Punjab Univ. J. Zool. Vol. 10, pp. 55-61, 1995

STUDIES ON THE PREVALENCE OF PATHOGENIC BACTERIA IN THE AIR OF LAHORE

A. HANIF, R. H. JAFRI, AND A. BABAR

Department of Zoology, University of the Punjab, Quaid-e-Azam Campus Lahore-54-590, Pakistan

Abstract: The survival pattern of *Staphylococcus aureus*, *Escherichia coli* and *Streptococcus pyogenes* was studied in the air of Southern, Central and Northern part of Lahore. Colony forming units (CFU) were noted down on Endoagar, MacConkey agar, Mannitol salt agar and blood agar medium. The CFU of *S. aureus* were more in number in Central part (Railway Station, Regal Chowk) and Northern part (Shad Bagh) of Lahore. The number of this bacterium was more during hot months of May and June. The CFU of *E. coli* were lesser in number as ocmpared to *S. aureus*. However, the CFU of this bacterium was fairly prevalent in Central part of Lahore particularly during high temperature period of May and June, 1994. In general the CFU of *S. aureus* and *E. coli* were eight and six times more than *S. pyogenes* in summer months. Humidity was an important factor for higher CFU in the air of Lahore.

Key words: Pathogenic bacteria in air, air pollution, *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus pyogenes*.

INTRODUCTION

Powar and Daginawala (1988) discussed that air is not a natural ecvironment for the growth and reproduction of microorganisms. It does not contain the necessary amount of moisture and utilizable form of the nutrients. Yet microorganisms are found in air, though they have a transient survival. The sources of organisms are the soil, the organic wastes of man and animals, nasal and rectal passages of man and animals and from lung throgh cough and sneezes. The ultimate fate of air borne microorganisms is governed not only by a complex set of circumstances including the atmospheric conditions *e.g.*, humidity, sunlight and temperature, but also the size of the particle bearing the microorganism and the nature of the microorganism. The population of Lahore is increasing day by day. The waste disposal system is not up to the mark which can cause an increase in the number of CFU of bacteria in the air of Lahore. Farzana (1988) studied the presence of pathogenic bacteria in the air of various parts of Ganga Ram Hospital, Lahore. The results of this study showed that *Staphylococcus sp.*, *Streptococcus pyogenes* and *Enterobacter sp.* are present in the air of various wards. The present study was undertaken to know as to how far *Staphylococcus aureus*, *Escherichia coli* and *Streprococcus pyogenes* are present in the air of Lahore.

MATERIALS AND METHODS

The areas slected for the study of bacterial air pollution were; University of the Punjab, (Quaid-e-Azam Campus), Model Town, Township, in Southern Lahore; Railway Station, Shah Alam Gate, Bhati Gate, Mozang, Ichhra, Regal Chowk, in Central Lahore and Shad Bagh in Nothern Lahore.

Procedure

Settle plate method as described by Cruickshank *et. al.* (1973) was used for demonstrating the pathogenic bacteria in the air. Three petri plates (4 inches in diameter) containing the given medium were exposed to the air in the given locality for a period of three minutes. The bacterial colonies developed after 24 and 36 hours of incubation. The mean number of colonies growing on three petri plates was taken and tabulated to determine the number and types of organisms present in the air at a given time. Endoagar medium as described by Rhode (1973) was used for the detection of coliform and other enteric organisms. Mannitol salt agar as described by Cheesbrough (1984) is a differential and selective media. It was used for isolation of *Staphylococcus aureus*. MacConkey agar medium is a differential and low slectivity medium. It was also used to distinguish lactose fermenting from non-lactose fermenting bacteria. Blood agar medium, as described by Rhode (1973) was used for the detection of hemolytic activity of *Streptococcus spp*. Identification of the predominantial bacteria was carried out in accordance with the method as described by Bergey's Maual of determinative bacteriology (1975). The experiments were carried out in the given localities on 13th May, 7th June, 20th August, 20th November and 22nd December, 1994.

RESULTS AND DISCUSSION

So far, a little published work is available on the presence of such pathogenic bacteria in the air which may be spreading upward and in all directions from the heaps of urban waste and open sewerage system. Keeping in view, these aspects, it was discovered that three types of bacteria were present in the air of Lahore: *Staphylococcus aureus*, *Escherichia coli* and *Streptococcus pyogenes*.

Table I. Number of colonies of *Staphylococcus aureus* obtained on the isolation media which were exposed to the air of different localities of Lahore city in different months of the year.

Name of locality	Dates				
	13.5.94	7.6.94	20.8.94	20.11.94	22.12.94
Railway Station	31	36	32	27	24
Regal Chowk	37	40	35	29	28
Shah Alam Gate	29	25	20	21	17
Bhati Gate	30	28	18	15	11
Ichhra	30	26	21	9	9
Mozang	26	22	18	10	7
Punjab Univ.	19	20	18	14	14
Model Town	17	17	15	10	7
Township	21	22	19	18	15
Shad Bagh	34	39	30	29	16

1. Staphylococcus aureus

S. aureus is a pathogenic bacterium causing boils, pneumonia, scaled skin reaction, septicemia, otitis, sinusitis, and toxic shock syndrome. S. aureus is responsible for a variety of purulet infections as discussed by Ross (1983). The present study revealed that there was maximum pollution, as indicated by colony forming units (CFU) of *S. aureus* in the air of Central Lahore (Regal Chowk) and Southernn Lahore (Shad Bagh). In Regal Chowk, there were 37, 40, 35, 29 and 28 CFU on 13th May, 7th June, 20th August, 20th November and 22nd December, respectively. The air of another central part of Lahore (Railway Station) demonstrated 31, 36, 32, 27 and 24 CFU on the given dates, respectively. Whereas the air of Shad Bagh demonstrated 34, 39, 30, 29 and 16 CFU on the above mentioned dates. These results indicated that the air of all the three localities harboured maximum number of CFU.

The air on the clean roads and houses of central Lahore-Regal Chowk was expected to harbour lesser number of CFU of this bacterium. However, when this area was studied very closely, it was discovered that there were no lids on the man holes of underground drainage system and a foul smell was coming out in the air. It appeared that clogged underground drains supported the rapid growth of *S. aureus* which were being spread in the air by the wind and high traffic.

The raw skins of goat, sheep, and buffaloes are stored in various buildings situated behind Railway Station. It appears that because of such unhygienic conditions and due to presence of dense human and animal population the maximum number of CFU of *S. aureus* were obtained in the air of this locality. Furthermore, the dense human population, over crowded houses, and unhygienic conditions inside populated area of Central Lahore (Ichhra and Mozang) also found as an important factor responsible for the growth of CFU in the air of these areas.

A medium degree of pollution, as depicted by the medium number of CFU was observed in four localities of Central Lahore *i.e.* Bhati Gate, Shahalam Gate, Ichhra and Mozang. There were 30, 28, 18, 15 and 11 CFU in the air of Bahti Gate as studied on 13th May, 7th June, 28th August, 20th November and 12th December, 1994 respectively. The CFU in Shah Alam Gate, Ichhra and Mozang were more or less in the same range during the hot season of May, June and August. However, CFU in these areas remained less during November and December. Rest of the area showed minimum number of CFU in the air of each locality both during the summer and winter seasons. It appeared that the high temperature played an important role in increasing the number of CFU in the air of given localities.

2. Escherichia coli

E. coli is a pathogenic bacterium of urinary tract and wound infections (Cruickshank *et al.*, 1973). It can survive for several days when dried on clothing or in dust and pathogenic serotypes have been found to be viable and numerous in floor dust and in air. According to Ross (1983) a number of diseases such as enteritis, peritonitis and eystitis are caused by *E. coli*. In the present work, the density, in terms of CFU of *E.*

coli was found to be fairly less in each area as compared to *S. aureus*. On 13 May and 7th June, there were 21, 25 CFU of *E. coli* in the air of Central part of Lahore (Railway Station). Later on after a few months the CFU declined and there were 18, 11 and 9 CFU of *E. coli* on 20th August, 20th November and 22nd December, 1994, respectively.

Table II. Number of colonies of *Escherichia coli* obtained on the Endoagar media which were exposed to the air of different localities of Lahore city in different months of the year.

Name of locality	Dates				
	13.5.94	7.6.94	20.8.94	20.11.94	22.12.94
Railway Station	21	25	18	11	9
Regal Chowk	17	19	13	8	8
Shah Alam Gate	18	25	20	10	10
Bhati Gate	19	23	15	12	11
Ichhra	15	20	13	11	12
Mozang	14	19	11	8	9
Punjab Univ.	12	17	9	6	6
Model Town	13	16	16	7	9
Township	18	19	18	15	13
Shad Bagh	21	22	16	12	9

In the air of central part of Lahore -- the Shahalam Gate, the CFU of *E. coli* were 18, 25, and 20 on 13th May, 7th June and 20th August, respectively. Later on, in this area there were just 10 CFU on 20th November and 22nd December, 1994, respectively.

In a densely populated area of Northern Lahore such as Shad Bagh, there were 21, 22, CFU of *E. coli* on 13th May and 7th June. Later on, there was a decline in this number and CFU were 16, 12 and 9, respectively on 20th August, 20th Nobember and 22nd December, 1994. These results indicated that during hot months of May and June, a high temperatue supported the prevalence of more bacteria in each locality.

3. Streptococcus pyogenes

Streptococcus pyogenes is responsible for a variey of inflammatory and supportive

conditions such as sore throat, scarlet fever, and wound infections (Cruickshank *et al.*, 1973). The most common route of entry of *S. pyogenes* is by the upper respiratory tract.

In the present study the maximum CFU were noted down in the air of central Lahore, such as Shah Alam Gate, Bhati Gate and Mozang particularly during the summer months of May, June and August (Table III).

Table III. Number of colonies of *S. pyogenes* obtained on the isolation media which were exposed to the air of different localities of Lahore city in different months of the year.

Name of locality	Dates				
	13.5.94	7.6.94	20.8.94	20.11.94	22.12.94
Railway Station	1	3	3	2	1
Regal Chowk	3	3	4	3	3
Shahalam Gate	5	6	7	3	1
Bhati Gate	4	3	5	4	3
Ichhra	2	3	3	-	2
Mozang	4	5	5	4	2
New Campus	1	2	2	-	2
Model Town	1	3	4	3	2
Township	1	2	5	4	3
Shad Bagh	2	3	3	3	-

Since it is Beta-hemolytic, its presence was in less number as compared to other bacteria. Further studies are needed to know if there were bactericidal gases in the air which checked its survival in the local environment. Further research is also needed to know as to how far the diseases caused by this bacterium are prevalent in the local population.

Impact of environmental factors on bacterial survival

The environmental factors that play significant role in the survival of *S. aureus*, *E. coli* and *S. pyogenes* in the air are as follow;

I. Temperature

It has been discussed earlier that CFU of *S. aureus* and *E. coli* were found more in number during the hot months of May and June, whereas during the cold months of November and December, the CFU of these bacteria decreased. Studies of Ahmad (1982) showed that the number of pathogenic bacteria increased in the air of Lahore during the high temperature period of May as compared to the lower temperature period of March.

II. Humidity

It is known that high humidity is favourable for the growth of a number of specific bacteria in the air. In the present study it was found that CFUs of *S. pyogenes* were little more in number during humid period of August as compared to dry periods of May and June. Chantefort *et al.* (1983) measured air microbiological contamination. This study showed that gram negative bacteria could survive only in a special, very moist atmosphere. However, the present preliminary studies did not support this point. Ali (1991) studied bacterial air pollution of Lahore. His results supported the findings of Chantefort *et al.* (1983) that gram negative bacteria particularly *E. coli* were more in number during humid period of August as compared to dry period of May and June. Further studies are needed to test this point.

III. Solar irradiation

Solar irradiation is also known to affect the viability of bacteria. According to Teltsch and Katzenelson (1978) relative humidity and solar irradiation appeared to affect viable bacteria in the air. A positive correlation was found between relative humidity and the number of aerosolized bacteria. Similar studies are needed in the local environment.

IV. Gases

Various gases are known to be present in the air. According to Crookshank *et al.* (1978) helium at a pressure of 20 to 70 atm. in the presence of air was found to stimulate growth of *Streptococcus faecalis*, *E. coli* and *S. aureus* mainly by increasing the rate of exponential growth.

de-Mic and de-Groot (1977) by using the Microthread technique, studied the survival of *E. coli* in open air in different parts of the Netherlands. The presence of bactericidal compounds (open air factor = OAF) could be demonstrated on several days and quantitated in relative units of OAF concentrations. In the absence of ozone, the one concentration was always low. In the persence of ozone the OAF concentration was dependent on wind direction. At the selected microthread exposure sites air from areas with high traffic intensity contributed more to OAF production than air from industrial areas. OAF production is probably related to the nature of hydrocarbons in the air. Jafri and Shah (1992) discovered corrosive effects of toxic industrial gases on redstone of Lahore fort.

In the present study the prevalence of lesser number of CFU of *E. coli* as compared to *Staphylococcus aureus* and the prevalence of little number of *Streptococcus pyogenes* may be attributed to the presence of bacterial gases in the local air. Further studies are needed to know as to what kind of bactericidal gases are present in the peri-urban and urban areas of Lahore.

REFERENCES

AHMAD, I., 1982. *A study of microbial pollution of Lahore*. M.Sc. Thesis, Department of Zoology, University of the Punjab, Lahore.

ALI, A., 1991. *A study of pathogenic bacterial air pollution in the urban and industrial areas of Lahore*. M.Sc. Thesis, Department of Zoology, University of the Punjab, Lahore.

BUCHANAN, R.E., GIBBONS, N.E., COWAN, S.T., HOLT, J.G., LISTON, J., NIVEN, C.F., RAVIN, A.W., STAINER, R.Y. AND MURRAY, R.G.E., 1975. *Bergey's Manual of Determinative Bacteriology*, 8th Ed. Williams and Wilkins Company, Baltimore, U.S.A.

CLITEFORT, A., DRUILLES, J., SINEGRE, F., BAYLET, R. AND HUET, M., 1983. Measuring air microbiological contamination. *Tech* and *Sci Municipales*, No. 3., pp. 95-98.

CHEESBROUGH, M., 1984. *Medical Laboratory Manual for Tropical Countries*. 1st Ed., Vol. II. pp. 40-420. English Language Book Society / Tropical Health Technology, Butterworths.

CRUICKSHANK, R., DUGUID, J.P. AND SWAIN, R.H.A., 1973. *Medical Microbiology*, The English Language Book Society, 11th Ed., Churchill and Livingstone, Edinburgh, London and New York. pp. 428.

DE-MIK, G. AND DE-GROOT, I., 1977. The germicidal effect of open air in different parts of the Netherlands. *J. Hyg. Lond.*, **78** (2): 175-187.

FARZANA, R., 1988. *Studies on the microbial pollution in the air of General Hospital, Lahore*. M.Sc. Thesis, Department of Zoology, University of the Punjab, Lahore.

JAFRI, R.H. AND FARIDA SHAH, 1992. Impact of environmental degradation on Islamic culture heritage in Pakistan and Central Asia. Paper presented in International Conference on Islamic Cultural Heritage, Lahore, (unpublished data).

MARQUIS, R.E., THOM, S.R. AND CROOKSHANK, C.A., 1978. Interaction of helium, oxygen and nitrous oxide of feeling bacterial growth. *Undersea-Biomed. Res.*, **5** (2): 189-198.

POWAR AND DAGINAWALA, 1988. *General Microbiology*, 2nd Ed., Vol. II. Himalaya Publishing House, Bombay, Delhi, Nagpur, pp. 32-39.

RHODE, P.A. 1973. *BBL Manual of Products* and *Laboratory Proceedings*. 5th Ed., Division of Becton Dickinson and Co. Cocky Hill, Maryland 21030, USA. 23-47, 107-120.

ROSS, F.C., 1983. *Introductory Microbiology*, 7th Ed. Charles E. Merrrill Publishing Company. A Bell Howell Company, Columbus, Tronto, London, Sydney.

TELTCH, B. AND KATZENELSON, E., 1978. Air-borne enteric bacteria and viruses from spray irrigation with wasted water. *Appl. Environ. Microbiol.*, **35**: 290-296.

Received: September 9, 1995