multiplexers causing a direct damage or using it as a backdoor to launch future attacks.
4) *Injecting false information (Replay Attack):* An attacker can send packets to inject false information in the network, such as wrong meter data, false prices, fake emergency event, etc. Fake information can have huge financial impact on the electricity markets.
5) *Network Availability:* Since smart grid uses IP protocol and TCP/IP stack, it becomes subject to DoS attacks and to the vulnerabilities inherent in the TCP/IP stack. DoS attacks might attempt to delay, block, or corrupt information transmission in order to make smart grid resources unavailable.
6) *Eavesdropping and traffic analysis:* An adversary can obtain sensitive information by monitoring network traffic. Examples of monitored information include future price information, control structure of the grid, and power usage.
7) *Modbus security issue:* The term SCADA refers to computer systems and protocols that monitor and control industrial, infrastructure, or facility-based processes such as smart grid processes. Modbus protocol is one piece of the SCADA system that is responsible for exchanging SCADA information needed to control industrial

processes. Given that the Modbus protocol was not designed for highly security-critical environments, several attacks are possible including:

(a)Sending fake broadcast messages to slave devices (Broadcast message spoofing),

(b) Replaying genuine recorded messages back to the master (Baseline response replay),

(c) Locking out a master and controlling one or more field devices (Direct slave control),

(d) Sending benign messages to all possible addresses to collect devices'information (Modbus network scanning),

(e) Reading Modbus messages (Passive reconnaissance),

(f) Delaying response messages intended for the masters (Response delay), and

(g) Attacking a computer with the appropriate adapters (Rouge interloper).

5. Challenges for New Security Solutions

Security solutions developed for traditional IT networks are not effective in grid networks [6] because of the major differences between them. Their security objectives are different in the sense that security in IT networks aims to enforce the three security principles (confidentiality, integrity and availability), while the security in automation (grid) networks aims to provide human safety, equipment and power lines protection, and system operation. Moreover, the security architecture of IT networks is different than that of the Grid network since security in IT networks is achieved by providing more protection at the center of the network (where the data resides), while the protection in automation networks is done at the network center and edge. Their underlying topology is also different where IT networks use a well defined set of operating systems (OSs) and protocols, while automation networks use multiple propriety OSs and protocols specific to vendors. Finally, their Quality of Service (QoS) metrics are different in the sense that it is acceptable in IT networks to reboot devices in case of failure or upgrade, while this is not acceptable in automation networks since services must be available at all times.

These major differences between the IT and grid network security objectives necessitate the need for new security solutions specific for the smart grid network. The development of these security solutions is faced with many challenges [5],[6] including:

1) Some components use propriety OS to control functionality rather than security,
2) Automation system network was designed without regard to security,
3) Security should be integrated with existing systems without downgrading the performance,
4) Remote access to grid devices should be monitored and controlled, and
5) The new protocols should have the capability of incorporating future security solution.

6. Best Practices to overcome above security threats

Having overviewed the major vulnerabilities and security challenges, this section the recent security solutions [3], [11]-[14]:

1) Identity should be verified through strong authentication mechanisms. Organizations should implement an *implicit deny* policy such that access to the network is granted only through explicit access permissions.
2) Malware protection on both Embedded and General purpose systems. Embedded systems are intended to only run software that is supplied by the manufacturer. The manufacturer is required to embed in its products a secure storage that contains keying material for software validation. Using a key, the system can validate any newly downloaded software prior to running. However, general purpose systems are intended to support third party software. For this system, up-to-date and frequently updated antivirus software along with host-based intrusion prevention are required.
3) Network Intrusion Prevention System (IPS) and Network Intrusion Detection System (IDS) technologies should augment the host-based defenses to protect the system from outside and inside attacks.
4) Vulnerability assessments must be performed at least annually to make sure that elements that interface with the perimeter are secure.
5) In some instances, user actions can open potential system vulnerabilities. As such, awareness programs should be put in place to educate the network users about security best practices for using network tools and applications.

6) Devices must know the sources and destinations they communicate with. This is accomplished through mutual authentication techniques using Transport Layer Security (TLS) or Internet Protocol Security (IPSec).
7) Devices should support Virtual Private Network (VPN) architectures for secure communication.
8) Devices must use Public key Infrastructure (PKI) to secure communication [14]. However, there are some constraints regarding cryptography and key management [15]: current devices do not have enough processing power and storage to perform advanced encryption and authentication techniques, communications in a smart grid system will be over different channels that have different bandwidths, and connectivity, where all devices, certificate authorities, and servers must be connected at all times.
9) From the huge amount of transferred data, utilities should only collect the data needed to achieve their goals.
10) Control system and IT security engineers should be equally involved in securing the smart grid network.
11) Since the life cycle of the smart grid is longer than that of the IT systems involved, all IT technologies should have the ability to be upgraded.
12) Security must be part of the smart grid design. Otherwise, security of devices becomes vendor specific; the fact that might produce many vulnerabilities because of incompatibility issues.
13) Utilities should consider utilizing third party communication companies. Letting the utilities handle all the grid communication becomes quickly a burden that the utility cannot handle. Third part companies can help in managing the communication and security issues of data transfer.
14) A robust authentication protocol is needed while communicating between smart grid parties. The protocol must operate in real-time abiding with some constraints such as minimum computational cost, low communication overhead, and robustness to attacks, especially Denial-of-Service attacks.

7. Conclusion

Traditional power systems are moving towards digitally enabled smart grids which will enhance communications, improve efficiency, increase reliability, and reduce the costs of electricity services. The massiveness of the smart grid and the increased communication capabilities make it more prone to cyber attacks. Since the smart grid is considered a critical infrastructure, all vulnerabilities should be identified and sufficient solutions must be implemented to reduce the risks to an acceptable secure level. In this paper, we surveyed the vulnerabilities in smart grid networks, the types of attacks and attackers, the challenges present in designing new security solutions, and the current and needed solutions.

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Synthetic Pathway, Characterization and Antimicrobial Activity of Novel N-p-methylbenzoyl-N' substituted thiourea

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ABSTRACT

A series of N-p-methylbenzoyl-N' thiourea derivatives bearing different substituents have been synthesized and screened in order to evaluate for their antibacterial and antifungal activity. Antibacterial and antifungal activity of the title compounds has been evaluated by varying the substituents in the thiourea moiety. Reaction of p-methylbenzoyl chloride with ammonium thiocynate followed by the addition of various aromatic amines afforded N-p- methylbenzoyl-N' substituted thiourea. The structures of newly synthesized compounds have been supported by IR and 1HNMR spectral analysis. Among the synthesized compounds N-(4-methylbenzoyl)-N'-(4-chloro-2-nitrophenyl) thiourea and N- (4-methylbenzoyl)-N'-(4-methylphenyl) thiourea have been found to exhibit excellent antibacterial and antifungal activity when compared with the standard drug.

KEYWORDS: Thiourea; aromatic amine; antibacterial activity; antifungal activity.

Introduction

A heterocyclic compound is one which possesses a cyclic structure with at least two different kinds of hetero atoms in the ring. Nitrogen, oxygen, and sulphur are the most common heteroatoms. Heterocyclic compounds are very widely distributed in nature and are essential to life in various ways[1,2]. The six and five membered heterocyclic compounds containing sulphur and nitrogen have maximum attention, as they have many biological and industrial application[3-5].

During recent years there has been intense investigation of different classes of thiourea compounds, many of which were found to be pharmacologically active like anticancer[6,7], hypnotic, antifungal[8,9], antibacterial[10], diuretic[11], antiviral, anti-tubercular, anti-thyroidal, herbicidal and insecticidal activities[12] organocatalyst[13], and as agrochemicals[14,15]. In this communication, results of synthesis, spectroscopic studies and antimicrobial activity of N-p-methylbenzoyl-N' substituted thiourea derivatives are presented.

Materials and Methods

Melting points of the synthesized compounds were determined by open capillary method and are uncorrected. Thin layer chromatography was performed on pre-coated silica gel G254 plates and visualized in iodine or UV. The IR spectra of synthesized compounds were recorded in potassium bromide discs on Schimadzu FTIR Spectrophotometer 8300. The 1H NMR spectra of the synthesized compounds were recorded in DMSO and $CDCl_3$ using AV-300 Broke Jeol Spectrophometer.

Synthesis of p-methylbenzoylchloride

13.6 g of p-toluic acid was transferred into 250 ml of two necked RBF then added 15 ml of thionyl chloride and some pieces of porcelain chips into RBF from 1st neck and 2nd neck was covered with stopper, at the same time the condenser was clamped with RBF and the top of condenser was capped with calcium guard tube or cotton wool and whole reaction mixture was reflux for 3-4 hours with occasional gentle shaking up to the complete evolution of gas after that cooled the flask and then fitted for distillation under reduced pressure the reaction mixture was heated at 70^{o}C-80^{o}C for the removal of excess of $SOCl_2$ or unreacted $SOCl_2$ and collected in 1st flask after that the temperature rapidly raised to 225^{o}C and the distilled was collected in another flask which was final product p-toluoyl chloride. The different compounds of the series were synthesized by reaction of p-

methylbenzoyl chloride (1) with ammonium thiocynate (2) followed by the addition of various aromatic amines (3) affording N-p-methylbenzoyl-N' substituted thiourea (3a-h).

Synthesis of N-(4-methylbenzoyl)-N'-(3-chlorophenyl)thiourea (3a)

0.01 mole of each methyl benzoyl chloride, ammonium thiocyanate, polyethylene glycol-400 and methylene chloride were added in 100 ml conical flask and stir it for 2-3 hours at room temperature, then after 0.01 mole (1.3 ml) of m-chloroaniline was added and again stir for 8-9 hours at room temperture. After stirring when reaction was completed the reaction mixture was filtered and wash with 10 ml of methylene chloride. The filtered filtrate was evaporated until the solid product was obtained, product was recrystallized with mixture of ethyl acetate, ethanol and methylene chloride in the ratio of 1:2:1. The TLC was determined using Chloroform: ethyl acetate (1:3), R_f value was 0.79. Similarly the other compounds (3b-h) were synthesized.

N-(4-methylbenzoyl)-N'-(3-chlorophenyl) thiourea (3a)

IR (KBr) cm^{-1} : 1670(C=O str. CONH), 1078(C=S str.), 3420(N-H str.), 3084(C-H str. aromatic ring), 2922, C-Hstr. (CH_3), 738 (C-Cl). ^{1}H-NMR (DMSO) δ (ppm): 7.33-7.94 δ(8H, Ar-H), 12.86 δ(1H, NH), 11.55 δ(1H, N'H), 2.50 δ(1H, CH_3).

N-(4-methylbenzoyl)-N'-(2-chlorophenyl)thiourea (3b)

IR (KBr) cm^{-1}: 1669 (C=O str.CONH), 1153 (C=S str.), 3370 (N-H str.), 3020 (C-H str. aromatic ring), 1337 C-Hstr. (CH_3), 670(C-Cl). ^{1}H-NMR (DMSO) δ (ppm): 7.29-8.08 δ (8H Ar-H), 12.77 δ(1H NH), 11.67 δ(1H, N'H),2.50 δ (1H, CH_3).

N-(4-methylbenzoyl)-N'-(2-chloro-4-nitrophenyl) thiourea (3c)

IR (KBr) cm^{-1}: 1680 C=O str.(CONH), 1140 (C=S str.), 3370 (N-H str.), 3025(C-H str. aromatic ring), 1380 C-H Bending (CH_3), 760 C-Cl (disubstituted), 1450 (NO_2). ^{1}H- NMR (DMSO) δ (ppm): 7.33-8.66 δ (7H, Ar-H), 13.18 δ(1H ,NH), 11.92 δ(1H N'H), 2.50 δ(1H, CH_3), 775 (C-Cl disubstituted), 1390 (NO_2).

N-(4-methylbenzoyl)-N'-(4-chloro-2-nitrophenyl) thiourea (3d)

IR (KBr) cm^{-1}: 1690 C=O str.(CONH), 1170 (C=S str.), 3370 (N-H str.), 3020 (C-H str. aromatic ring), 2890 (C-Hstr. CH_3). ^{1}H-NMR (DMSO) δ (ppm): 7.32-8.16 δ (7H, Ar-H), 12.91 δ(1H, NH), 11.82 δ(1H, N'H), 2.50 δ (1H,CH_3).

N- (4-methylbenzoyl)-N'-pyridinthiourea (3e)

IR (KBr) cm^{-1}: 1685 C=O str.(CONH), 1160 (C=S str.), 3375 (N-H str.), 3027 (C-H str. aromatic ring), 2910 (C-H str. CH_3), 1615 (C-C ring str.), 1430 (C-N ring str.). ^{1}H- NMR (DMSO) δ (ppm): 7.29-8.43 δ (8H, Ar-H), 12.86 δ(1H, NH), 11.12 δ(1H, N'H), 2.50 δ (1H, CH_3).

N- (4-methylbenzoyl)-N'-phenylthiourea (3f)

IR (KBr) cm^{-1}: 1690 C=O str.(CONH), 1125 (C=S str.), 3480 (N-H str.), 3040 (C-H str. aromatic ring), 2890 (C-H str. CH_3), 1615 (C-C ring str.), 1430 (C-N ring str.). ^{1}H-NMR (DMSO) δ (ppm): 7.24-7.29 δ (9H, Ar-H), 12.68 δ(1H, NH), 11.45 δ(1H, N'H), 2.50 δ (1H, CH_3).

N-(4-methylbenzoyl)-N'-(2,3-dimethylphenyl)thiourea (3g)

IR (KBr) cm^{-1}: 1665 C=O str.(CONH), 1152 (C=S str.), 3422 (N-H str.), 747 (C-H bending, aromatic ring), 2941(C-H str. CH_3), 1615 (C-C ring str.), 1430 (C-N ring str.).
^{1}H-NMR (DMSO) δ (ppm): 7.33-7.92 δ (7H, Ar-H), 12.28 δ(1H, NH), 11.48 δ(1H, N'H), 2.50 δ (1H, CH_3).

N- (4-methylbenzoyl)-N'-(4-methylphenyl)thiourea (3h)

IR (KBr) cm^{-1}: 1671 C=O str.(CONH), 1157 (C=S str.), 3439 (N-H str.), 3038 (C-H str. aromatic ring), 1352 (C-H bending disubstituted). ^{1}H-NMR (DMSO) δ (ppm): 7.20- 7.91 δ (8H, Ar-H), 12.60 δ(1H, NH), 11.41 δ(1H, N'H), 2.50 δ (1H, CH_3).

Antimicrobial Activity [16,17]

The synthesized compounds were evaluated for the *in vitro* antibacterial activity against microorganism strains *Bacillus subtilus* (MTCC-441)), *E.coli* (ATCC-11775). The compound was also tested for the *in vitro* antifungal activity against C*andida albicans* (ATCC10231) and *Aspergillus niger* (ATCC16404) by cup plate method at 50 µg/ml, 100 µg/ml concentration of test compound. Ampicillin, was used as the standard antibacterial agent whereas Fluconazole was used as standard antifungal agent. The observed data was recorded for the tested compound as the average diameter of zone of inhibition (IZ) of bacterial or fungal growth around the disc in mm. The values are recorded in Table 1 and 2 respectively.

Table 1 Antibacterial activity of synthesizedcompound.

COMPOUNDS	ZONE OF INHIBITION (in mm)			
	B. subtilis		***E. coli***	
	50 µg	**100 µg**	**50 µg**	**100 µg**
3a	13	15	16	18
3b	11	13	16	17
3c	13	15	15	17
3d	15	17	17	20
3e	15	17	16	18
3f	16	18	18	21
3g	15	19	13	15
3h	12	15	19	20
Ampicillin	20	22	20	22

Table 2 Antifungal activity of synthesized compound.

COMPOUNDS	ZONE OF INHIBITION (in mm)			
	Candida albicans		***Aspergillus niger***	
	50 µg	**100 µg**	**50 µg**	**100µg**
3a	11	15	13	15
3b	13	14	12	14
3c	15	18	11	12
3d	14	17	13	15
3e	11	12	12	14
3f	12	15	11	13
3g	15	16	11	13
3h	16	18	12	14
Fluconazole	18	20	14	16

Result

A series of N'-substituted aromatic amines thioureaderivatives were synthesized. In all cases the compounds were obtained in solid state and yields varied from maximum 94% to minimum 80%. The purity and homogencity of all compounds were confirmed by their sharp melting point and TLC. The structures of all thederivatives were established on the basis of IR and ^{1}HNMR spectral studies.

Discussion

It has been found that compounds 3a to 3h showed significant activity as compared to Ampicillin but N-(4-methylbenzoyl)-N'-(4-chloro-2-nitrophenyl)thiourea (3d) and N-(4-methylbenzoyl)-N'-(4-methylphenyl)thiourea (3h) compound was found more potent as compared to other synthesized compounds against bacterial and fungal strains in non dose-dependent manner. The values are recorded in Table 1 and 2 respectively.

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Study of Hepatoprotective Activity of Musa paradisica (Whole plant) Linn. Against Carbontetrachloride Induced Hepatotoxicity

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A B S T R A C T:
Ethonolic extract of *Musa paradisica* (Whole plant) has a multiple pharmacological activities including wound healing, antimicrobial, antiviral, anti-inflammatory, anticancer effects, ant diabetic. The present study aims to determine the hepatoprotective effects of *Musa paradisica* on serum and tissue superoxide dismutase (SOD) levels, the histology in tetrachloride (CCl_4) -induced liver injury. Wister rats aged were injected intraperitoneally with 50% CCl_4 in olive oil. *Musa paradisica* was orally administered before or after CCl_4 treatment in various groups. Twenty-four hours after CCl_4 injection, serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities, serum and liver superoxide dismutase (SOD) activities were measured and Histological changes of liver were examined by microscopy. Serum ALT and AST activities significantly decreased in a dose-dependent manner in both pre-treatment and post-treatment groups with ethonolic whole plant extract of *Musa paradisica*. The present study demonstrates that *Musa paradisica* possesses hepatoprotective effects against CCl_4- induced hepatotoxicity and that the effects are both preventive and curative. *Musa paradisica* should have potential for developing a new drug to treat liver toxicity.

Keywords: Carbon tetrachloride(CCl_4), *Musa paradisica*, ALT, AST, Silymarin, Histopathology

INTRODUCTION:

Musa paradisiaca is a mono herbacious plant, belonging to family Musaceae, commonly known as plantain. Plantain refers in India to a coarse banana. The plants having two genera and 42 different species, 35 species are belongs to Musa species.[1] In India dried fruits, flowers and roots are employed orally for diabetes. The roots are used as anthelmimtic, aphrodisiac and laxative. The fresh fruit is used for peptic and duodenal ulcers.[2] Banana contains completely different amino acids like essential amino acid, tryptamine, tryptophan, flavonoids and sterols.[3] Until date completely different elements of genus *Musa sapientum* have been studied for antiulcerogenic[4, 5,6], hypoglycemic[7,8], hypolipidemic[9], antimicrobial [10], antihypertensive, wound healing, antacid, diuretic and antiestrogenic activities[11].The pill extract of banana was found to enclose analgesic property. [12]The Ayurvedic Pharmacopoeia of India recommends the fresh rhizomein dysuria, polyuria (in females) and menstrual disorders; the flower in asthma, bleeding disorders, vaginal discharges and leucorrhoea (API. VOL-IV) but there's no proof in the literature for Hepatoprotective activity of whole plant of *Musa paradisica* linn. Liver ailments stay one in every of the intense health issues[13]. Present medicines have very little to offer for alleviation of hepatic diseases and it's primarily the plant based preparations that are used for the treatment of liver disorders[14]. Therefore, many folk remedies from plant origin are being tested for their potential hepatoprotective activity in experimental animal models.[15]

The liver demonstrates a major role in the metabolism of xenobiotics by regulating the synthesis, secretion and metabolism of xenobiotics. Various physiochemical functions of the body, including oxidation, reduction, hydroxylation, hydrolysis, conjugation, sulfation, acetylation etc. are well balanced by the liver alone. Injury to liver and damage to the hepatic parenchyma are always proved to be associated with distortion of different metabolic functions of the liver. [16, 17]

At present, worldwide, much attention has been focused on the use of a natural antioxidant to maintain the health of the individual. As the liver is a major organ attacked by ROS and OS in induced toxicity is considered as the pathological mechanism in initiation and progression of a various liver disease, the present study was designed to evaluate the antioxidant activity of the *Musa paradisiaca*. This study would be play or important role for further advanced study & development of new drug formulation.

MATERIALS AND METHODS:

Collection of Plant Material:

The source of freshly collected whole plant in CSIR-NBRI, Lucknow .The plant material was identified and authenticated by a botanist, Department of Botany, NBRI, Lucknow.

Preparation of Plant Extract:

The 4 kg whole plant part (leaf, fruit, root, stem and flower) was collected, cut into as small pieces and shade-dried, after that it was tray dried under controlled conditions and powdered. The powdered plant material 1000 g was macerated with 50% ethanol. The process of extraction was repeated for four times, filtered, concentrated on rotavapour (Buchi, USA) and then freeze-dried (Freezone 4.5, Labconco, USA) under reduced pressure to obtain 73 g of solid residue (yield 7.3 % w/w). The extract obtained was further subjected to toxicological and pharmacological investigations.

Experimental Animals:

Wistar rats weighing 160-190g from our own breeding colony (Animal House-holding NBRI, Lucknow), were kept in cages with free access to foods and water, in a room with controlled temperature (22-24^{0}C) and relative humidity 44-56%, light/dark cycles of 12 hours respectively for one week before and during the experiments. Animals were provided with a standard rodent pellet diet (Amrut, India) and the food was withdrawn 18-24 h before the experiment though water was allowed ad libitum. The composition of diet is 10% protein, 4% arachis oil, 1% fiber, 1% calcium, 1000 IU/gm vitamin A and 500 IU/gm vitamin D. All experiments were performed in the morning in accordance with the current guidelines for the care of laboratory animals and the ethical guidelines for investigations of experimental pain in conscious animals. The protocol for this study has been approved by the Institutional Animal Ethics Committee as per the guidance of the Committee for the Purpose of Control and Supervision of Experiments on Animals-CPCSEA, New Delhi.

Determination of Effective Dose:

The *Musa paradisica* extract was administered at different doses of 100, 150, 300, 600 and 1200 mg/kg/day orally for 4 days of five groups of rats (five in each group) and the animals were observed for mortality during the course of treatment or on the 5thday were tested again at lower dose levels and dose showed no mortality in rats and was selected as effective dose.

CCl_4 Induced Hepatotoxicity:

Rats were divided into five groups of six animals in each group. Group I (control) animals were administered a single daily dose of liquid paraffin (1 ml/kg body weight, p.o.). Group II (toxic control) received carbon tetrachloride (1 ml/kg b.w., i.p.). Test groups (Groups III–IV) were administered orally 200 and 400 mg/kg b.w. 50% ethanolic extract, respectively, in the form of aqueous suspension daily once a day. Group V received silymarin, the known hepatoprotective compound (Sigma Chemicals Company, USA), at a dose of 100 mg/kg, p.o., along with carbon tetrachloride. The Test drug was given simultaneously with carbon tetrachloride. Treatment duration was 14 days. Carbon tetrachloride was administered as a 30% solution in liquid paraffin for every 72 h. Animals were sacrificed 48 h after the last dose and blood was collected, allowed clotting and the serum separated. Liver was isolated for further biochemical investigations.[18,19]

Biochemical Investigations:

Serum biochemical parameters such as Alanine transaminases (ALT), Asparate transaminases (AST), Total bilirubin (TB) and Alkaline phosphatase (ALP) were assayed as per the methods[18, 19]. Total protein and albumin were evaluated by the method [20] and enzymatic parameters like- lipid peroxidation (LPO)**,** catalase superoxide dismutase (SOD) by the methods[21, 22, 23].

Histopathological Assessment:

Each formaldehyde-fixed sample was embedded in paraffin, cut into 5 μm thick sections and stained with hematoxylin-eosin (H-E). The slides were observed under a light microscope and photomicrographs were captured by using a camera (Olympus SZX 12, stereomicroscope system). These were observed for fibrosis, fatty aggression, and centrilobular necrosis and lymphocyte infiltration stereomicroscope system). These were observed for fibrosis, fatty aggression, and centrilobular necrosis and lymphocyte infiltration

Statistical Analysis:

All the statistical comparison between the groups were made by means of One Way Analysis of Variance (ANOVA) and followed by Student-Newman-Keuls test. The $p<0.05$ regarded as significant using, Graph Pad Prism 5.03 Software (CA, USA). The data expressed are Mean± standard error of mean (S.E.M.).

RESULTS:

Table 1: Effect of Test drug on Body weight and Liver weight in control and Toxic group.

Treatment/dose	Body weight	Liver weight
Control	187.00 ± 4.52	6.42 ± 0.05
CCl4	180.9 ± 3.98	7.69 ± 0.29z
MP-200	182.36 ±3.94	7.11 ± 0.19
MP-400	1.82 ± 4.10	6.75 ± 0.15c
SYL-100	185.66 ± 4.39	6.45 ± 0.09c

Note: All values expressed as g, in form of mean±SEM, where n=6. If $^{z}p< 0.05$ when compared to respective control and $^{c}p<0.05$ when compared to respective CCl_4 control.

50% ethanolic whole plant extract of *Musa paradisica* at a dose of 200 mg and 400 mg/kg once daily for 14 days and standard drug Silymarin at a dose of 100mg/kg were subjected for studying the body weight and liver weight in hepatotoxic rats. The study showed that the body weights were significantly decreased in CCl_4 groups. However, 50% ethanolic whole plant extract of *Musa paradisica* showed a dose dependent protection in body weight. The result of the high dose (400 mg/kg) was compared with standard drug Silymarin (100 mg/kg) **(Table 1).**

Table 2: Effect of test drug on biochemical parameters in CCl_4 induced hepatotoxicity in rats.

Treatment	ALT(IU/L)	AST (IU/L)	ALP (IU/L)	Total Protein(g/dl)	Albumin (g/dl)	TBL (mg/dl)
Control	69.5 ±7.745	108.25 ± 9.25	83.59 ± 7.52	6.59 ± 0.72	4.213± 0.440	0.59± 0.05
CCl_4	177.91± 9.54	228.70 ±17.66	140.27±7.90	2.18 ± 0.56	1.080± 0.230	1.78 ± 0.08
MP-200	93.76±5.73**	156.52 ± 9.03**	109.09±8.29*	6.80± 0.40**	3.310±0.629*	1.09±0.18**
MP-400	79.09±4.89**	129.78±11.80**	96.60±6.84**	8.45± 0.28**	4.676±0.094**	0.69±0.18**
SYL-100	76.82±6.25**	137.60± 3.89**	89.46±6.78**	7.27± 0.41**	5.030±0.130**	1.09±0.14**

Note: All values expressed as g/dl and mg/gdl in form of mean ± SEM, where n=6. If $*p < 0.05$, $**p < 0.05$ when compared with respective CCl_4 treated group. TP: total protein, TB: total bilirubin, SEM: standard error of mean.

Table 3: Effect of test drug on antioxidant and lipid per-oxidation in liver homogenate of CCl_4induced hepatotoxicity in rats.

Treatment/Dose	Catalase (U/mg)	SOD (U/mg)	LPO (U/mg)
Control	25.14 ± 2.10	112.47 ± 2.41	0.4 ± 0.05
CCl_4	7.03 ± 0.42	54.36 ± 3.52	4.50 ± 0.41
MP-200	16.19 ± 1.04*****	79.21 ± 4.15*****	3.28 ± 0.38*****
MP-400	20.39 ± 0.74******	94.05 ± 2.72******	0.98 ± 0.08******
SYL-100	22.38 ± 0.79******	103.80 ± 2.80******	0.87± 0.08******

Note: All values expressed as U/mg in form of mean ± SEM, where n=6. If $*p < 0.05$, $**p < 0.05$ when compared with respective CCl_4 treated group. SOD: superoxide dismutase; LPO: lipid peroxidation, SEM: standard error of mean.

Pharmacological studies:

Effect of Test drug on ALT, AST, ALP, Total Protein, Albumin and Total Bilirubin actions.

Table 2. That CCl_4 caused a significant elevation of liver serum markers. In the CCl_4 treated group, the level of ALT, AST, ALP, Total Protein, Albumin and Total Bilirubin (TBL) were significantly raised. In contrast, the groups treated with hydro alcoholic whole plant extract of *Musa paradisica* in doses of (200 & 400 mg/kg) once daily for 14th days prohibited the hepatotoxicity in a dose dependent manner.

Effect of Test drug on CAT, SOD and LPO

Table 3. illustrated the lipid peroxidation and the enzymatic and non-enzymatic antioxidant level in the liver of experimental animals. Administration of CCl_4 led to elevation in the levels of LPO and drop in enzymatic scavenger viz. CAT, SOD levels in the liver homogenate. Treatment of rats with 50% ethanolic whole plant extract of *Musa paradisica* in doses of (200 and 400 mg/kg) noticeably prohibited the CCl_4 induced alterations of various parameters LPO, CAT, SOD.

Figure legend:

(a) Liver sections of normal control rats showing: normal hepatic cells with well preserved cytoplasm; well brought out central vein; prominent nucleus and nucleolus in Group-I.
(b) Liver section of CCl_4 (1 ml/kg, i.p.) treated rats showing: massive fatty changes, necrosis, ballooning degeneration, and broad in filtration of the lymphocytes and kupffer cells around the central vein and the loss of cellular boundaries in Group-II.
(c) Liver section of rats treated with CCl_4 (1 ml/kg, i.p.)+ MPE (200 mg/kg, p.o.)×14 days, showing: well brought out central vein, hepatic cell with well preserved cytoplasm, prominent nucleus and nucleolus in Group-III.
(d) Liver section of rats treated with CCl_4 (1 ml kg, i.p.) + MPE (400 mg/kg, p.o.)×14 days, showing: well brought out central vein, hepatic cell with well preserved cytoplasm, prominent nucleus and nucleolus in Group IV.
(e) Liver section of rats treated with CCl_4 (1 ml kg, i.p.) + silymarin (100 mg/kg, p.o.)×14 days, showing: well brought out central vein, hepatic cell with well preserved cytoplasm, prominent nucleus and nucleolus in Group-V.

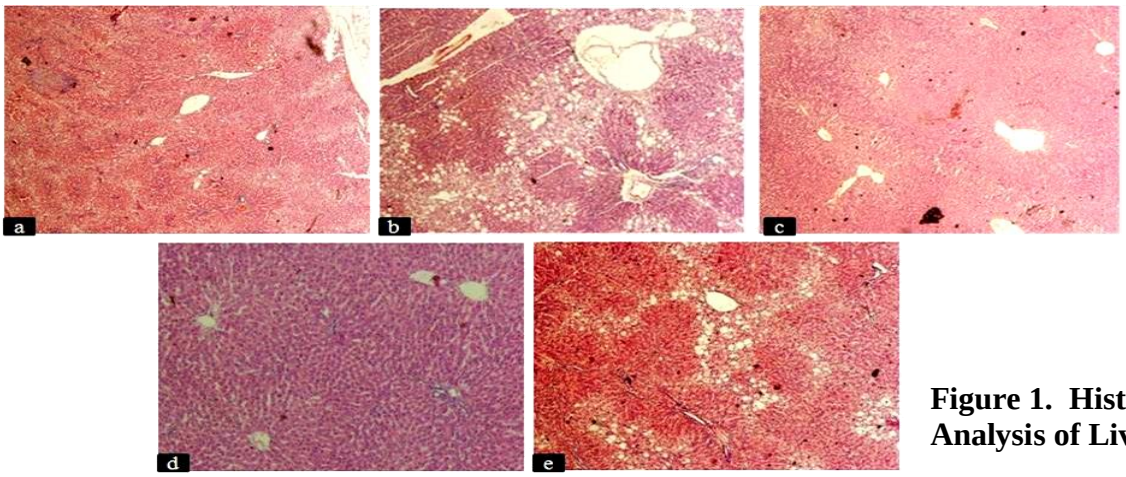

Figure 1. Histopathological Analysis of Liver

DISCUSSION:

The world health organization survey indicates that a total of about 70-80% of the world population rely on non commercial medicine mainly the herbal sources, in the primary health care units.[24] The results of the present study clearly indicated hepatoprotective effects of the ethanolic extract of *Musa paradisica* against CCl_4-induced hepatic damage in rats. Hepatotoxicity induced by CCl_4 is one of the best characterized systems of xenobiotic-induced hepatotoxicity in experimental animals. This method usually used to evaluation hepatoprotective properties of many bioactive substances and medicinal plants.[25] Liver as a vital organ in the body playing a Central role in metabolic homeostasis and detoxification of a variety of drugs and xenobiotics is vulnerable to a wide range of toxic, microbial, metabolic, circulatory and neoplastic insults.[26,27] CCl_4-induced hepatic damage is widely used for hepatoprotective drug screening. Hepatotoxicity of CCl_4 involves its biotransformation into free radicals such as trichloromethyl free radical (CCl3) and trichloroperoxyl radical (CCl3O2-), and increased lipid peroxidation.[28]

Hepatocyte injury initiates the activation of Kupffer cells which secrete potent mediators of the early inflammatory response, such as reactive oxygen species (ROS), especially superoxide anions that accounted for the formation of peroxynitrites and hydrogen peroxides (H2O2) therefore oxidative stress can be occur.[29] The antioxidants could attenuate this oxidative damage caused by free radicals indirectly by enhancing natural defenses of cell and or directly by scavenging the free radicals.[30]Antioxidants such as superoxide dismutase (SOD) can scavenges the superoxide anions whereas the glutathion reduced (GSH) is responsible to remove H2O2 through the action of glutathione peroxidase[31] and also, H2O2 is consumed by the action of catalase.[32]

Assessment of liver function can be made by estimating the activities of serum ALT, AST, ALP and bilirubin, which are enzymes originally present in higher concentrations in cytoplasm. When there is hepatopathy, these enzymes leak into the bloodstream in conformity with the extent of liver damage.[33] Total bilirubin, a byproduct of the breakdown of red blood cells in the liver, bilirubin is a good indicator of liver function. High levels will cause icterus and are indicative of damage to the liver and bile duct.[34] Silymarin used as a standard drug derived from the milk thistle *Silybum marianum.* This has been shown to reduce lipid peroxidation and inhibit fibrogenesis in rodent animal models.[35, 36]
The histopathological studies are direct means of assessing the defensive effect of the drug. The groups received CCl_4 alone, the spoils of cells around the central vein were well evident. While, the amount of damage was found minor in the studies included pre-treatment of MPE. The results of the histopathological study supported and well associated with data obtained from an assessment of the biochemical parameters.

This study quantifies ethanolic whole plant extract of *Musa paradisica* flavonoids content and investigates the in vivo antioxidant effects of this extract in a carbon tetrachloride (CCl4) -induced hepatotoxicity rat model as an alternative for improving and/or reversing liver damage.

CONCLUSION:

The 50% ethanolic whole plant extract of *Musa paradisica* could efficiently manage the AST, ALT, ALP and TB levels and elevated the protein levels in the protective studies. The defensive effect of MPE may be ascribed due to the abridged lipid peroxidation and improved defense of the hepatocytes against the reactive oxygen species. The histopathological studies also authenticate the activity of the drug. Therefore the study scientifically supports the treatment of this plant in various Ayurvedic preparations and traditional medicine for treatment of liver disorders and as a tonic.

CONFLICT OF INTEREST
We have no conflict of interest to declare.
CONTRIBUTIONS OF AUTHORS
1. Pritt Verma: Literature search, study design, data collection, data analysis and data interpretation writing.
2. Dr. Ch.v Rao: Data interpretation and manuscript review, data analysis.

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A Comparative study on Container clustering & orchestration tools for deploying complex application

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Abstract: Our containerized application should scale up and down based on application resource requirements. Container are mostly short lived and when come to orchestration the main factor to consider are networking, high availability, ease of deployment and good service delivery. Keeping this in mind we shall study various container orchestration and clustering tools. We shall also compare features of three main tools namely kubernetes, Docker swarm and Mesos.

I. Introduction to Container Orchestration and Clustering Tools

In this section, we shall cover the list of best container clustering and orchestrations tools which are being used in production by many companies. Some of the briefings for these tools are as follows:

1. Kubernetes

Kubernetes is an open-source, out of the crate holder bunch administrator and coordination. It is worked with a brilliant scheduler and asset director for sending compartments in an increasingly effective and profoundly accessible manner. Kubernetes has become the accepted holder coordination instrument for some associations. The kubernetes venture is kept up by google with givers everywhere throughout the world. It offers a lot of usefulness that local docker apparatuses don't offer. Also, it is anything but difficult to begin with kubernetes.

2. Openshift

Openshift is based over kubernetes. Openshift venture is kept up by Red cap. It has both open source (openshift starting point) and endeavour rendition (openshift compartment stage). Alongside center Kubernetes highlights, it offers out of the case parts for compartment the board and arrangement.

3. Docker Swarm

The Docker biological system comprises of devices from improvement to creation arrangement structures. In that rundown, docker swarm fits into group the executives. A blend of docker-make, swarm, and overlay organize and a decent assistance disclosure instrument, for example, etcd or delegate can be utilized for dealing with a group of Docker holders.

Docker swarm is as yet developing regarding functionalities when contrasted with other open-source holder group the executive's apparatuses. Thinking about the tremendous docker supporters, it won't be so long for docker swarm to have all the best functionalities different devices have. Docker has archived a decent generation plan for utilizing docker swarm underway.

4. Mesos

Mesos is another group the executive's apparatus which can oversee holder coordination proficiently. It was made by Twitter for its framework and afterward got open sources. It is been utilized by organizations like eBay, Airbnb, and so on. Mesos is certainly not a devoted device for compartments. Mesos is anything but a committed instrument for holders; rather, you can utilize it for VM or Physical machine grouping for running outstanding burdens (Big information and so on) other than compartments. It has a proficient structure called Marathon for conveying and overseeing holders on a Mesos group. You can really run a Kubernetes group on a Mesos bunch.

5. Google Container Engine

GKE is a managed container service on google cloud. At the backend, GKE used kubernetes. You can use all the kubernetes functionalities on GKE.

6. AWS EKS Service

EKS is a managed Kubernetes cluster service from AWS.

7. Amazon EC2 Container Service

ECS is a service offered by AWS for managing the cluster of containers. ECS is not cloud agnostic as it uses its proprietary cluster management and scheduling technologies at the backend. The only thing you have to worry about is the vendor lock-in.

8. Azure AKS Service

Azure Kubernetes Service is a managed highly available kubernetes service from Azure.

9. Digital Ocean Kubernetes Service

Digital ocean offers a managed kubernetes service for deploying container-based applications.

10. Red Hat Open Shift Online

Openshift online is one of the PaaS offerings from Red hat. You can deploy applications on the cloud with openshift using this service. You don't have to manage the cluster as it is a pure PaaS service.

II. Comparing Kubernetes, Docker Swarm and Mesos

Features	Kubernetes	Docker Swarm	Mesos
Architecture Scheduler	Shared State	Monolithic	Two level
Service discovery	Native support with an intra-cluster DNS source or using environment variables	No native support, requires third parties	Native support with Mesos-DNS
High-Availability	Native support by replicating master in HA-cluster	Native support by creating multiple manager	Native support from having multiple masters with Zookeeper coordinating
Load balancing	External load balancer automatically created in front of a service configured for such source	No native support [source required]	Provided from the selected framework such as Marathon source
Deployment	Native support for deployment with the deployment definition source	No deployment strategies, only applies the Docker Compose on a cluster	Depends on the framework source

III. Conclusion

Picking a tool or assistance absolutely relies upon your requirements and the multifaceted nature of your application. There is no uncertainty in that reality that the previously mentioned devices and administrations are being utilized by numerous associations for their generation remaining tasks at hand. There are many other features which shall be understood while choosing the tool. In future, we shall be more comprehensive in evaluating a tool.

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TO ANALAYSE AND INVESTIGATE THE PERFORMANCE OF RECTANGULAR FIN ARRAY WITHIN A TRIANGULAR ENCLOSURE

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Abstract - Heat transfer within the enclosures has been turned out to be a one of the prime functional areas of investigation due to its prominent engineering applications ranging from nuclear reactors to solar panels, domestic heating and building insulation cavities. The present analysis deals with an experimental investigation for the performance of a system consisting of a heated rectangular finned base plate within a horizontally oriented and air filled triangular enclosure in natural convection dominated region at a wide range of Rayleigh number (2997770 to 5548480) for different fin array distance (10 mm to 24 mm) and fin spacing values (26 mm to 65 mm). The system is arranged in such a way that the vertical side of the enclosure is insulated, base side is heated uniformly while its inclined side is cooled isothermally. The attachment of fins always results to the heat transfer enhancement as compared to the bare base plate during the experiments. Important parameters affecting system performance (convective heat transfer coefficient and fin effectiveness) are noticed as Rayleigh number (Ra), fin spacing

(S) and fin array distance (D). The convective heat transfer coefficient (h) is reported to increase with increasing Rayleigh number while diminished system performance is noticed with increased values of fin array distance. Fin spacing is found as the most critical parameter affecting systemperformance. The results gave an optimum fin spacing at which the best system performance (highest convection heat transfer coefficient and finned surface effectiveness) is achieved.

Key Words: Rectangular Fin, Heat Transfer, Convection , Prandtl number (Pr), Rayleigh number (Ra).

1. INTRODUCTION

Heat is defined as energy under transmission from one medium or object to another by the virtue of temperature gradient between them. There are three basic modes of heat transfer- conduction, convection and radiation. Convection relates to the transfer of heat by means of motion of the molecules in the fluid. Convection may cause a related phenomenon called advection, in which mass or heat is transported by the currents or motion in the fluid.

Natural convection is a type of heat transfer involving the heat transfer due to density difference and a body force without application of any external source. Fluid flow generated by any external source creates forced convection. Forced convection is generally more efficient than free convection because of faster velocity of flow currents. Various dimensionless numbers involved in the study of natural convection are Grash of number, Prandtl number, Rayleigh number and Nusselt number. As per definitions, the Grash of number is directly proportional to temperature difference between the hot and cold parallel plates and Rayleigh number is defined as the product of Grash of and Prandtl numbers. number shows the relationship between buoyancy and viscosity within the fluid while Prandtl number is the relation between momentum diffusivity and thermal diffusivity. We can say that the temperature difference imposed between the parallel hot and cold walls must exceed a certain finite value for significant convective heat transfer between the plates. The Rayleigh number at this instant is known as critical Rayleigh number. So Convection cells are the cellular flow consisting of counter rotating two dimensional cells. They occur in plane horizontal layer of fluid heated from below due to density difference and Buoyancy (gravity) is responsible for these convection cells. Bénard cells come in to the picture above critical Rayleigh number **[1]**.

There are numerous studies in the literature regarding natural convection in enclosures. Most of the previous studies on natural convection in enclosures are related to either side heating or bottom heating. These studies are mainly focused on the

investigations of heat transfer and flow profiles for fluids of different Prandtl number (Pr) at a wide range of Rayleigh number (Ra) and are conducted at various temperatures and geometries of the enclosure. There are several types of two-dimensional enclosures, which receive considerable attention. The various types of the enclosures are square, rectangular, triangle, sphere, cylinder inclined and partition. The most common case studies are the square and the rectangular enclosures, which are heated and cooled uniformly either at the two vertical or horizontal walls while the remaining two walls are thermally insulated. Regardless of the nature of the convection heat transfer process, the convective heat flux is proportional to the temperature differences. The proportionality constant, which is termed the convective heat transfer coefficient, is essential in any study of convection **[2]**. Dimensional analysis shows that in free convection the Nusselt number, Nu, which is a dimensionless heat transfer coefficient and signifies the ratio between convective and conductive heat transfer, depends on two dimensionless groups: the number and Prandtl number. The number approximates the ratio of the buoyancy force to the viscous force, and its value primarily determines the transition from laminar to turbulence occurrence, while the Prandtl number, which is a fluid property, represents the ratio between the fluid viscosity (momentum diffusivity) and thermal diffusivity. Some studies, including the present one, use the Rayleigh number instead of the number, which is simply the product of the and Prandtl numbers.

LITERATURE REVIEW

Natural convection is the motion that arises from density difference within a fluid. These differences may result from gradients in temperature, concentration or composition. Natural convection in an enclosure is the result of a complex interaction between the finite fluid system and all the walls that confine it. The complexity of this internal interaction is responsible for the diversity of flows that can exist inside the enclosure. At the same time the complexity of the phenomenon is linked to our relative inability to predict both the flow and heat transferred across the enclosure. Also, the investigation on the natural convection within the enclosures can be broadly categorized under two important headings:

- **i.** Enclosures heated from bottom
- **ii.** Enclosures heated from side

The problem of heat transfer due to natural convection in triangular or attic-shaped enclosures is quite widespread and has application to buildings, solar collectors and greenhouses. However, unlike rectangular, square and cylindrical enclosures, it has received relatively little attention. It should be noted that the problem has not been completely ignored; in fact many of the studies undertaken in the area have relied upon the use of computational fluid dynamics to further the understanding of the flow and heat transfer in triangular enclosures, although there are relatively few experimental studies. A comparative analysis regarding optimum parametric design for heat transfer through triangular fin array within a rectangular enclosure was carried out by Das and Dwivedi **[9]** using classical and Taguchi methodologies. The Taguchi‟s methodology was determined about 67% more effective as compare to classical one for horizontal enclosure orientation. In their computational study Akinsete and Coleman **[2]** found that for a right triangular enclosure with a cooled inclined wall, heated base and adiabatic vertical side that there was an increase in heat transfer near the apex of the heated and cooled side. In this study they observed a single convection cell as did Poulikakos and Bejan **[10]**. However, in a separate computational study Poulikakos and Bejan **[11]** found that at higher Rayleigh numbers Benard- type instability resulted in multiple cells forming in their enclosure. They found that the formation of these cells was related to the aspect ratio of the right triangular enclosure, as did Asan and Namli **[12, 13]**. Similar results were also reported in literature of Aramayo et al. **[14, 15]**. The flow behavior and presence of convection cells has also been discussed in recent times for isosceles triangular enclosures, similar to those formed by pitched roofs. Holtzman et al. **[16]** showed computationally that the flow in such enclosures was asymmetric and undertook flow visualization to validate this conclusion. A similar phenomenon was computationally observed by Ridouane et al. **[17]**. Given the large number of computational studies that have examined natural convection in triangular enclosures, there is a distinct lack of generalized correlations to predict the heat transfer in these spaces **[18– 20]**. Al-Shariah and Ecevit **[21]** were perhaps the first to present a truly generalized equation for heat transfer in a triangular enclosure. In their study they examined a right triangular enclosure with one heated and one cooled side and found that the heat transfer could be expressed as a function of the Rayleigh number.

RESEARCH OBJECTIVES

In an effort to complete and extend some of the previously reported results of natural convection from sources in enclosures, two configurations have been considered in this investigation. The test rig configuration is a horizontal narrow triangular enclosure heated from bottom, cooled from the inclined top wall. Rests of the walls are assumed to be adiabatic. The configurations have applications in cooling of electronic equipment. The purpose of this portion of investigation is to address the unanswered questions from the previous investigations.

2. EXPERIMENTAL SETUP

The main aim of this experimental analysis is to investigate the effects of several influencing geometrical parameters like fin array distance, fin spacing and Rayleigh number from the rectangular fin array within an air filled triangular enclosure. In order to facilitate this investigation, total three base plates were designed and built. A number of fins with rectangular geometry with various geometrical parameters were prepared. A series of tests having in total, 37 experimental runs were undertaken. The experimental study was conducted for wide parametric ranges; fin array distance 10 mm $\leq$ D $\leq$ 24 mm, fin spacing 26 mm $\leq$ S $\leq$ 65 mm and Rayleigh number 2997770 $\leq$ Ra $\leq$ 5548480.

To enable this investigation, total 10 samples of fin arrangements, were designed and machined at Mechanical Workshop, Allen house Institute of Technology, Kanpur. Nut and bolts were used to make physical contact between the base plate and the fin surface. Aluminum was used as the material for finned base plate of constant thickness (T'Plate= 3 mm) due to its high thermal conductivity, low emissivity, structural strength and durability. A bare base plate was prepared for validation of the fabricated experimental test rig with the existing analytical empirical correlations in the literature. Table 3.1 shows the all possible test array combinations for the present investigation.

A test-rig was designed for measurement of natural convection heat transfer from rectangular fin array within a triangular enclosure. The detailed schematic diagrams and pictorial view of the experimental test-rig has been shown in figures . There were three main sections of the experimental setup:

a) Heating section
b) Test section
c) Cooling section

Figure-1: Pictorial View of a Fin Array Sample

During the experiments, the heater was connected with a power supply through a variable transformer to control the power input. The variable transformer was used to control the power input and hence the input heat flux and corresponding Rayleigh number were controlled. A digital multimeter with accuracy of ±0.4% for voltage as well as the resistance was used to record the output data. The surface temperature distribution of the base plate of the fin array was measured using six K- type Teflon coated chromel- alumel thermocouples are equally spaced and distributed as shown in figure. In order to facilitate the thermocouples installation within the enclosure without disturbing the heat transfer

3. RESULTS AND DISCUSSION

The effects of different important geometrical parameters on the steady state natural convection heat transfer and fin effectiveness for both horizontal and vertical enclosure orientations are discussed. In this section deals with the validation test for an experimental technique used in the present study. The validation has been done by comparing experimental results for bare plate with standard empirical correlations available in literature. In the second section, the effects of several influencing parameters on the natural convection heat transfer from rectangular fin array within a triangular enclosure are examined. The fin effectiveness as the function of different controlling parameters is reported in succeeding section. A detailed discussion regarding the impact of fin array

distance (D), fin spacing (S) and Rayleigh number (Ra) is made.

The enclosure with heated bare plate is used for establishment of confidence level in the experimental method. The experimental results are compared with the empirical correlations recommended by V. Akinsete [2] as described in the form of equations

$$Nu = 1.102(Gr)^{0.0535}(H / a)^{1.19}$$

3.1. Heat Transfer Rate

This section includes the effects of several influencing parameters like fin array distance (D), fin spacing (S) and Rayleigh number (Ra) on the natural convection heat transfer from rectangular fin array within an air filled triangular enclosure.

Table -1: Tested Fin Array Combinations

Fin array combination	Fin array distance (D) (mm)	Fin spacing (S) (mm)	Number of fins (n)
1	10	26	10
2	10	37	7
3	10	65	4
4	17	26	10
5	17	37	7
6	17	65	4
7	24	26	10
8	24	37	7
9	24	65	4
10	-	-	Bare plate

The Nusselt number variation with fin height has been illustrated in figures for horizontally oriented triangular enclosures at different fin spacing and Rayleigh number values. As it can be seen from the graphs attained that the Nusselt number decreases continuously with increase in fin array distance for all the fin spacing and Rayleigh number values. This result can be attributed to the reduced effective surface area available for heat transfer due to reduced fin height as a result of increased fin array distance.

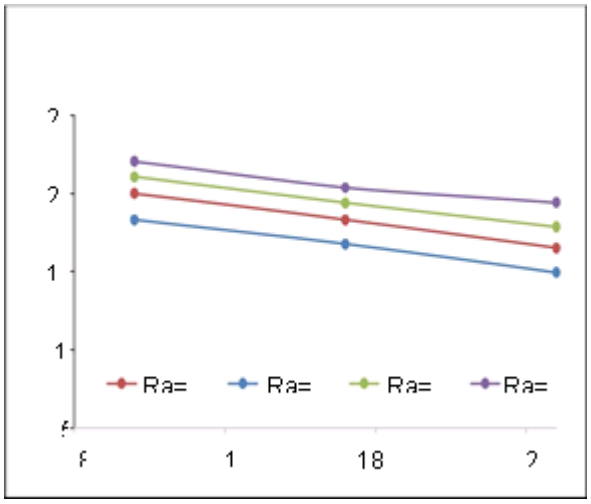

Figure 3.1: Variation of Nusselt Number with Fin Height- S= 26 mm

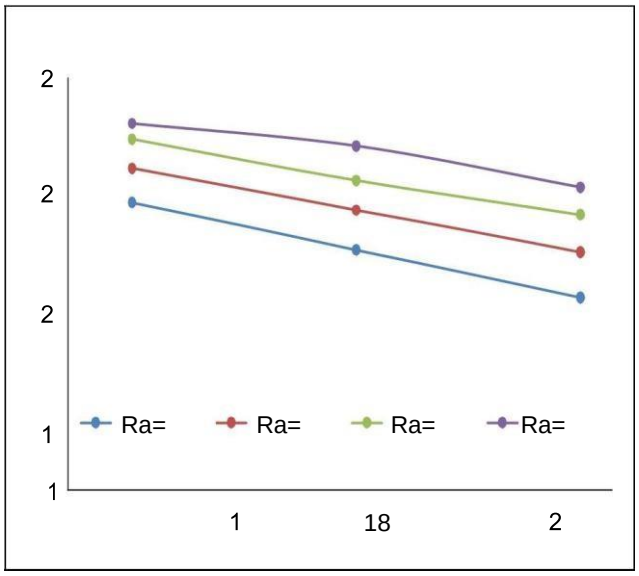

Figure 3.2: Variation of Nusselt Number with Fin Height- S= 37 mm

4. CONCLUSIONS

An experimental investigation regarding laminar natural convection heat transfer from heated rectangular fin arrays within a triangular enclosure was performed in order to analyse the effects of several influencing parameters on system performance. Air was used as a working fluid. Three new custom-designed test base plates were designed and fabricated to carry out the experimental analysis with various testing samples at different scales. An uncertainty analysis was carried out to check the feasibility of experimental work and the uncertainty of 9.35% was reported in the measurement of convection heat transfer. On the basis of investigation, the major concluding remarks can be highlighted as following:

The Nusselt number is reported as a strong function of various geometrical and design parameters as fin array distance, fin spacing and Rayleigh number for any tested fin array combination for enclosure orientation considered for the study. The continuous increase in the Nusselt number with Rayleigh number is observed while with increase in fin spacing, the Nusselt number increases firstly up to a maximum value then tends to decrease. Continuous increase in fin array distance causes the reduced system performance.

- The effectiveness of the finned surface is a very strong function of fin spacing, fin array distance and Rayleigh number. The fin effectiveness decreases with increase in fin array distance and Rayleigh number respectively, while with increase in fin spacing, the fin effectiveness increases initially up to a certain value beyond which it tends to decrease. The finned surface effectiveness is always greater than 1 for each fin array configuration and enclosure orientation taken under consideration during the investigation.

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Vetiveria Zizanioides roots extract: *Invitro* Antioxidant Activity

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Abstract: Vetiveria zizanioides belonging to the family Gramineae, is a densely tufted grass which is widely used as a traditional plant for aromatherapy, to relieve stress, anxiety, nervous tension and insomnia. It has been reported that some of the extracts from plants possess antioxidant properties capable of scavenging free radicals in vivo Free radicals induce numerous diseases by lipid peroxidation and DNA damage. Keeping in mind this view, the roots of V. zizanioides were extracted with ethanol and used for the evaluation of various in vitro antioxidant activities such as reducing power ability, superoxide anion radical scavenging activity, deoxyribose degradation assay, total antioxidant capacity, total phenolics and total flavonoid composition. The various antioxidant activities were compared with suitable antioxidants respectively. The generation of free radicals was effectively scavenged by the ethanolic extract of V. zizanioides. The result clearly states that V. zizanioides scavenges free radicals, ameliorating damage imposed by oxidative stress in different disease conditions and serve as a potential source of natural antioxidant in a dose dependent manner. The study proves ethnomedical claims and reported biological activities. The plant has therefore possessed potent antioxidant activity.

Keywords: Vetiveria zizanioides, antioxidant, ethnomedical, Free radicals

Introduction

Free radicals contain one or more unpaired electrons, produced in normal or pathological cell metabolism. Reactive oxygen species (ROS) react easily with these free radicals to become radicals themselves. ROS are various forms of activated oxygen, which include free radicals such as superoxide anion radicals and hydroxyl radicals, as well as non-free radical species and the singled oxygen (Gulcin *et al.,* 2004). They are formed in living organisms in different ways, including normal aerobic respiration, stimulated polymorphonuclear leukocytes and macrophages, and peroxisomes. They are natural by-products of our body's metabolism. They are dangerous;[2] however, when present in excess, they can attack biological molecules such as lipids, proteins, enzymes, DNA and RNA, leading to cell or tissue injury (Amarowicz *et al*., 2004). The cells experience an oxidative stress which contributes in a various clinical disorders such as cancer, heart diseases, neurogenerative diseases like multiple sclerosis, Parkinson`s disease, autoimmune disease, stroke, arthritis, ischemia, reperfusion injury, acute hypertension, haemorrhagic shock, emphysema, cirrhosis, diabetes mellitus, hepatitis, cancer, atherosclerosis as well as other ailments (Gomes *et al*., 2001; Ajith *et al.,* 2002; Kang *et al*., 2003; Roome *et al*., 2008).

Great number substances of plant origin have been shown to exhibit antioxidant activity (Gulcin *et al*., 2003; Ali *et al*., 2007). The use of antioxidants that scavenge ROS has been studied by evaluating its potential and therapeutic applications. The most commonly used antioxidants since the starting of this century are butylated hydroxyanisole, butylated hydroxytoluene, propyl gallate and *tert*-butylhydroquinone (Velioglu *et al*., 1998). However, they are suspected of being responsible for liver damage and carcinogenesis in laboratory animals. Naturally occurring substances in higher plants have antioxidant activity that has long been recognized. Thus, the interest in natural antioxidants has increased considerably. In this respect, we screened some *in vitro* antioxidant activities of *V. zizanioides* root extract for the possible discovery of safe and efficacious plant antioxidant agent(s). To the best of our knowledge and the literature search, it was revealed that only a few scientific studies has been undertaken to evaluate *V. zizanioides* to its therapeutic potential in phytomedicine or its value for the isolation of active chemical constituents. Therefore the current study was designed and undertaken to screen *V. zizanioides* to confirm and provide scientific basis for its use in traditional system of medicines and also to explore some new biological and pharmacological activities of this plant.

Materials and Methods

Preparation of the extract

Fresh roots of *V. zizanioides* were collected and dried in shade under room temperature, powdered mechanically and sieved through No. 22 mesh sieve. The finely powered roots were kept separately in an air tight container until the time of use. About 750 g of powder was soaked with 3 litres of ethanol for 12 h and then macerated at room temperature using a mechanical shaker for 4 h. The extract was filtered off and the marc was again soaked and then further extracted for 4 h and filtered. The filtrates were then combined concentrated under reduced pressure and evaporated at 40^0 C. The percentage yield of the ethanolic extract of *V. zizanioides* (EEVZ) was found to be 9.8% w/v.

Drugs and chemicals

Ascorbic acid, 2, 2 diphenhy-1-picryl hydrazyl hydrate (DPPH), ammonium molybdate, beta carotene, xanthine oxidase were purchased from Himedia, Mumbai. Hypoxanthine, 2-deoxy-2- ribose, quercetin, pyrocatechol, butyl hydroxy toluene (BHT) were purchased from S D Fine, Mumbai. Thiobarbituric acid, tricholoacetic acid, Folin ciocalteau reagents were purchased from SD Fine ltd., Mumbai. All other chemicals employed in the study were of analytical grade.

Phytochemical screening

Preliminary phytochemical screening of the powdered leaves was performed for the presence of alkaloids, flavonoids, tannins, phenols, terpenoids and saponins.

Reducing power ability

Reducing power ability was measured by mixing the EEVZ (50-800 µg) in 1 ml of distilled water to 2.5 ml of phosphate buffer (0.2 M, pH 6.6) and 2.5 ml of 1% potassium ferric cyanide and then the mixture was centrifuged for 10 min at 3000 rpm, about 2.5 ml from the upper part was diluted with 2.5 ml water and shaken with 0.5 ml fresh 0.1% ferric chloride. The absorbance was measured at 700 nm using UV-spectrophotometer. Increased absorbance of the reaction mixture indicates increased reducing power. All experiments were done in triplicate using butyl hydroxy toluene (BHT) as positive control (Yildirim *et al*., 2001).

Superoxide radical scavenging assay (NBT reduction assay)

A final volume of 3 ml per tube was prepared as a reaction mixture with 1.4 ml of 50 mM KH_2PO_4- KOH, pH 7.4 containing 1 mm EDTA, 0.5 ml of 100 µM hypoxanthine, 0.5 ml of 100 µM NBT. The reaction was started by adding 0.066 units per tube of xanthine oxidase freshly diluted in 100 µl of phosphate buffer and 0.5 ml of the test extract in saline. The xanthine oxidase was added last. The basis of spectrophotometric determinations of absorbance was the subsequent rate of NBT reduction at 560 nm. The standard employed was ascorbic acid. The results were expressed as the percentage inhibition of NBT reduction rate with respect to the reaction mixture without the test compound (saline only) (Guzman *et al*., 2001).

Deoxyribose degradation assay (Hydroxyl radical scavenging activity)

Hydroxyl radicals were decomposed by EEVG, which was determined by the assay of malondialdehyde chromogen formation due to 2-deoxy 2-ribose degradation. The assay mixture contained in a final volume of 1 ml: 100 µl of 28 mM 2-deoxy 2-ribose dissolved in phosphate buffer, pH 7.4, 500 µl of the EEVZ of various concentrations (5-80 µg) in buffer, 200 micro l of 20 mM ferric chloride (1:1 v\v) and 1.04 µM EDTA and 100 µl of 1.0 µM hydrogen peroide and 100 µl of 1.0 µM ascorbic acid. After incubation of the test sample at 37^0 C for 1 h the extent of free radical damage imposed on the substrate deoxyribose was measured using thiobarbituric acid (TBA) test.

For the TBA test, about 1 ml of thiobarbituric acid in 50 mM sodium hydroxide and 1 ml of 2.8% W/V trichloroacetic acid was added to the test tubes and heated at 100^0 C for 20 min. after cooling absorbance was measured at 532 nm against a blank containing deoxyribose and buffer only. Percentage inhibition of deoxyribose degradation was calculated. Quercetin was used as standard (Gomes *et al*., 2001).

Estimation of total antioxidant capacity

Total soluble phenolics in the extract were determined with Folin-Ciocalteu reagent according to the method of Gulcin *et al*., 2004. Pyrocatechol is used as the standard and expressed as mg pyrocatechol equivalents (PCE). One millilitre (1000 µg/ ml) of extract solution in a test tube was added to 0.2 ml of Folin Ciocalteu reagent (1:2 in distilled water) and after 20 min, 2.0 ml of purified water and 1.0 ml of sodium carbonate (15%) are added. Allowed to react for 30 min and then absorbance was measured at 765 nm. The concentration of total phenolic component in the EEVZ was determined as microgram of pyrocatechol equivalent/mg (Gulcin *et al*., 2004).

To determine the total flavonoid, about 1 mg samples were added in 1ml of 80% ethanol. An aliquot of 0.5 ml was added to test tubes containing 0.1 ml of 10% aluminum nitrate, 0.1 ml of 1 M potassium acetate, and 4.3 ml of 80% ethanol. The absorbance of the supernatant was measured at 415 nm after 40 min at room temperature. Quercetinwas the standard used to calculate total flavonoid concentration.

The total antioxidant capacity of *V. zizanioides* was evaluated by the method of Asokkumar *et al.* (2008). The total antioxidant capacity of the extract of *V. zizanioides* was determined with phosphomolybdenum using Đ – tocopherol as the standard. An aliquot of 1.0 ml of extract (1000 µ g) solution is combined with 1.0 ml of reagent (0.6 M sulphuric acid, 28 µ M sodium phosphate and 4 µ M ammonium molybdate). The tubes were capped and incubated in a boiling water bath at 95^0 C for 90 min. after the samples had cooled to room temperature, the absorbance of the aqueous solution of each were measured at 695 nm in UV spectrophotometer. The blank solution contained 1.0 ml of reagent solution and the appropriate volume of the same solvent used for the sample and it was incubated under same conditions as the rest of the samples. The totalantioxidant capacity was expressed as equivalents of Đ– tocopherol (Asokumar *et al*., 2008).

The concentration (µ/ml) of the extract required to scavenge the radicals was calculated by using the percentage scavenging activities at five different concentrations of the extract. Percentage inhibition (I %) was calculated using the formula:

$$I\ \% = \frac{(Ac-As)}{Ac} \times 100$$

Where Ac is the absorbance of the control and As is the absorbance of the sample.

Result and Discussion

Preliminary phytochemical screening of the hydroethanolic extract of *V. zizanioides* (EEVZ) revealed the presence of alkaloids, flavonoids, tannins, phenols, saponins and triterpenoids. Table 1 shows the reductive capabilities of EEVZ when compared to the standard butylated hydroxyl toluene (BHT). The increase in absorbance of the reaction mixture containing the extract showed increased reducing power with increase in concentration. The reducing power increased significantly ($P<0.01$) with increasing concentration of the extract. However, the activity of the extract (0.8451±0.001) was lower than the standard (1.0794±0.010). The EEVZ was found to be a scavenger of superoxide anion generated in xanthine oxidase-NBT systems.

Flavonoid content in the extract was expressed as µg quercetin equivalent per mg. The EEVZ showed high flavonoid content which has contributed directly to the antioxidant activity by neutralising the free radicals.

The phosphomolybdenum method was used to investigate the total antioxidant activity of the extract. The quantitative antioxidant capacity of EEVZ was measured spectrophotometrically through the phosphomolybdenum method which is based on the reduction of Mo (VI) to Mo (V) by the sample analyte and the subsequent formation of green phosphate/Mo (V) complex with a maximum absorption at 695 nm (Asokkumar *et al.,* 2008)

Antioxidants derived from fruits, vegetables, spices and cereals are very effective and have reduced interference with the body's ability to use free radicals constructively. Natural antioxidants mainly come from plants in the form of phenolic compounds (flavonoids, phenolic acids and alcohols, stilbenes, tocopherols, tocotrienols) ascorbic acid and carotenoids. The quest for natural antioxidants for dietary, cosmetic and pharmaceutical uses has become a major industrial and scientific research challenge over the last two decades. Efforts to gain extensive knowledge regarding the power of antioxidants from plants and to tap their potential are therefore on the increase (Ali *et al*., 2008).

It can be concluded that therapeutic claims on EEVZ used as traditional plant have been supported by the results which show positive activity against free radicals. Further isolation of bioactive constituents in the The extract showed significant (P<0.001) superoxide inhibiting activity at a concentrations ranging from 25 to 400 µg/ml. The IC_{50} of the EEVZ was found to be 130.36±6.13 µ g/ml whereas the IC_{50} of the standard ascorbic acid is 100.33±2.61 µg/ml. The degradation of deoxyribose by Fe^{3+}- ascorbate- EDTA-H_2O_2 system was markedly decreased by EEVZ indicating the significant (P<0.001) hydroxyl radical scavenging activity. The 50% inhibitory concentration of quercetin was 15.5±3.42 µ g/ml. The amount of total phenolic content in the extract correlated with the antioxidant activity. About 42µ pyrocatechol equivalent of phenols was detected in 1 mg of EEVZ. The total flavonoid content of EEVZ was 50 µg implying that EEVZ extract contains a high quantity of flavonoids. In the measurement of quantitative antioxidant capacity, about 12.5µ tocopherol/mg equivalent of phenols was detected in 1 mg of EEVZ.

The reducing capability of the EEVZ was compared with the standard BHT. For the measurements of the reductive ability, we investigated the fe^{3+}- fe^{2+} transformation in the presence of the EEVZ. The reducing capacity of a compound also serves as a significant indicator of its potential antioxidant capacity (Devi *et al.*, 2008). However, the antioxidant capacity of antioxidants may have been attributed to various mechanisms, among which are the prevention of chain initiation, binding of transtition metal ion catalysts, decomposition of peroxides, prevention of continued hydrogen abstraction, reductive capacity and radical scavenging antioxidant activity **(**Gulcin *et al*., 2003). The presence of reductants (antioxidants) in the EEVZ causes the reduction of Fe^{3+} (ferric cyanide complex) to Fe^{2+} (ferrous form). The reducing power of the EEVZ increased with increasing concentration. In this study, yellow colour of the test solution changed to various shades of green and blue depending upon the reducing power of the extract.

Superoxide anions were generated *in vitro* enzymatically by hypoxanthine/xanthine oxidase system that reduces NBT and forms a blue coloured chromophore, formazone that can be measured at 560 nm. Superoxide radicals generated *in vitro* by the system was determined by NBT photoreduction method. The decrease in absorbance at 560nm with antioxidants thus indicates the consumption of superoxide anion in the reaction mixture. Superoxide radical was converted by superoxide dismutase (SOD) to hydrogen peroxide, which subsequently can produce extremely reactive hydroxyl radicals in the presence of transition metal ions such as iron and copper or by UV photolysis. Determination of the mean rate of increase in absorbance over a 1 minute period provided a measure of the extent to which the EEVZ capable of inhibiting NBT reduction by the superoxide anion radical and thus superoxide scavenging activity.

Hydroxyl radicals are reactive biological molecules and their scavenging property may provide an important therapeutic approach against oxidative stress induced ailments. It is well established in the absence of EDTA, Fe^{3+} directly bind with deoxyribose sugar and causes its site specific degradation due to hydroxyl radicals which are found immediately at the vicinity of the ions binding site. Hydroxyl radicals are the most reactive radicals which are produced via the Fenton`s reaction in living system. Hydroxyl radicals scavenging activity was quantified by measuring the inhibition of the degradation of the deoxyribose by free radicals (Guzman *et al*., 2001). Deoxyribose levels were determined by reaction with thiobarbituric acid. Phenolics are widely distributed and are found in large quantity in the plant kingdom. They have been shown to the multiple biological functions including antioxidant **(**Hsu *et al.*, 2006). According to the recent report, the phenolic compounds may contribute directly to the antioxidative action. In addition, it was reported that phenolic compounds were associated with antioxidant activity and play an important role in stabilizing lipid peroxidation (Gulcin *et al*., 2004). Phenolic compounds appeared to be responsible for the antioxidant activity of EEVZ. Folin – Ciocalteu method and aluminium chloride coloration are currently used to determine the total phenolic and flavonoid contents as they are important in various food materials. Phenols are very important constituents because of their scavenging ability due to their hydroxyl group. The chemical composition of plants indicates the presence of phenolic compounds which are known to possess antioxidant activities.

Flavonoids are a group of polyphenolic compounds, which exhibit several biological effects such as anti-inflammatory, antihepatotoxic, antiulcer, antiallergic, antiviral, anticarcinogenic and antioxidant properties. The important effect of flavonoids is the scavenging of oxygen-derived free radicals (Umamaheswari *et al.*, 2009). The total extract would help to ascertain its potency and safety, to provide leads and candidates of antioxidants for dietary, cosmetic and pharmaceutical uses.

TABLES

Group	Concentration in µg/ml	Absorbance at 700 nm
Control	50	0.1192±0.001
EEVZ	100	0.1956±0.003
	200	0.2871±0.008
	400	0.4217±0.004
	800	0.8451±0.001
	50	0.2037±0.005
	100	0.3283±0.001
Butyl hydroxyl toluene	200	0.4747±0.003
	400	0.8566±0.001
	800	1.0794±0.010

Values are mean S. E. M. (n=3), p<0.001 when compared with control

Table 1: Reducing Power Ability

Group	Concentration µg/ml	Absorbance at 700 nm	% inhibition	IC_{50} µg/ml
Control		1.140		
	25	0.919±0.002	19.50±0.21	
	50	0.721±0.004	36.75±0.28	
EEVZ	100	0.543±0.022	52.36±1.94	130.36 ± 6.13
	200	0.377±0.001	66.89±0.15	
	400	0.245±0.002	78.50±0.23	
Ascorbic acid	25	0.910± 0.006	21.70±0.57	
	50	0.790±0.004	30.64±0.43	
	100	0.654± 0.023	42.59±1.05	100.33 ± 2.61
	200	0.417± 0.003	63.41±0.26	
	400	0.215 ±0.002	81.13± 0.25	

Values are mean S. E. M. (n=3), p<0.001 when compared with control

Table 2: Superoxide radical scavenging activity

Free radicals, antioxidant, traditional, *Vetiveria zizanioides* **Group**	Concentration µg/ml	Absorbance at 700 nm	% inhibition	IC_{50} µg/ml
Control		0.542		
	5	0.474±0.002	12.42±0.37	
	10	0.443±0.001	18.21±0.33	
	20	0.331±0.016	38.87±1.90	39.5± 2.5
	40	0.264±0.001	51.21±0.32	
	80	0.152±0.001	71.87±0.23	
Quercetin	5	0.424± 0.004	21.64±0.86	
	10	0.346±0.001	33.37±0.31	
	20	0.213± 0.002	60.17±0.81	15.5 ±3.42
	40	0.124± 0.002	77.04±0.43	

	80	0.071 ±0.002	86.78± 0.43	

Values are mean S. E. M. (n=3), $p<0.001$ when compared with control

Table 3: Deoxyribose degradation assay

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