Faculty of Veterinary Medicine

Airborne Contamination with Bacteria in Poultry Houses in - Khartoum North Locality

By

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قال تعالى:

{ هو الله الخالق البارى
المصور له الأسماء الخنسى
يسبح له ما في السماوات و
الأرض و هو العزيز الحكيم
}
DEDICATION

To My Mother's Soul
I would like to thank my supervisor Dr. Tawfig El Tigani for his guidance, patience and the encouragement and support.

My thanks are also due to the technical staff of the Department of Veterinary Preventive Medicine and Public Health, University of Khartoum, Technician, Huassin Abdel Rahim, Zienab Eltyeb and Tahani Ibrahim for their kindness and the assistance they gave to me during my research, and special thanks to my colleague Salma Kamal.

I am so grateful to everyone who helped me.
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This study was conducted in Khartoum North poultry farms during February 2007 to August 2007. The main objective was to determine the level, enumeration and characterization of microorganisms in poultry farms air, in addition, to study the factors that contribute to the presence of these microorganisms in the air.
The results showed that the total bacterial counts were high in all studied farms (100% uncountable).

Gram positive Bacilli (28,92%) Staphylococci (27,27%), Micrococci (28.92%) and Gram-negative Bacilli (10,74%) respectively were the most abundant in the air from the studied farms.

Other types of microorganisms were isolated in varying percentages.

The isolated microorganisms included both pathogenic like Escherichia coli and non-pathogenic ones like some types of gram positive Bacilli. The results also showed that the type of system adopted in poultry farms in the study area has no significant role in the level of air contamination.
العوامل التي تعزز من وجود البكتريا في الهواء ومصادر هذه البكتريا، وقد خرجت هذه الدراسة بالنتائج التالية:

العدد الكلي للبكتريا كان عالياً في جميع المزارع تحت الدراسة، (لا يمكن عدها) وقد كانت أكثر أنواع البكتريا تواجداً في الهواء الجوي لمزارع الدواجن تحت الدراسة كالآتي:

- البكتريا العصوية الموجبة لصبغة الجرام 28.92%، البكتريا الغانودية 27.27%، والبكتريا من جنس الميكروكوكس 28.92%، والبكتريا العصوية السالب لصبغة الجرام 10.74%.

وقد عزلت أنواع أخرى من البكتريا بنسب مختلفة من الهواء الجوي للمزارع تحت الدراسة.

وقد أشتملت الأنواع المعزولة من البكتريا على أنواع مرضية مثل الأشريشيا القولونية وأخرى غير مرضية مثل بعض أنواع البكتريا العصوية الموجبة لصبغة الجرام، وأظهرت الدراسة أن أنواع مزارع التربية في منطقة الدراسة ليس لها دور في التلوث الميكروبي للهواء من حيث الكم.
INTRODUCTION

Air is considered as an important element for all forms of life, as oxygen it is important for oxidation and energy production in nature. Beside that carbon dioxide is used by plants for organic substance formation. From medical point of view air plays an important role in regulation of body temperature. Also it plays role in the transmission of pathogenic organisms.

It is of utmost importance for the workers in the animal health to be aware of the common contaminants in the air and animal pens, their mode of accumulation, the level of tolerance by human and animals and how to purify and control the microbial contaminants in the air.

Over crowding of animals in the pens will distort the constituents and standard of air in the environment, and this may lead to discomfort to the animals and subsequent decrease in their vitality and productivity.(Abdel – Meuz and Mahmoud 1982)

Air composition:

Pure air consists of a mixture of colorless gases in the following percentages:

- Oxygen 20.94%
Also it contains Ammonia, Ozone, Nitric acid, hydrogen peroxide and methane in small amounts. (Abdel – Meuz and Mahmoud 1982).

Impurities of air in animal's pens can be divided into two main groups:

1-Gaseous impurities, such as carbon monoxide, ammonia, and sewer gases.

2-Solid impurities and these include:

A-Inorganic substances such as dust, sand, calcium carbonate and inorganic insecticides.

B-Organic substances, such as plant cells, pollen grains, hair and organic insecticides.

C-Biological objects such as the bacteria, Rickettsia, Viruses and fungi.

Bedding in animal's pen and specially in poultry houses plays a crucial role in air contamination, beside the water and the daily animal activities, natural and pathogenic discharges.
The indoor environment, density of animals over space unit, administration and the health status of the herd are the determinants factors in the level of viable microorganisms in the air.

**Role of air as a vehicle of pathogenic microorganisms:**

Air is considered as an important vehicle of infection for air-borne diseases which can be transmitted in different ways as follows:

1-Droplets infections, in this case the microbes are transmitted from one animal to the another through droplet or droplet nuclei, which are suspended in the air.

2-Dust-borne infections, this occurs when the pathological discharges adhere to the animal hide, and when dry it falls to the ground and carried by air and infect another animal or contaminate its feed and water. The level of contamination depends on the ability of the microorganism to stand the adverse environmental conditions. (Abdel – Meuz and Mahmoud 1982).

Ambient air may be contaminated with or carry significant levels of a variety of potentially harmful microorganisms. There are three major sources of such microbes:
a) Those arising from microbial decomposition of various substrates associated with particular occupants (moldy hay)

b) Those associated with certain types of environment (e.g. Legionnaires, bacteria in water supplies) and,

c) Those stemming from infective individuals harboring a particular pathogen (e.g. tuberculosis).

Microorganisms that are uniformly injurious are differentiated from those that are more opportunistic. Such microorganisms are categorized according to whether they are allergic, infectious or capable of inducing toxic or inflammatory reactions when inhaled. (Robert Burrell, 1991).
Table (1) Showing the Primary airborne pathogens from nonhuman sources

<table>
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<tr>
<th>Agent</th>
<th>Disease</th>
<th>Source</th>
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<td><em>Bacillus anthracis</em></td>
<td>Woolsorters disease, pneumonic</td>
<td>Hides, bone meals</td>
</tr>
<tr>
<td></td>
<td>and cutaneous anthrax</td>
<td></td>
</tr>
<tr>
<td><em>Histoplasma capsulatum</em></td>
<td>Histoplasmosis</td>
<td>Soil enriched with birds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>droppings</td>
</tr>
<tr>
<td><em>Coxsiella burnetii</em></td>
<td>Q fever</td>
<td>Contaminated meat</td>
</tr>
<tr>
<td><em>Chlamydia psittici</em></td>
<td>Ornithosis</td>
<td>Dried droppings from infected</td>
</tr>
<tr>
<td></td>
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<td>fowl</td>
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</table>

Source: (Robert Burrell, 1991)
The study objectives:

General objective:

1. To evaluate the level of microbial contamination of air in poultry farms.

Specific objectives:

1. To determine the common microbial contaminants in the air
2. To study the magnitude and distribution of microbial Contaminants in poultry farms air (environment).
3. To determine the airborne pathogenic flora.
4. To determine the effect of rearing systems on the microbial diversity in the environment.
CHAPTER ONE

LITERATURE REVIEW

It is first to realize that air is not sterile, even in highly controlled environments. The fungal spores concentration in outdoor air can reach $3 \times 10^9$ spores /m³ (Lacey et al., 1972). By comparison, the fungal spore content of indoor ambient air, such as that found in homes and offices, may reach a burden of only 10 to 30 % in that of normal outdoor airs provided that there is no additional internal source of contamination (Morey, 1989).

The outer range is affected by temperature, relative humidity, and season. The bacterial content of indoor air may be more than that found outdoors, where ultraviolet light is bactericidal to air borne microorganisms. Indoor air is affected by such factors as moisture, relative humidity, and insulation. A typical aerobic concentration of bacteria may be approximately 15 to 500 colony –forming units (CFU)/m³ (Cousinns and Collett, 1989). Although no actual safety data are available, the figure of $10^3$ microorganisms /m³ is generally considered the maximum safety level, (Dutkiewicz et al., 1988).
Zucker et al., (2000a) stated that dust and microorganisms with different admixtures are abundant in the air of livestock houses.

Riley (1972), stated that the atmosphere of a building along with its occupants constitutes an ecological unit through which aerosols from various sources move on air currents.

As stated by WHO (1988), that ventilation system can support the growth of fungi, bacteria and other microorganisms. They added that increase in humidity up to 70%, aids the growth of microorganisms on the structural parts of the building. Riely, (1972), stated that the lack of outdoor air supply will increase the likelihood of the airborne transmission of infectious diseases through the increase of suspended bacteria in droplet nuclei.

1. Sources of microbial bioaersols:

1.1. Human source

Davies and Noble, (1962), stated that aerosols particulates from human body arises from the droplets nuclei and desquamated skin. In addition some aerosols may arise from toilet flushing. Chausse and Magne, (1916), added that coughing and sneezing can be a source of microbe in the air.
Duguid, (1946), showed that the smaller the size of the droplet nuclei the greater its chance to remain suspended in the air, it can reach the deepest tissues of the lungs and have the greater chance to initiate infection.

Dutkiewicz et al., (1988), stated that among the best studied sources are those arising from microbial decomposition of various substrates associated with particular occupants.

1.2. Environmental sources:

A second common source of significant microorganisms in the indoor is associated with certain types of environment.

Environmental factors that promote the spread of infections are poor ventilation; close quarters, lack of sterilizing sunlight, and high humidity together with stressful conditions imposed on the host. Rabies, a disease transmitted by the bite of an infected animal, can also be acquired by the respiratory route in caves with high concentrations of bats, some of which were known to be infected, (Warhurst, 1985).

Aerosol particulates resulting from the desquamated skin was considered by Noble, (1961) as a source of staphylococcus in the air. Speers et al., (1966), showed that different human activities can increase the rate of shedding of microbial aerosol particles for up to 1 hour afterwards.
1.3. Animal source:

Winkler, (1968) found that animals shed aerosol particles in a fashion similar to man, that is, through respiration and shedding from the hide.

In addition, faecal droppings and urination can be sources of microbial aerosols.

Indoor transmission of diseases between animals by aerosols is well established for Newcastle disease, Rift Valley fever, Venezuelan equine encephalitis, and similar diseases (Hugh – Jones 1973).

Indoor processing of animal products can generate high concentrations of microbial aerosols that may contain organisms with potentially significant adverse effects on human health.

Spear, (1891) reported that in the period 1880 -90, in England, about 50 fatal cases were recorded which resulted from indoor aerosols of Bacillus anthracis.

Dahlgren et al., (1960) found up to 33000 organisms of various species per cubic meter in weaving area of mills in Pennsylvania U.S.A. They also reported that Q.fever could also be contracted through exposure to aerosols produced in textiles that handle animal hide and hair.
Hendricks et al., (1962) reported a high level of Brucellosis epidemic in an abattoir that was transmitted by aerosol.

Fruclow et al., (1955), Loosli, (1952) reported that the infectious aerosols of histoplasma capsulatum were generated by cleaning of chicken coops and other areas where birds live.

The human health consequences of exposure to aerosols from plants sources are generally less important than the consequences of exposure to aerosol caused by animal sources and animal products.

Mundt et al., (1966) found an aerosols of Leuconostoc ,and Aerococcus along with many different species of Streptococci ,particularly Streptococcus faecalis in industrial plants that process and freeze vegetables. Krue et al., (1970) stated that the transmission of a number of diseases between adjacently caged ,experimentally infected animals has been demonstrated. Pike, (1976) indicated that among the large numbers of bacterial species implicated in laboratory infections, a large portion can be traced to indoor aerosols. Huddleson, (1940) stated that closed environments and other structures in which virtually all the inside air is reticulated can present particular problems. Walter, (1966) reported that aerosols loded with Staphylococcus aureus are of a considerable importance in disease production particularly in hospital environment.
Gunderman, (1980) indicated that microbial growth within the ventilation system may occur at any time, especially when humidity exceeds 97 percent, and that *pseudomonas* species are common organisms found to grow and disseminate in aerosols from ventilation systems.

Anderson, (1959) reported that *pseudomonas aeruginosa* was reported to spread from water in the cooling unit of ventilation system. Gunderman, (1980) was able to isolate both *Klebsiella* and *pseudomonas* species, as well as sporforming bacteria and molds from aerosols of the ventilation systems.
1.4. Intimate source:

Spendlove, (1975) showed that a variety of potentially hazardous aerosols is available to penetrate residences and other structures. These aerosols arise from industrial activities in the rendering plants, abattoirs, sewage treatment facilities and from agricultural activities.

Seabury et al.,(1976) isolated a large number of spore forming and non-spore forming thermo tolerant bacteria of undetermined disease significance, from home-humidifiers.

Studies of Burge et al., (1980) revealed that thermophilic actinomycetes were recovered from air of all houses studied. Reinarz et al.,(1965) demonstrated that nebulizer assemblies generated aerosols containing large number of gram-negative Bacilli, namely *Pseudomonas* species, *Flavobacterium* species and *Acromobacter*. Walter, (1966), noted that the floor is the largest and most persistent secondary bacterial aerosol reservoir in hospital environment.

Anderson (1969) found that the microbial contamination on carpeted floors were up to 100 million organisms per square meter. The redispersion of these organisms into the air was found, to be influenced by floor traffic than the type of floor covering (Walter, 1969).
Bakutis, (2004), found that the concentration of endotoxins transmitted in air differ, not only indifferent environment, but also in the same environment depending on the type of livestock, way of animal keeping and system of farm management (Muller et al, 1987, and Wijnad et al., 2000b). Epidemiological studies in livestock indicate that due to long term influence of endotoxins, chronic bronchitis and deficiency of lung function might develop (Rylander, 1987).

The results of bacteriological test carried by Bakutis, (2004), showed that the concentration of airborne bacteria in insulated and uninsulated cowsheds for dairy cows was much smaller than in pigs and poultry houses. The study showed that the average microbiological contamination in pigs and poultry houses was 5.6 and even 14.1 times higher than in insulated cowsheds. Gram-negative bacteria made approximately 2.6% in poultry houses, which was the highest among all animal houses.

In poultry houses, the average amount of gram-negative bacteria was 1.6 times higher than in insulated cowsheds. Muller et al., (1987) affirm that airborne Gram-negative bacteria survive in the environment for a short time, while the end toxins survive even after the death of the bacteria.

2. Types of Microorganisms in indoor Air:
Microorganisms represent a very heterogeneous and extremely diverse group of entities having in common only their microscopic size. Even size may extend into the macro range among fungi, (Austwick, 1966).

The mycobacteria are related to the *actinomycetes* and contain species responsible for tuberculosis and leprosy. Although the former is certainly transmitted from active cases to susceptible hosts, ambient air would only be expected to contain viable tubercle bacilli if an infected individual inhabited the premises. Other less virulent species (the "atypical" mycobacterium) are associated with normal environmental sources. Although it is not clear just how man contacts these agents, it almost certainly is via the respiratory route but not from other infected cases and usually does not lead to overt disease. Overt disease is usually a result of other complicating or debilitating factors. (Robert Burrell 1991)

3. Types of reactions caused by Airborne Microbes:

A major type of reaction caused by the inhalation of airborne microorganisms is

3.1. IgE -mediated, immediate hypersensitivity or allergy:

This type of hypersensitivity is due to antigen -specific antibodies of IgE, (Wasserman, 1983).
Almost all microbial allergens are fungal in origin, with some extracellular enzymes of bacteria occasionally being important in selected environments.

Moldy and dusty environments are exceedingly uncomfortable places for Allergic individuals.

3.2. Opportunistic Infections:

Airborne microbes may cause a variety of infections, including the obvious cases of person-to-person transmission diseases. One of the most famous causes of airborne disease from an environmental source is the microbe responsible for what has become known as Legionnaires disease.

The original epidemic attributed to this disease occurred in 1976 and it was notable because of its high rate of hospitalization and mortality, (McDade, 1977). As stated by Ajello, (1980), a variety of environmental fungi are capable of causing pulmonary infection in man and animals. Cryptococci are yeast associated with environmental sources that may be picked up by the aerosol route. Cryptococci are most closely associated with soil contaminated with pigeon droppings, although this microbe can be found in the air in most urban environments.
Aspergillus spores, which are produced in large amounts, are found in indoor air and can cause simple seasonal rhinitis or lead to a more complicated form known as bronchopulmonary aspergillosis.

It is becoming increasingly recognized that even protozoa may become airborne and be associated with human infection., these species are certainly capable of being quarried by the respiratory route in environments where contaminated water sources may become aerosolized by either natural or artificial means, (Warhurst, 1985). Anthrax is a rapidly fatal disease, made worse by the fact that the endospores are entesily resistant to environmental disinfectants. Once soil becomes contaminated with the spores, it becomes environmentally unsuitable for further animal or human use. The only rickettsial disease to be concerned with from airborne sources is a disease of animals called Q fever; all other rickettsial diseases are transmitted from person to person by intermediate arthropod vector, Robert Burrell (1991).

3.3. Toxic or Inflammatory Reactions:

Inhalation of microbes or their structural cell wall components may lead to a variety of inflammatory conditions of complex pathogenesis. Chief among these is hypersensitivity pneumonitis,a range of clinical entities from acute mycotoxicosis caused by the one-time inhalation of
large amounts of mycelial/spore matter, to acute disease in individuals with prior sensitivity, and to progressive, lethal disease occurring in individuals with undefined intrinsic susceptibility (Seaton, and Morgan, 1984). Cell walls of the representative microorganisms associated with these entities are known to incite inflammatory reactions (largely through the enzymatic cascades like the alternative complement pathway), activate macrophages, initiate lymphocyte mitogenesis, and induce specific immunocytotoxic cells. The combination of any of these specific immunologic mechanisms together with undefined host fitors may lead to one of these manifestations or, indeed, to no manifestation at all (Burrell, and Rylander, 1981). It is not necessarily a prerequisite to inhale living microbes to cause adverse reactions. Activation of inflammatory cascades or elicitation of allergic reactions does not require inhalation of living agents because the response is to molecular constituents of the microbe. It is well known that the structural components of bacteria and fungi are extremely bioactive, capable of initiating a variety of inflammatory and immunomodulatory activities. One such material is bacterial endotoxin, an integral structural component of the cell walls of Gram-negative bacteria. This substance is highly inflammatory and can activate innumerable mediator systems, giving rise to a variety of physiologic effects (Burrell, 1990, Morrison, and Ryan, 1987).
3.4. Endotoxin:

Is heat stable, ubiquitous, and capable of eliciting inflammatory reactions in extremely small concentrations? Worse, the substance has the capacity to enhance the effects of other inflammatory stimuli such that coincidental exposure to two or more incitants, including endotoxin, can possibly result in serious pulmonary injury. Occupations in which workers are constantly exposed to endotoxin may be at risk of developing pulmonary or even systemic disease. (Rylander et al., 1978)

4. Types of Air samplers:

In response to a rapidly increasing awareness of problems in air pollution and air hygiene, considerable emphasis has been placed on sampling of gaseous and particulate contaminants.

The intrinsic characteristics of microbes make them difficult to collect and assay quantitatively. There are few standard devices for sampling and virtually no standards for allowable or desirable microbial burden in the air.

Sampling for airborne microorganisms does not differ from ordinary particulates sampling except for the added necessity of assessing viability of the microbes of interest.
Much of the technology of sampling of airborne microbes has been developed by medical researchers concerned with both viability and infectivity of the airborne microorganisms.

Air hygiene studies have been done by workers on the dispersal of microbes from sewage plants airborne Q fever from rendering plants, Coccidiosis immitis from open ground, and rabies virus in bats caves. Extramural air sampling studies are of importance to workers concerned with transmission of animal diseases. In almost all cases, the strategy is to collect viable organisms by optimal means and to demonstrate their presence by appropriate culture methods, Hugh and Jones, (1973).
Table No: (2) Showing the system for Samples more frequently recommended for use in sampling microbial aerosols

<table>
<thead>
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<th>Sampler</th>
<th>Principle</th>
<th>Sampling time</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson multi-stage sieve-type</td>
<td>Impact nutrient</td>
<td>1 min</td>
<td>Bacteria and viruses</td>
</tr>
<tr>
<td>Slit sampler</td>
<td>Impaction</td>
<td>1 mi. to 1 hour</td>
<td>CFU</td>
</tr>
<tr>
<td>Open Petri dish</td>
<td>Sedimentation</td>
<td>0 - 4 hours</td>
<td>Large particulates CFU</td>
</tr>
<tr>
<td>Hirst spore trap</td>
<td>Impaction</td>
<td>24 hours</td>
<td>Spores and pollen</td>
</tr>
</tbody>
</table>

Source: May 1969
The indoor environment was found to have fewer types of infection sources and variety of microbes but more favorable environments for the survival of airborne microbes, Settling plate do not provide good overall size presentation since they collect only the large particles, but they can be useful in many applications requiring knowledge of surface contamination from aerosols, Wadkins (1970).

5. Environmental and biological factors in the indoor environment:

5.1. Ventilation:

Indoor-outdoor exchange will dilute indoor generated concentrations of viable air contaminants. It may also affect indoor humidity levels and thermal loads, and introduce viable outdoor contaminants (WHO, 1988).

5.2. Moisture:

Moisture levels extreme in air can promote the survival of several species of microorganisms and enhance the release of fungal spores (WHO, 1988).

5.3. Temperature:

Human susceptibility to biological aerosols increases with warm temperatures (WHO, 1988).
5.4. Building Microbiology:

Spores and viable bacteria are ubiquitous. In the indoor environment they form part of the house dust found on surfaces, and in air as aerosols. (WHO, 1988), they also stated that any sediment in water is a habitat for a rich flora containing bacteria, fungi, actinomycetes, algae and amoebae, depending on the temperature, the flora may be dominated by mainly thermophilic organisms.

Riley, (1972), stated that some infectious diseases such as tuberculosis, Legionnaires disease or measles have been demonstrated to spread through the airborne transmission of the infectious agent. And airborne transmission may play a contributory role in the others. Lack of adequate supply of outdoor air will also increase the likelihood of the airborne transmission of infectious diseases through an increase in the concentration of suspended viruses and bacteria in droplet nuclei.

6. Pathogenicity of Air Microorganisms:

6.1. Bacilli:

6.1.1. Bacillus coagulans

May be an opportunistic pathogens, spore formation, universally found in the genus, is thought to be a strategy for survival in the soil
environment, wherein the bacteria predominate. Aerial distribution of the dormant spores probably explains the occurrence of *Bacillus* species in most habitats examined.

6.1.2. *Bacillus megaterium*

*Is a spore-forming bacterium found in soil, seawater, sediments, rice paddies, dried food, honey, and milk* (Vary, 1994). The economic importance of *B. megaterium* includes its production of vitamin B₁₂.


6.1.3. *Bacillus cereus*

*Bacillus cereus* is a spore-forming organism, which occurs naturally in most foods. It causes two different forms of food poisoning: an emetic illness and adiarrheal illness. (http://www.nzfsa.govt.nz/science data-sheet -Bacillus cereus pdf)

**SOURCES**

**Human:** Humans are not a significant source of food contamination by *B. cereus*. This organism already exists on many foods and can therefore be transiently carried in the intestine of healthy humans (0-43%).
**Animal:** Animals can carry *B. cereus* on parts of their body. May occasionally cause mastitis in cows.

**Food:** Raw foods of plant origin are the major source of *B. cereus*. The widespread distribution of the organism, the ability of spores to survive dried storage and the thermal resistance of spores, means that most ready-to-eat foods will contain *B. cereus* and will require control measures to prevent growth especially after cooking has eliminated competing flora.

6.1.4. *Bacillus subtilis*

It has been incriminated, as have other "nonpathogenic" aerobic spore bearers, in human infections of the eye, generalized infections, urinary tract infections, pneumonia, postoperative wound infections, septicaemia, and infections of the central nervous system.

7. *Aerococcus*

7.1. *Aerococcus viridans:*

Organisms are gram-positive, usually airborne cocci that are widely distributed in hospital environments. These bacteria have infrequently
been encountered as a human pathogen causing bacteremia, endocarditis and urinary tract infections. The clinical significance of these bacteria may be overlooked due to their fastidious growth and often confused with other strains of *Streptococci*.

It is generally considered as a contaminant in clinical cultures, but occasional reports have noted clinically significant roles for this organism in systemic infections such as bacteremia and endocarditis. *Aerococci* appear to be of low virulence and may be normally pathogenic only in patients with vulnerable conditions.
8. Micrococcus

8.1. Micrococcus luteus

Is a genus of bacteria in the Micrococcaceae family. Micrococcus occurs in a wide range of environments, including human skin, water, dust, and soil. Micrococci have Gram-positive spherical cells ranging from about 0.5 to 3 micrometers in diameter and are typically arranged in clusters. Micrococci have been isolated from human skin, animal and dairy products, and beer. They are found in many other places in the environment, including water, dust, and soil. M. luteus on human skin transforms compounds in sweat into compounds with an unpleasant odor. Micrococci can grow well in environments with little water or high salt concentrations. Most are mesophiles; Micrococcus is generally thought to be a saprophytic or commensal organism, though it can be an opportunistic pathogen, particularly in hosts with compromised immune systems, such as HIV patients. It can be difficult to identify Micrococcus as the cause of an infection, since the organism is a normally present in skin microflora, and the genus is seldom linked to disease. In rare cases, death of immunocompromised patients has occurred from pulmonary infections caused by Micrococcus.
Micrococci may be involved in other infections, including recurrent bacteremia, septic shock, septic arthritis, endocarditis, meningitis, and cavitating pneumonia (immunosuppressed patients).

(http://www.en.wikipedia.org/wiki/Micrococcus.)
9. *Staphylococcus*

9.1. *Staphylococcus epidermidis*

Is a commensal bacterium of the human skin. However, *S. epidermidis* and other coagulase-negative *staphylococci* emerge also as common nosocomial pathogens infecting immunocompromized patients carrying medical devices.

The staphylococci are a diverse group of species that are routinely categorized in the clinical setting as either coagulase positive or coagulase negative (Archer, 1995).

Being the species most frequently isolated from bloodstream infections (Kloos, and Bannerman. 1994).

Concentrations of airborne bacteria and fungi were lower than $7.1 \times 10^2$ and $4.4 \times 10^1$ CFU/m$^3$, respectively. *Staphylococcus* sp. was by far the most dominant airborne bacterial genus, whereas *Aspergillus* sp. and *Penicillium* sp. dominated the fungal population. (Natalia Novikova, 2006)

9.2. *Staphylococcus aureus*

In most cases, coagulase-positive staphylococci isolated from humans. *S. aureus* has always been considered a human pathogen with a
wide array of disease syndromes, ranging from minor skin abscesses to life-threatening endocarditis, osteomyelitis, and pneumonia (Waldvogel, 1995).

While the coagulase-negative staphylococci may include any of the remaining 32 species that constitute the genus *Staphylococcus* (Kloos, and. Bannermann. 1994). A notable exception to this axiom is *Staphylococcus intermedius*, which is coagulase positive (Kloos, and Schleifer. 1986). However, only about 15 of the coagulase-negative species are indigenous to humans.

### 9.4. *Staphylococcus saccharolyticus*

Is an anaerobic, gram-positive coccus, which is part of the bacterial skin flora (Evans, and Mattern. 1978). It was previously known as *Peptococcus saccharolyticus*, but oligonucleotide analysis of 16S rRNA has shown it to be, instead, a member of the genus Staphylococcus (Ludwig, 1981).

Aerobic *staphylococci* are a common cause of bacterial endocarditis. *Staphylococcus lugdunensis* is a recently described coagulase negative *staphylococcus* that forms part of the normal skin flora and has considerable potential as an opportunistic pathogen of humans (Felner, and Dowell. 1970,).

### 9.5. *S. lugdunensis*
*Staphylococcus lugdunensis* is a recently described coagulase negative *staphylococcus* that forms part of the normal skin flora and has considerable potential as an opportunistic pathogen of humans (Felner, and. Dowell. 1970).

Causes Osteomyelitis which has been documented on only a few occasions and, when details have been provided, has been reported to complicate bone surgery (Evans, and Mattern, 1978). In one series, this organism was associated with skull osteitis, wound infection following neurosurgery, and was isolated from a knee joint and bone from another patient following orthopedic surgery (Evans, and Mattern. 1978).

*Staphylococcus caprae:*

Since its identification by *Staphylococcus caprae* has been frequently isolated from udder halves of goats with subclinical intramammary infection several different studies have demonstrated the capacity of *Staph. caprae* to persist throughout lactation ,and during the dry period found that isolates of *Staph. caprae* from udders of uninfected goats express potential virulence factors.

*Staphylococcus species:*
S. epidermidis, S. aureus, S. haemolyticus, S. caprae, S. simulans, S. hominis, S. capitis, S. saprophyticus, S. warneri, and S. lugdunensis. Recently, the coagulase-negative staphylococci have been studied extensively because of their pathogenicity and involvement in some kinds of human and animal diseases.
10. Enterobacteriaceae (Proteus mirabilis Proteus vulgaris)

10.1. Proteus mirabilis

Major agent in human infection of urinary tract. Abundant production of urease splits urea (CO(NH$_2$)$_2$) into carbon dioxide (CO$_2$) and ammonia (NH$_3$). Ammonia raises the pH of urine and causes the formation of kidney stones (renal stones; renal calculus) which can be extremely painful. Wound infections, pneumonia, and septicemia found in soil, water, sewage, decomposing matter, and human intestinal tract. Hyper motile with cultures demonstrating a swarming phenomena on agar media. Hydrogen sulfide production. O, H, K antigens: grouping on basis of these antigens for epidemiologic studies have not been correlative. Share antigens with the intracellular pathogen Rickettsia.

*Bacillus pumilus:*

*Bacillus pumilus* is found in the soil and the use rate of GB34 concentrate is 0.1 ounces per 100 pounds of seed, equivalent to 1.7 grams per acre. *Bacillus pumilus* GB34 is unlikely to leach from the treated seed and would not be distinguishable from other naturally occurring Bacillus pumilus.

10.2. Klebsiella:
We all have millions of bacteria in our gastrointestinal tracts, primarily in the colon (or "large" bowel). These bacteria are important for normal bowel health and function. *Klebsiella* is the genus name for one of these bacteria found in the respiratory, intestinal, and urinogenital tracts of animals and man. When *Klebsiella* bacteria get outside of the gut, however, serious infection can occur. *K. pneumoniae* is second only to *E. coli* as a urinary tract pathogen. *Klebsiella* infections are encountered far more often now than in the past. (Eickhoff, 1972).

**10.3. Enterohaemorrhagic Escherichia coli (EHEC)**

Have emerged as the most important non-O157:H7 EHEC, with respect to their ability to cause diarrhoea and the haemolytic uraemic syndrome (HUS). HUS is a leading cause of acute renal failure in children, and is mainly caused by EHEC expressing Shiga toxins 1 and/or 2. Since 1996, EHEC, which produce Stx2 only and appears to have enhanced virulence, has been increasingly isolated from HUS patients in Germany. In contrast, EHEC O26 found in cattle predominantly produce Stx1 as the sole Additional potential virulence factors of EHEC O26 include cytolysins, serine proteases, lymphotoxins and adhesions. (Martena, 2007)

**10.4. Enterobacter spp.**

Characteristics: Gram negative rods, peritrichous flagella, some encapsulated, facultatively anaerobic; family Enterobacteriaceae - 14 species

Pathogenicity: Associated with a variety of infections including those of nosocomial origin; urinary, pulmonary, wound and bloodstream infections; often as a secondary or opportunistic infection.

Epidemiology: Worldwide; often associated with hospitals; nationwide epidemic of septicemia caused by contaminated intravenous injections. (http://www.en.wikipedia.org/wiki/Enterobacter)
CHAPTER TWO

2-MATERIALS AND METHODS

Study Area

This study was conducted at Khartoum North, which is bounded by Algyli locality from the North and Blue Nile from the south, and The River Nile bound Sharg El Neel Locality, from the East and from the West.

The population of the locality is about (1064751), and most of the people in the area are farmers. There are about 40 farms in the study area, all farms adopt the open system for rearing their flocks.

2. Laboratory Techniques:

2.1: Sterilization

Sterilization was carried according to Merchant and Paker (1977).

2.1.1: Sterilization of equipments

Bottles, flasks, test tubes, Petri-dishes pipettes and instruments were sterilized in the hot air oven at 160 °C for 2 hours. Other glassware were sterilized by autoclaving at 15 pounds pressure, 121 °C for 15 minutes.
2.12: Sterilization of culture media and solutions

Nutrient agar used for samples collection and subsequent subcultures was sterilized by autoclaving at 15 pounds pressure, 121 ºC for 15 minutes.

2.1.3: Source of samples

Nine poultry farms were chosen from Khartoum North and Gezira state for this study. Seven farms were open system and the other two from semi intensive and intensive systems. Two samples were collected from each farm using plate sedimentation (18) air samples.

2.1.4: Collection of samples

To perform the quantitative analysis of microorganisms in the air, the air samples were collected from different latitudes, one from 2.5m and the other from 0.75, from each poultry house. Samples were collected on standard plate count agar (Oxoid) in Petri dishes. The dishes were incubated at 37 ºC for 24 hours. The grown colonies were counted and the average count of microorganisms was calculated for m2 of air.
To perform the quantitative analyses of gram negative bacteria, the Potassium Hydroxide (KOH) test was applied. The bacterial culture grown for 24 hours was added to a drop of 3% KOH solution and well mixed. After 1-2 minutes due to lysis of the Gram negative bacteria the drop becomes slimy (Sitnikov et al., 1997).

Appropriate labeling was made for air samples and then delivered immediately to the laboratory, and incubated at 35 ºC for 24 hours.
2.2: Laboratory Methods

2.2.1: Subcultures:

Subcultures for all samples were made on Petri dishes using nutrient agar (Oxoid) by streaking using a wire loop. Dishes were incubated at 37 °C for 24 hours, and then isolated colonies were subjected to different biochemical tests to determine the genus and species of each isolate.

2.2.2: Media:

2.2.3: Nutrient agar (Oxoid)

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<tr>
<td>Agar</td>
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2.3: Staining techniques:

2.3.1: Preparation of the smears:
Smears were prepared by spreading of a colony on a drop of saline on clean slide, and allowed to dry and then fixed by gentle flaming.

2.3.2: Staining Method:

2.3.2.1: Grams stain:

This was done according to (Barrow and Feltham, 1993).

1. Crystal violet was added to the smear for 1/2 minutes
2. Lugils iodine was added for one minute.
3. wash with distilled water
4. Decolorize with alcohol for 2-3 seconds.
5. Wash
6. Counter stain with diluted carbolfuchsin for 1/2 minute.
7. wash
8. Dry with filter paper and examine.

Gram-positive organisms appear purple while Gram negative ones appear red.

2.4: Identification of bacteria:

The purified isolates were identified according to the criteria outlined by Barrow and Feltham (1993).

1. Reaction to Gram s stain
2. The shape of the organism

3. Biochemical tests

2.5: Biochemical test for bacteria identification:

All biochemical tests were performed according to (Barrow and Felham, 1993), as follows:

2.5.1: Catalase test

Slide test was used to detect for catalase, a loopfull of bacterial growth was added to a loop of catalase reagent and examined for gas evolution. Positive organisms produce gas when mixed with the reagent, while no gas evolved in case of negative organisms.

2.5.2: Oxidase test:

Paper oxidase test was performed by rubbing the organism grown on nutrient agar on the test paper containing tetramethyl-p-phenylenediamine dihydrochloride. Development of dark purple color within 10 seconds indicates positive reaction.

2.5.3: Fermentation of sugars:

Carbohydrate media were inoculated with a loopfull of bacterial culture grown on nutrient agar and examined daily for seven days. Positive reactions were indicated by color change of the media into red.
2.5.4: Urea test:

Urea agar medium was inoculated with the test organism, incubated and examined after 24 hours and daily for five days. Change of color into pink or red indicates positive reaction.

2.5.5: Nitrate reduction:

Nitrate broth was inoculated with the test organism, incubated and examined after 48 hours, after the end of the incubation, period one ml of the nitrate reagent was added. Red color indicated positive reaction. Powdered zinc was added to the tubes showing no color within 5 minutes, red color indicates negative reaction.

2.5.6: Motility test:

Was done by inoculating the test organisms on tubes containing semisolid media, incubated for 24 hours and then examined for motility.

2.5.7: Oxidation/Fermentation of Glucose (OF) test:

Duplicates of tubes of Hugh and Lifsons medium were inoculated by stabbing with a straight wire. Environment of One tube was made anaerobic by adding a layer of paraffin; tubes were incubated and examined daily for fourteen days. Development of yellow color in both
tubes indicates the presence of fermentative organism, while yellow color in the open tube indicates the presence of oxidative organisms.

2.5.8: Coagulase test:

Tube coagulase test was performed for the isolated organisms. Diluted plasma was inoculated with 0.1ml of broth culture, incubated at 37°C and examined after 1/2 an hour and three to six hours intervals. Positive results were indicated by plasma clotting.

2.5.9: Citrate test:

Kosers citrate was inoculated with the suspension of the test organism using straight wire loop, incubated at 30°C (Enterobacter) and at optimum temperature for other types of bacteria and examined up to seven days. Green color indicates negative reaction while blue color is a positive reaction (Barrow and Felham, 1993).

2.5.10: Indole test:

Peptone water or nutrient broth was inoculated with the test organism and incubated for 48hours. After the end of the incubation period, 0.5ml of Kovacs reagent was added, and the tubes were examined
after one minute. Red color indicates in dole production (Cowan and Steels, 1977).

Statistical analysis: The results were processed and presented in form of tables and graphs.
3.1-Observations:

3.1.1-Semi intensive system:

In this type of system, the poultry house was constructed of iron, the roof was from local materials, and the floor was concrete with the presence of litter on the top composed of wood shavings. Some areas were found dusty. No foot bathes were found in all the farms studied (100%).

Each farm had one worker responsible for all the daily activities of the farm. No protective clothes were observed during the visits.

The environment around all farms was found to be unsatisfactory clean wise. The ventilation in all farms was natural.

3.1.2- Intensive system:

In this type of system, the poultry house was constructed of brick, the roof was from metal, the floor was concrete with the presence of litter
on the top composed of wood shavings. Some no dusty areas were observed. No foot bates were found in all the farms studied (100%).

Each farm had one worker responsible for all the daily activities of the farm. No protective clothes were observed during the visits.

The environment around all farms was found to be dirty in most of the farms (90%) ,while in the rest 10% the cleanliness was moderate. The ventilation in this type of farms was artificial (Air-conditioned).

3.2-LaborotaryTests:

3.2.1. Aerobic Plate Counts:

The aerobic plate counts in all studied farms (100%) were found uncountable after half an hour exposure plate sedimentation .No variations were recorded concerning the locations and different heights from which samples were taken.

3.2.2. Bacterial isolates:

A round (120) isolates were obtained from all the tested samples; the majority of the isolates were shown in the following table:
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Table no; (4) Characterization of Micrococcus species isolated from air samples in poultry farms -Khartoum North -2007

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d= doubtful
Table no ; ( 5 ) Characterization of ( Gram +ve) Bacilli species isolated from air samples in poultry farms -Khartoum North - 2007

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</table>

V=Variable
Table No ; ( 6) Characterization of Aerococcus species isolated from air samples in poultry farms –Khartoum north -2007

<table>
<thead>
<tr>
<th>Tests</th>
<th>Oxidase</th>
<th>Glucose</th>
<th>Lactose</th>
<th>Maltose</th>
<th>Mannitol</th>
<th>Sucrose</th>
<th>Nitrate</th>
<th>Urease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerococcus viridans</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>d</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table No ; ( 7 ) Characterization of Gram –ve Bacilli species isolated from air samples in poultry farms –Khartoum north - 2007

<table>
<thead>
<tr>
<th>Tests</th>
<th>urea</th>
<th>vp</th>
<th>lactose</th>
<th>mannitol</th>
<th>glucose</th>
<th>sucrose</th>
<th>oxidase</th>
<th>citrate</th>
<th>indole</th>
<th>KIA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>d</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>Y</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>Enterobacter spp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>d</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>Proteus vulgaris</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>d</td>
<td>-</td>
<td>R</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>+</td>
<td>d</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>d</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>R</td>
</tr>
</tbody>
</table>

KIA: slope Butt H2s gass
R=Red color (Alkaline reaction)

Y=Yellow (Acid reaction)

D=Different strains give different results
Table No: (8 ) Showing the percentage of different species of Staphylococci isolated from air samples – Poultry farms – Khartoum North -2007

<table>
<thead>
<tr>
<th>Organism</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staph-epidermides</td>
<td>4</td>
<td>12.12</td>
</tr>
<tr>
<td>Staph. aruicularis</td>
<td>6</td>
<td>18.18</td>
</tr>
<tr>
<td>Staph-intermedius</td>
<td>6</td>
<td>18.18</td>
</tr>
<tr>
<td>Staph-aureus</td>
<td>1</td>
<td>3.03</td>
</tr>
<tr>
<td>Staph-capitis</td>
<td>1</td>
<td>3.03</td>
</tr>
<tr>
<td>Staph-warneri</td>
<td>1</td>
<td>3.03</td>
</tr>
<tr>
<td>Staph-schleiferi</td>
<td>4</td>
<td>12.12</td>
</tr>
<tr>
<td>Staph-lugdunensis</td>
<td>1</td>
<td>3.03</td>
</tr>
<tr>
<td>Staph-saccharolyticus</td>
<td>6</td>
<td>18.18</td>
</tr>
<tr>
<td>Staph-caprae</td>
<td>2</td>
<td>6.06</td>
</tr>
<tr>
<td>Staph-caseolyticus</td>
<td>1</td>
<td>3.03</td>
</tr>
</tbody>
</table>
Table No: (9) Showing the percentage of different species of *Micrococi*

isolated from air samples - Poultry farms - Khartoum North -2007

<table>
<thead>
<tr>
<th>Organism</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M.varians</em></td>
<td>12</td>
<td>34.29</td>
</tr>
<tr>
<td><em>M.luteus</em></td>
<td>13</td>
<td>37.14</td>
</tr>
<tr>
<td><em>M.roseus</em></td>
<td>4</td>
<td>11.42</td>
</tr>
<tr>
<td><em>M.kristinue</em></td>
<td>5</td>
<td>14.29</td>
</tr>
<tr>
<td><em>M.agilis</em></td>
<td>1</td>
<td>2.86</td>
</tr>
</tbody>
</table>
Table No: (10) Showing the percentage of different species of Bacilli isolated from air samples – Poultry farms – Khartoum North -2007

<table>
<thead>
<tr>
<th>Organism</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.pumilis</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>B.subtilis</td>
<td>6</td>
<td>17.10</td>
</tr>
<tr>
<td>B.coagulans</td>
<td>6</td>
<td>17.10</td>
</tr>
<tr>
<td>B.megaterium</td>
<td>9</td>
<td>25.7</td>
</tr>
<tr>
<td>B.sterothermophilus</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>B.cereus</td>
<td>2</td>
<td>5.71</td>
</tr>
<tr>
<td>B.lentus</td>
<td>5</td>
<td>14.29</td>
</tr>
</tbody>
</table>
Table No: (11) showing the percentages of different species of gram negative Bacilli isolated from air samples-poultry farm – Khartoum North 2007

<table>
<thead>
<tr>
<th>Organism</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>B. firmus</em></td>
<td>5</td>
<td>14.29</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>5</td>
<td>38.46</td>
</tr>
<tr>
<td><em>Proteus vulgaris</em></td>
<td>2</td>
<td>15.38</td>
</tr>
<tr>
<td>Microorganism</td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------</td>
<td>------------</td>
</tr>
<tr>
<td><em>Proteus mirabilis</em></td>
<td>3</td>
<td>23.08</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>1</td>
<td>7.69</td>
</tr>
<tr>
<td><em>Enterobacter species</em></td>
<td>2</td>
<td>15.38</td>
</tr>
</tbody>
</table>
Table No: (12) showing the percentages of different species of bacteria isolated from air samples - poultry farm – Khartoum North - 2007

<table>
<thead>
<tr>
<th>Organism</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micrococcus</td>
<td>35</td>
<td>28.92</td>
</tr>
<tr>
<td>Gram positive Bacilli</td>
<td>35</td>
<td>28.92</td>
</tr>
<tr>
<td>Staphylococcus spp.</td>
<td>33</td>
<td>27.27</td>
</tr>
<tr>
<td>Gram negative Bacilli</td>
<td>13</td>
<td>10.74</td>
</tr>
<tr>
<td>Aerococcus spp.</td>
<td>4</td>
<td>3.30</td>
</tr>
</tbody>
</table>
Fig(1): Showing the percentage of Staphylococcus Spp found in air samples from poultry farms - Khartoum North - 2007
Fig(II): Showing the percentage of Microccuc spp. in air samples from poultry from Khartoum North 2007.
Fig(III): Showing the percentage of Bacilli recovered from air samples in poultry farm - Khartoum North - 2007.
Fig(IV): Showing the percentage of Gram negative bacteria isolated from air samples - Khartoum North - 2007

- E.coli
- Proteus vulgaris
- Proteus mirabilis
- Klebsiella pneumoniae
- Enterobacter species
Fig(V): Showing the percentage of different bacteria in air samples from poultry farms - Khartoum North - 2007

- Micrococcus
- Gram positive Bacilli
- Staphylococcus spp.
- Gram negative Bacilli
- Aerococcus spp.
CHAPTER FOUR

4- Discussion

4. Laboratory Tests:

4.1. Total Plate Count:

From the results obtained by this study, it was clear that the level of total bacterial counts for all the farms studied was high, irrespective of the type of farm. In the farms that adopted the intensive system, the level of bacterial count was relatively high compared to the semi-intensive system. These results disagree with the findings by Cousinns and Collett, (1989), who stated that, typical aerobic concentration of bacteria may be approximately 15 to 500 colony-forming units (CFU)/m³. Although no actual safety data are available, the figure of $10^3$ microorganisms/m³ is generally considered the maximum safety level, (Dutkiewicz et al., 1988).
Zucker et al., (2000a) stated that dust and microorganisms with different admixtures are abundant in the air of livestock houses.

Concerning the concentration of bacteria in relation to the type of buildings, the study did not find any associations, which contradict the findings of Riley (1972), who stated that the atmosphere of a building along with its occupants constitutes an ecological unit through which aerosols from various sources move on air currents.

In both types of farms studied, the type of ventilation used did not affect the diversity of micro flora present in the air, and this agrees with what stated by WHO (1988), that ventilation systems can support the growth of fungi, bacteria and other microorganisms. They added that increase in humidity up to 70% aids the growth of microorganisms on the structural parts of the building. Riley, (1972), stated that the lack of outdoor air supply will increase the likelihood of the airborne transmission of infectious diseases through the increase of suspended bacteria in droplet nuclei.

4.2. Types of bacterial isolates:

From all sampled farms, a diversity of bacteria was isolated. The Gram positive bacilli and Micrococcus spp. accounts for the high percentage among the isolates (28.92%), staphylococcus spp. accounts for 36.27%, while Gram negative bacilli showed a percentage of 10.74%, and the Aerococcus spp.
accounts for 3.30 % and streptococcus spp. Isolated showed a very low percentage, 0.82 %. Table No (13). This agrees with Austwick, (1966). Who stated that microorganisms represent a very heterogeneous and extremely diverse group of entities having in common only their microscopic size. Even size may extend into the macro range among fungi.

From the results obtained by this study, it was clear that among the Gram positive bacilli isolated, *Bacillus megaterium* showed the highest prevalence, (25.71%), while the *Bacillus pumplis* and *Bacillus steroothermophilus* were the least among the isolates,( 2.90 % each ) Table No ( 11 ), and this agrees with the findings of Gunderman, (1980) who was able to isolate both *Klebsiella* and *pseudomonas* species, as well as sporforming bacteria and molds from aerosols of the ventilation systems.

The dominant *Micrococci* isolated from air in poultry farms were *Micrococcus luteus*, 37.14% table No (10).

*Staphylococcus aruicularis, Staphylococcus intermedius,* and *S.saccharolyticus* showed high percentage among the *Staphylococci* isolates (18.18%). *Staphylococcus epidermidis, S.schleiferi* come in the second level with a percentage of 12.12% for each organism. *Staphylococcus aureus, S.capitis, S.warneri, S.caseolyticus* and *S.lugdunaensis* was the least among the isolates of this group with a percentage of 3.03%. Most of these are pathogenic or
opportunistic organisms, and can play a role in disease occurrence among the flocks and human, this agrees with what has been stated by Hugh - Jones (1973), that Indoor transmission of diseases between animals by aerosols is well established for Newcastle disease, Rift Valley fever, Venezuelan equine encephalitis, and similar diseases. Indoor processing of animal products can generate high concentrations of microbial aerosols that may contain organisms with potentially significant adverse effects on human health.

Among the Gram negative bacteria isolated from the studied farms, *Escherichia coli* showed the highest percent among this group (38.46%), while the other types showed varied percentage of isolation, as *Klebsilla pneumoniae* (7.69%). *Enterobacter spp.* (15.38%), *Proteus valgaris* (15.38%), *Proteus mirabilis* (23.08%).

*Streptococci* were very rare among the total bacterial isolates, with a percentage of (0.82%) which is negligible, while the percentage of *Aerococcus spp.* was relatively low (3.30%)
RECOMMENDATIONS

1. Separation of poultry farms from other animals.

2. Increase the awareness of workers about the importance of sanitation and hygiene.

3. Periodic change of litter to avoid accumulation of microorganisms.

4. Prevention of farms from outdoor environmental contaminants.

5. More studies should be done to clear the role of fungi.
CONCLUSION

This study showed that all types of farm systems sampled had high level of microorganisms, as the total plate count was found to be uncountable for both systems.

Gram positive Bacilli were the dominant microorganisms isolated from the air samples, while the Gram – ve bacilli were the least isolated ones.

The surrounding environment in all farms seemed to play an important role as a source of air contamination, as all the areas around the farms were of poor sanitation.
The farm hygiene was found to be poor, with the lack of regular schedule for litter change and removal, which might aid in microorganisms accumulation inside the farm.

The presence of animals other than poultry in the same farm might attribute to the heterogeneous microorganisms encountered in the tested samples.

The poor knowledge of the personnel in charge of these farms also can be one of the factors that increased the level of bacterial contamination in these farms.
REFERENCES


Society of Heating, Refrigeration and Air Conditioning Engineers.

Atlanta, GA, pp. 104-113.


