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Effect of Mobile Tower Radiation on Microbial Diversity in Soil and Antibiotic Resistance

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***Abstract*—A substantial increase in the number of mobile phone base stations (MPBS) has been demonstrated in the world. This development has raised concerns with biological systems due to electromagnetic field and radiations. Antibiotic resistance is referred as "the silent tsunami facing modern medicine". The aim of this in vitro study was to demonstrate the impact of these radiations transmitted by Mobile tower stations on microbial diversity in soil and antibiotic resistance pattern. Soil samples were taken from near four different base stations located in Dausa city, while control samples were taken far from stations. Isolation and identification of microorganisms was done using biochemical reactions and antibiotic resistance was observed. Chi-square test with Yates correction was applied to compare the pattern of antibiotic resistance. Stenotrophomonas maltophilia, Chryseobacterium Gleum, Kocuria Rosea were isolated and identified in soil samples collected near radiation exposed zone. Greater antibiotic resistance was observed in microbes present in soil near base stations compared to control. A statistical significant difference in pattern of antibiotic resistance was found with Nalidixic acid, and cefixime when used as antimicrobial agents. (P-value less than 0.05). Our findings suggest that mobile tower radiations can significantly alter the vital systems in microbes and turn them multidrug resistant (MDR) which is most important current threat to public health.**

Keywords—Mobile phone base station, radiation, microorganism, antibiotic resistance, soil.

I. INTRODUCTION

In modern era, tremendous use of telecommunication technologies has led to ever increasing exposition to radiofrequency electromagnetic fields and radiations. In order to cover wide range, mushrooming in the number of mobile phone base stations (MPBS) has taken place in the world. This phenomenon has put concerns about the possible adverse health effects due to radiations emitted by these stations [1–3]. Mobile towers may prove dangerous as microwaves radiations with frequency range between 900 to 1900MHz are transmitted by them. Current research has shown that the emissions from mobile phone base stations may adversely impact living organisms. Electromagnetic radiations from Mobile phones and base stations penetrate the living bodies to a distance that decreases with increasing frequency, poses threat to human health and other flora and fauna in different ways like environmental and health hazard. Currently, almost all of the flora and fauna has been chronically exposed to electromagnetic fields from different sources [4]. The impact of these radiations emitted by mobile phone stations on the vital functions and response of cells is a prime area of importance as it is related with detrimental effects on environment [5].Various researchers have focused their studies on the effects of electromagnetic field and radiation on cell metabolisms and functional parameters [6-8]. Findings are ambiguous, as some have shown no impact while others reported altered cell responses and functional parameters [9]. The possibility of an effect developed by Radio Frequency Radiations on microbial diversity and antibiotic resistance seeks attention as increasing antibiotic resistance among microbes is a new and difficult challenge to public health. Microorganisms are gradually becoming more and more resistant to almost all available antibiotics and that is why, studying the effect of radiations on antibiotic resistance among microbes is of utmost importance [10-11]. There is a scarcity in published literature regarding effect of electromagnetic radiations (EMR) transmitted by mobile phone base stations (MPBS) on soil microbes. We therefore undertook this study as an attempt to investigate the impact of these possible influences of EMR on soil microbes near mobile phone base stations.

II. MATERIAL AND METHODS

Our study was aimed to illustrate the effects of radiations emitted by Mobile phone base stations on microbial diversity in soil and antibiotic resistance among them. Prior to start of the study, necessary permission were taken, research protocol was approved. Dausa city was divided in four parts as per geographic boundaries as in north, south, east and west. Information about the mobile base stations was obtained from telecom offices. Stations operating less than 5 years were not included in the study.

A. Collection of Soil

To check impact on microbial diversity in Soil, samples were collected near four different mobile base stations located in Dausa city. These were collected within 50 meter distance from the foot of 4 mobile base towers. 4 samples of soil were collected from outer / far (>300m) area of radio towers as control. 1gm of each soil sample from near mobile base towers as well of control was combined to form compost soil respectively. Samples were then taken to microbiology lab for analysis.

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B. *Isolation and identification of organisms*

Serial Dilution of these samples was made using distilled water. One gram of each soil samples near and far from base stations was mixed with 10 ml of sterile distilled water. Then one ml of this diluted solution was weighed with 9 ml of sterile distilled water. Thus 1:100 proportion serial dilutions of the samples were made. Later, these samples alone with control sample were spread on Nutrient agar (NA) plate. Different colonies were sub cultured on NA plates. Incubation of cultures was done at 37*C for 24 hours and on the basis of morphological pattern of microbes using the streaking out technique, pure bacterial cultures were obtained. Pure Colonies were later identified through gram staining. Colonies from each sample were sub cultured again on the basis of their colony morphology and microscopic identification. Out of these colonies few of them selected on the basis of their similarity in both the culture to test the difference in their outcome toward AST through Vitek.

C. *Antibiotic resistance tests*

Antibiotic resistance among the microbes isolated and identified was demonstrated using disk diffusion on Mueller-Hinton agar plates as per guidelines of Clinical and Laboratory Standards Institute (CLSI) against different standard antibiotics. They were incubated for 24 hours at 37◌̊C. After incubation, the area of clearing (zones of inhibitions) was measured with Vernier calipers. Subsequently results were drawn by making comparison with the standard antibiotic sensitivity chart to explain their antibiotic resistant patterns.

D. *Statistical analysis*

Chi-square test with Yates correction was applied to compare the pattern of antibiotic resistance between soil samples near and far (control) from mobile base stations.

III. RESULTS

The present study was conducted to demonstrate the effects of radiations emitted by Mobile base stations on microbial diversity and antibiotic resistance among them. A list of isolated bacteria was prepared and tabulated. A total of 29 bacteria were isolated which belonged to different genera. Table I, II and Fig 1 shows a majority of cocci isolates (52%), bacilli (29%), and rod like structures in the soil sample collected near Mobile base stations.

TABLE I. MORPHOLOGICAL IDENTIFICATIONS OF MICRO-ORGANISMS FROM SOIL SAMPLES

Soil sample near Mobile base tower (Exposed)	
Gram positive -17 isolates	6-bacilli 9-cocci 2-rod like structure
Gram negative- 12 isolates	6-cocci 3-bacilli 3- rod
Soil sample (Control)	
Gram positive – 8 isolates	1-Positive 5-cocci 2-rod
Gram negative – 15 isolates	6-bacilli 5-cocci 2-rod 2-unidentified

TABLE II. DIVERSITY AND PREVALENCE OF BACTERIA ISOLATES FROM MOBILE TOWER EXPOSED ZONE

Isolates (Total Isolates = 10)	**Prevalence**	**Gram reaction**	**Shape**
Chryseobacterium Gleum	1 (10%)	Negative	Bacilli
Stenotrophomonas maltophilia	1 (10%)	Negative	Cocci
Kocuria Rosea	1 (10%)	Positive	Cocci
Staphylococcus spec.	3 (30%)	Positive	Cocci
E. Coli	1 (10 %)	Negative	Rod
Enterobacter Cleacae	1 (10%)	Negative	Rod
Pseudomonas spec.	2 (20%)	Negative	Rod
Total	10		

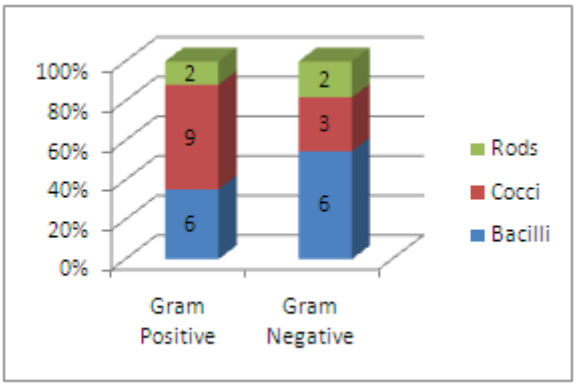

Fig.1: Morphlogical identifications of micro-organisms from radio frequencies exposed zone

A total of 23 bacteria isolates were identified in control soil sample (Table III, Fig 2). Stenotrophomonas maltophilia, Chryseobacterium Gleum, Kocuria Rosea were isolated and identified in soil sample collected near radiation exposed zone. Aerococcus Viridans was identified in control soil sample.

TABLE III. DIVERSITY AND PREVALENCE OF BACTERIA ISOLATES FROM MOBILE TOWER UN-EXPOSED ZONE.

Isolates (Total Isolates=7)	**Prevalence**	**Gram reaction**	**Shape**
Aerococcus Viridans	1 (14%)	Negative	Cocci
Bacillus Spec.	2 (28%)	Positive	Rod
Staphylococcus Arlettae	1 (14%)	Positive	Cocci
Pseudomonas Oleovorans	1 (14%)	Negative	Rod
Oligella Ureolytica	1 (14%)	Negative	Coccobacillus
E.Coli	1 (14%)	Negative	Rod
Total	7		

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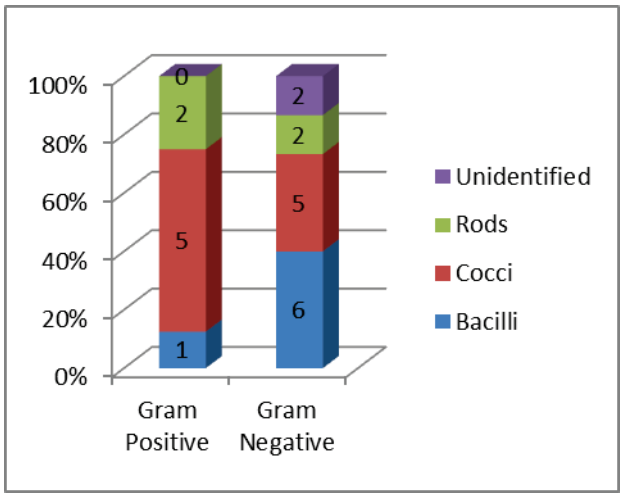

Fig. 2: Morphlogical identifications of micro-organisms from radio frequencies un-exposed zone.

Pseudomaonas, E coli, Staphylococci were found from both soil samples as near mobile station and far from base station as well. When antibiotic resistance pattern was explored it was found that there was more antibiotic resistance present in microbes present in soil near base stations then control. Table IV illustrates a statistical significant difference in pattern of antibiotic resistance was found with Nalidixic acid, and cefixime when used as antimicrobial agents. (P-value <0.05)

TABLE IV. ANTIBIOTIC RESISTANT PATTERN IN TEST VS CONTROL MICROBIAL POPULATION

Antimicrobial agents (Most common for all isolated isolates)	**Resistant population in exposed population (A) (n= 10)**	**Resistant population in radiation non-exposed population (B) (n=07)**	**Total resistant pobulation (A+B) (n=17)**
Amoxy-Clavulanate (20/10 µg)	1(14%)	1(10%)	2(12%)
Cefepime(30µg)	1(14%)	2(20%)	3(18%)
Ceftazidime(30µg)	1(14%)	0	1(6%)
Aztreonam (30µg)	0	2 (20%)	2(12%)
Cefazolin(30µg)	1(14%)	0	1(6%)
Nitrofurantoin(300µg)	2(28%)	2(20%)	4(24%)
Nalidixic acid (30µg)	3(42%)	1*(10%)	5(30%)
Cefixime(5µg)	4(52%)	2*(20%)	6(36%)

IV. DISCUSSION

Soil properties are dependent on flora and fauna of the soil and Soil microbes are sufficient enough to influence underground ecosystem. Assessing microbial assortment in soil remains important as microbial composition and functioning can modify the soil quality through different mechanisms such as symbiotic activity, nitrogen fixing etc [12]. This study is one of the few of its kind, although we have tried to compare the results with other studies, comparison cannot be justified due to variation in geography, environment and methodological issues. Our findings ae in the line of results found by Jasuja ND et al where they observed Klebsiella pneumoniae, Staphylococcus aureus, Escherichia coli, Enterobacter aerogenes, Shigella sp., Pseudomonas aeruginosa, Pseudomonas, Bacillus anthracis, Bacillus subtilis, and S. epidermidis as frequent species in the soil samples [13]. Stenotrophomonas maltophilia, Chryseobacterium gleum, kocuria rosea were among the microbes found near mobile station soil.

Stenotrophomonas maltophilia, has been observed as an environmental globally emerging Gram-negative multi-drug-resistant organism that is commonly associated with respiratory infections in humans, and is increasingly isolated from cystic fibrosis (CF) patients [14-16]. This species has been implicated in different infections like respiratory tract infections (RTI), urinary tract infections (UTI), bone infections, eye infections, endocarditis and meningitis. High diversity of antibiotic resistance has also been demonstrated [17]. Chryseobacterium gleum is usually present in the environment. It can cause different infections in immunocompromised patients in hospital environment. Resistant pattern has been found in Chryseobacterium spp to antibiotics as aminoglycosides, chloramphenicol, tetracyclines, and erythromycin. Diseases have been seen all over the world including India by C. gleum [18].

Kocuria species are omnipresemt in the environment worldwide and is part of flora in humans and other mammals [19]. These are somewhat uncommon human pathogens and generally infect immunosuppressed patients [20]. Kocuria are gram positive, aerobic, catalase positive, coagulase negative and non motile cocci in nature [21]. This bacteria may cause c catheter related bacteraemia and peritonitis in long term ill patients. This study is one of the few of its kind, although we have tried to compare the results with other studies, comparison cannot be justified due to variation in geography, environment and methodological issues.

Currently, we are living a world floating in the sea of microwave radiations by various radiofrequency sources which in turn can lead to adverse health effects. Apart from direct health effects on human beings from these radiations, other indirect aspect is through altered microbial flora and increasing antibiotic resistance among them. This in turn can create problems for medical care delivery approach and cure/success rate of disease or administration of injudicious dosage of antibiotics than what is normally required. Ultimately period of hospitalization and side effects will be observed more.

Various causes of antibiotic resistance among microbes due to radiations have been observed and discussed by different researchers, which includes properties of electromagnetic fields like intensity, wavelength, frequency, period of vulnerability, and kind (genera, species) of bacteria [22-23]. Keeping this point in mind, assessment of the impact of electromagnetic radiations on microbes is a must to investigate in view of environmental effects, and with of similar importance regarding antibiotic susceptibility pattern in vivo also. Microorganisms have been found more resistant

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to Cephalosporins (Cefuroxime and Ceftazidime) due to exposure of electromagnetic radiations [24-26] which is in line with our results. Structural features, composition of bacterial cell wall, and unique presence of peptidoglycan bacteria were among the factors that altered antibiotics resistance pattern among them, as observed by some studies [27-28]. Cell wall thickness also was found having significant role in antibiotic resistance pattern. This can be justified as; the greater the thickness of cell wall, the more resistance will be there for entrance of the molecules of antibiotics, decreasing permeability. Gram positive bacteria have thicker cell wall than gram negatives. Electromagnetic radiation also can alter peptidoglycans of cell wall and fasten the entrance of the antibiotics across the membrane. Subjection to weak radiofrequencies can modify the oxido reduction state of proteins in the cell wall, is one of the reason as studied by some researchers [9].

V. CONCLUSION

Present study results suggest that electromagnetic radiations from mobile tower base stations alter or influence the microbial diversity and the pattern of normal antibiotic sensitivity pattern among them. This is an alarming indication of widely growing communication technology from health point of view. Further advanced and long term research is necessary to clear this situation and to find out possible ways out of this problem.

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