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Bio-Contamination of Air at a Slaughter House in Cairo

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THE DENSITIES of total viable bacteria ,spore forming bacteria , total coliform, faecal streptococci , staphylococci ,yeasts and coliphage were determined in the air at slaughter house (El-Sayeda Zeinab) indoor and outdoor and at Ramses street (as a control site) in Cairo. Total viable bacterial counts , spore forming bacteria and yeasts were detected in higher densities in the outdoor samples than those recorded in the indoor, at the slaughter house. Total coliform bacteria were recorded in very low densities, (7.4MPN/m^3) in the hall of the slaughter house, only. However, faecal streptococci, staphylococci and coliphage were detected in higher counts at the slaughter house than at Ramses street. Moreover the distribution of faecal streptococci and staphylococci species revealed that slaughter house added different types to the air of such area. The presence of *Streptococcus faecalis* indicates the absence of hygienic state whereas the presence of staphylococci indicates pollution from man and animal

Keywords: Slaughter house, Air *bio-contamination.*

Animal rearing , slaughter houses and other manufacturing processes as well as inflating of meat blocks lead to emission of many types of microorganisms into the surrounding ambient air. Many studies were carried out to evaluate the hygienic status of animal confinement buildings. As early as fifties, farm

animals have been considered one of the most important sources of microbial pollutants (Wilson and Miles,1957). Microorganisms such as *Staphylococcus aureus* and *haemolyticus* , *Streptococcus* , *E.coli, Proteus sp* and *Klebsiella* were found common in the air inside large animal and poultry houses (Lopes, 1977 and Dosokey *et al.*, 1984). The animal houses are found to be important sources of infectious staphylococci bacteria. The counts of staphylococci were decreased at 20 m far away from inside building (Platz,1979). Moreover , Northrop *et al.* (1980) reported that *Staphylococcus aureus* was transmitted from person to person and was not of an environment origin. Also staphylococci are emitted from nose and skin (Cox, 1987). Potential health depends not only types but also number of pathogenic organisms. However, Scott *et al.* (1982) reported that small number of organisms such as *Staphylococcus aureus* and *E. coli* may proliferate and become hazardous if transferred to food. Also, bacterial concentrations less than 100 cfu/m^3 were unhealthy to immunosuppressed people (ACGIH,1989). Schimberg *et al.* (1992) reported that epithelial and excremental matter from animal and feed materials are considered sources of airborne organic matter (microorganisms and endotoxins). In addition, organic matter, dust, bacteria, fungi, endotoxins, ammonia and hydrogen sulphide were studied in swine and poultry houses by many investigators such as Manninen *et al.* (1989), Lenhart *el al.* (1990), Crook *et al.* (1991) and Reynolds *et al.* (1994). Zimmerman (1987) pointed out that airborne microorganisms are potentially a source of wide variety of health hazards between residents and workers at sewage treatment plants, slaughter houses and hospitals.

The present study was directed to determine the air microbial quality in the air of a slaughter house at El-Sayeda Zeinab, Cairo ,in order to prospect the health hazards as a result of exposure to such airborne microorganisms.

Material and Methods

Sampling sites

Air samples were taken at a slaughter house in Cairo namely El-Sayeda Zeinab slaughter house which is situated in a highly populated area. The air samples were collected from the slaughter hall after 3 days of slaughtering. Outdoor samples were taken at 25 m distance away from the hall downwind . Samples were collected also from the air of Ramses street, at the Engineering Syndicate Building in Cairo (Fig. 1).

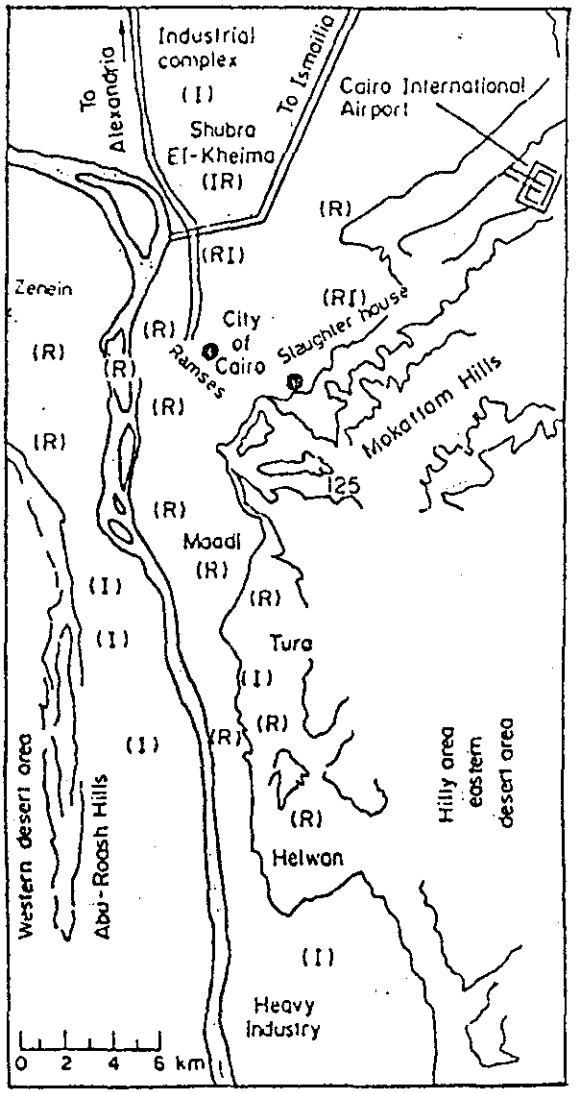

Fig. 1. Map of the Greater Cairo area showing districts of residential (R), industrial (I) activities, and sampling sites (*).

Air sampling:

The samples were collected by using liquid impinger samplers, containing 200 ml 0.1 % peptone water (Difco Detroit, Mi) and a calibrated pump with a flow rate 3.5 l/min, for 30 min duration. The samples were collected at 1.5m

height above the ground level (breathing zone), during the period from December 1993 to November 1994, monthly.

Microbial analysis

The samples were transported to the laboratory in ice boxes, and were subjected to analysis within two hours after collection. Poured plate technique and plate count agar (Difco, Detroit, Mi) were used for detecting total viable bacteria and spore forming bacteria, whereas, spread plate technique and Littman oxgall agar were used for yeast detection (APHA, 1989). The most Probable Number (MPN) technique was used for determining the densities of total coliform, faecal streptococci and staphylococci according to (APHA, 1989). Rapid plaque technique was applied to determine the counts of coliphage, using *E. coli. c* (ATCC No.13706) as a host as recommended by El-Abagy and Kamel (1989).

Meteorology

Wet and dry temperatures were recorded with Psychemeter (type 2756 Lurilh LAMPRACHT, Göttingen) and the relative humidity was computed from Psychometer chart. The air samples were collected under a wide range of meteorological parameters. Temperature ranged between 14-33°C with mean value of 23°C at indoor and 25°C at outdoor of the slaughter house and 26°C at Ramses street. Relative humidity varied between 38 and 85% with mean values of 71, 59, 55% at indoor, outdoor of slaughter house and Ramses street, respectively.

Results

The range and the mean of densities of detected microbes at the sampling sites are recorded in Table 1. It is clear that total viable bacteria, spore forming bacteria and yeasts counts were higher at the Ramses street and the outdoor of slaughter house sites than in the slaughter house hall. However , total coliform

bacteria were detected only at the indoor site of slaughter house and occasionally after fresh slaughtering processes (7.4 MPN/m^3) . Faecal streptococci bacteria were detected in mean values of 83,68 and 15 MPN/m^3 in indoor, outdoor of slaughter house and Ramses street samples, respectively. A total of 48 isolates of faecal streptococci were identified biochemically according to Bergye's Manual (1986) and were recorded in Table 2. The distribution of this group in air of slaughter house and Ramses street revealed that the predominant species were of human and warm blooded animals origin such as *Streptococcus faecalis, Streptococcus faecalis var zymogenes* and *Streptococcus faecalis var liqueficanes*. The other types are known to be non enteric species (*Streptococcus bovis ,Streptococcus equines and Atypical faecalis Π*), these organisms are of insect or vegetative origin and indicates that some of the collected bacteria are ubiquitous and soil born.

Staphylococci bacteria were detected in relatively higher levels at the slaughter house (with the means 90 and 46 MPN/m^3 at indoor and outdoor, respectively) than at the Ramses street site (with the mean 26 MPN/m^3) . These results indicate that, staphylococci were related mainly to human and animal activities, animal carcasses and blood. Also, animal houses are found to be important sources of staphylococci and pathogens. The identification of 46 isolates of staphylococci according to biochemical reactions (Bergye's Manual, 1986) was recorded in Table 3. *Staphylococcus epidermidis* and *Staphylococcus saprophyticus* were the dominant species. However, *Staphylococcus aureus* (6.25%), *Staphylococcus haemolyticus* (37.5%) and *Staphylococcus cohneii* (6.25%) were found in the samples of the slaughter house only. Coliphage was detected in a higher density (a mean value of 103 pfu/m^3) at the slaughter house than that recorded at the Ramses street site (a mean value of 10^2pfu/m^3) .The highest density of coliphage was found in the wet site, the slaughter house hall, while lower level was found in the outdoors (Table 1).

TABLE 1. The densities of microbial parameters at slaughter house and Ramses street sites.

	Slaughter house		
	Indoor	Outdoor	Ramses
Total viable count	($1.4x10^3$ - $1.4x10^6$)	$2.4x10^3$ - $1.9x10^6$	$1.1x10^3$ - $3.7x10^7$
cfu/m^3	$1.5x10^5$	$2.7x10^3$	$5.5x10^6$
	[3.96]	[4.32]	[4.56]
	{0.88}	{0.97}	{1.52}
Spore forming bacteria	($1.4x10^3$ - $1.4x10^4$)	($2.3x10^3$ - $1.6x10^6$)	($3.5x10^3$-$2.5x10^6$)
cfu/m^3	$7.1x10^3$	$1.4x10^5$	$2.3x10^5$
	[3.76]	[4.13]	[4.4]
	{0.29}	{0.77}	{0.76}
Total coliform	(0 - 48)	0	0
MPN/m^3	7.4	-	-
	[0.26]	-	-
	{0.6}	-	-
Faecal streptococci	(0 - $3.88x10^2$)	(0 - $277x10^2$)	(0 - 56)
MPN/m^3	83	68	15
	[1.48]	[0.95]	[0.52]
	{0.84}	{1.05}	{0.78}
Staphylococci	(0 - $3.33x10^2$)	(0 - $1.66x10^2$)	(0 - 48)
MPN/m^3	90	46	26
	[1.38]	[1.33]	[0.91]
	{0.95}	{0.83}	{0.84}
Yeasts	($3.7x10^2$-$3x10^3$)	(0 - $4.6x10^3$)	(0 - $3.6x10^3$)
cfu/m^3	$1.7x10^3$	$2.4x10^3$	$2x10^3$
	[3.13]	[2.58]	[2.3]
	{0.35}	{1.5}	{1.45}
Coliphage	($1.1x10^3$-$7.2x10^3$)	($4.8x10^2$-$9.1x10^3$)	(0 - $1.2x10^3$)
pfu/m^3	$2.9x10^3$	$2.2x10^3$	$4x10^2$
	[3.41]	[3.17]	[1.52]
	{0.22}	{0.36}	{1.40}

(Range), Arithmetic mean, [Geometric mean], {Geometric standard deviation}.

TABLE 2. Identification of faecal streptococci group.

	Slaugter house		Ramses	
Types of isolates	No	%	No	%
Streptococcus faecalis	10	26.3	0	0
Streptococcus faecalis[a]	3	07.9	0	0
Streptococcus faecalis[b]	7	18.4	0	0
Streptococcus bovis	4	10.5	2	20
Streptococcus equinus	5	13.1	5	50
Atypical faecalis I	2	05.3	0	0
Atypical faecalis II	2	05.3	3	30
Atypical faecalis IV	2	05.3	0	0
Atypical faecalis V	3	07.9	0	0
Total	38		10	

[a]: Var liqueficanes [b]: Var zymogenes.

TABLE 3. Identification of staphylococci group.

	Slaughter house		Ramses	
Types of isolates	No.	%	No.	%
Staphylococcus aureus	2	6.25	0	0
Staphylococcus epidermids	6	18.75	6	46.15
Staphylococcus heamolyticus	12	37.5	0	0
Staphylococcus saprophyticus	8	25	6	46.15
Staphylococcus capitis	2	6.25	1	7.7
Staphylococcus cohnei	2	6.25	0	0
Total	**32**		**13**	

Discussion

The higher densities of total viable counts and spore forming bacteria at the Ramses street site (control) and at the outdoor of the slaughter house compared to indoor counts might be due to human activities (bedding, dressing and sweeping), (Meyer, 1983), air conditioning (Gebra *et al.*, 1975), traffic intensity (Jones and Cookson, 1983),animal movement and air turbulences. Outdoors , the action of wind and rain as well as movement of animal and vehicles produces large aerosols particles (Cox ,1987). In the present study, our results at slaughter house are in agreement with Sobih and Hefnawy (1987) who found that the aerobic plate counts at the air of Assuit abattoir ranged between $2x10^4$ and $6.8x10^7$ cfu/m^3 with a mean value of $1.2x10^5$ cfu/m^3. Spore forming bacteria are related to natural dust and larger dust particle sizes (Simard *et al.*, 1983). Moreover, spore forming bacteria are coincided mostly to dust of soil contamination and exists on surfaces (NASA, 1986). In contrast, the lower spore forming bacterial counts at indoor site of the slaughter house compared to outdoor of slaughter house and the Ramses street sites may be attributed to less amounts of suspended dust there and to hydration and desiccation at higher relative humidity (in the present study Rh % was 80% and temp. 22°C, indoor) , (Cox, 1987) , their movement by low terminal velocity (indoor) and loss of water by diffusion and consequently denaturation of cell wall (Gregory, 1973).

Generally , coliforms are less capable to survive in air. They are unsuitable air microbial indicators (Mueller *et al.*, 1980, and Scott *et al.*, 1982). Many biochemical defects lead to the death and loss of coliform viability. Cell wall is freely permeable to ions and sugars (Anderson and Dark, 1969) , loss ability to

synthesis of β-galactosidase immediately after aerosolization and in turn, lose the ability to form colonies (Webb *et al.*, 1965), and oxygen effects, damage of cytochrome flavin linked enzymes (Benbough, 1969). Moreover, Cox (1966) attributed the rapid death of coliform and *E. coli* aerosols to three stresses: i- air stresses (low Rh%), ii- relative humidity (at high Rh%) and iii- collection stresses and osmotic pressure. On the other hand , faecal streptococci group is considered a reliable bacterial indicators at environment rather than faecal contamination. It is highly resistant to adverse weather conditions (Crawford and Jones, 1979 and Lembke and Kniseley, 1980). Also, decay rate of faecal streptococci is low due to its less affection by initial shock of aerozolisation (Sorber and Sagik, 1980). However, Sobih and Hefnawy (1987) found enterococci in the air of Assuit abattoir in higher numbers ($5.4x10^5$ cfu/m^3) than that recorded in the present study. This difference may be due to difference in conditions, technique and procedures used in both studies. The authors used filtration technique and medium based on manganese deficiency for detection enterococci. In the present study, the comparison of the types of faecal streptococci isolated from the two areas (slaughter house and Ramses sites) confirmed the emission effects of slaughter house which adds different pathogenic species to the air of such areas (Table 2). The presence of *Streptococcus faecalis* indicates a bad hygiene of air. Moreover , enterococci group is indicative of sanitary neglected measures during slaughtering and preparation of carcasses and lack in cleaning of slaughter houses. In the present study, *Streptococcus faecalis* was found in a percentage of 26.3% whileas it was found in a percentage of 31.5% at farm building (Dosokey *et al.*,1984) and was 28.7% in air at Assuit abattoir (Sobih and Hefnawy, 1987).

In the present study , slaughter houses are found to be sources of infectious staphylococci (*Staphylococcus aureus*). Dosokey *et al.* (1984) found that *Staphylococcus aureus* was common inside and outside of farming building which constituted 49 out of 111 isolates. The isolation of staphylococci indicated pollution from man and animal (Ahmed *et al.*, 1984). The danger of staphylococci organisms may be due to their implication as etiological agents of foot borne illness , skin abscesses and osteomylitis (Ivler, 1974). In addition,. *Staphylococcus aureus* is one of the most common agents of food poisoning. Also , *Staphylococcus aureus* in drinking water may serve a source of colonizing residents exposed to contaminated water. Moreover, yeasts and *Candida*

albicans are responsible for severe types of intestinal disturbances and mouth diseases (Bailey and Scott, 1974). However, many factors are affecting on the infectivity airborne microorganisms such as air pollutants, infective dose , host antibodies, landing site and aerodynamic diameter (Cox, 1987).

There are no data regards coliphage at slaughter house. In contrast, many investigators studied coliphage densities at wastewater treatment plants such as Fannin *et al.* (1985) and El-abagy *et al.* (1992). The presence of coliphage could estimate animal viral levels and indicates the presence of faecal contamination in spite of absence of coliform. Coliphage has more resistance to stresses such as desiccation, radiation, ozone and open air factor (ozone + olefins) compared with other microbial indicators (coliforms), (Cox, 1987). Sorber and Sagik (1980) suggested the reliability of faecal streptococci and coliphage as air microbial indicators at wastewater treatments plants. El-abagy and Kamal (1989) found coliphage in water samples in absence of coliform. So, it is suggested that the presence of coliphage indicates the presence of pathogenic enteroviruses and faecal contamination. This conclusion is confirmed by Fannin *et al.* (1976) who proposed the use of coliphage as indicator of animal viruses. Also, Fannini *et al* . (1977) concluded that wastewater treatment facilities could serve as continuous source of low level of animal viruses aerosols. They added that phages were more stable than coliforms in airborne state and therefore more acceptable as indicators of airborne animal viruses concentrations.

The results in the present study revealed that slaughter house can be considered a continuous source of pathogenic (streptococci and yeast) and infectious (staphylococci) besides offensive odor. So, the chance of a potential infections or outbreaks by biological aerosols via inhalation or settling on food or skin are present. However, many factors such as chemical composition of the aerosols, aerosol age and particle sizes can affect virulence of microorganisms. Also, measurements of infectious doses are fraught with difficulties and quoted values need to be treated with caution (Cox, 1987). Thus , these results reinforce the importance of the presence of a buffer zone between such facilities and residential areas, continuous removal of waste and cleaning of halls (in and out). Such facilities should be constructed in places far away to residential areas. Moreover, prevailing wind direction should be taken in consideration during construction of such facilities.

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التلوث الحيوى لهواء أحد المجازر بالقاهرة

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تم تعيين تركيزات الكائنات الحية الكلية، البكتريا المكونة للجراثيم، بكتريا القولون الكلية، بكتريا القولون السبحية والبكتريا العنقودية والخمائر والكوليفاج فى الهواء الداخلى والخارجى بمجزر السيدة زينب ومنطقة شارع رمسيس بالقاهرة. وقد وجد أن المجزر يعتبر مصدراً من مصادر التلوث الحيوى للهواء وذلك لوجود أعداد كبيرة من الدلائل الميكروبية مثل بكتريا القولون السبحية والعنقودية وأيضاً الكوليفاج. من الناحية الاخرى وجد أن بكتريا القولون الكلية قد رصدت فقط فى منطقة المجزر (داخل العنبر أثناء عمليات الذبح) وقد ثبت عدم كفائتها كدليل للتلوث البرازى للهواء وذلك نتيجة لسرعة موتها. بينما رصدت الكائنات الحية الكلية والبكتريا المكونة للجراثيم والخمائر باعداد كبيرة فى المناطق المفتوحة (شارع رمسيس وخارج المجزر) مقارنة بتلك الموجودة داخل العنبر بالمجزر وذلك لارتباط هذه الكائنات بنسبة الاتربة المتساقطة والعالقة فى هواء المنطقتين.