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Air Pollutants and its Effects on Animal Health, Production and Reproduction

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Abstract

Air pollution refers to any physical, chemical or biological changes in air quality i.e. contamination of air by harmful gases, dust and smoke which affects plants, animals and humans drastically. Air pollution is one of the major problems which affect the animal's health, production and reproduction parameters throughout the world. Air pollutant may be an anthropogenic, biogenic or geogenic source that is either not part of the natural atmosphere or is present in higher concentrations than in the natural atmosphere and can have harmful effects in the short or long term on the living creatures. Mostly inhalation triggers the health problems in animals as well as in human being also, but occasionally deposition of particulate matters from industrial exhaust on pasture land may also affect health directly or indirectly. Pollutants may enter the animal's body system by inhalation or ingestionmechanism and affects mostly the respiratory and cardiovascular system. Particulate matter (dust) and Bio aerosols are also responsible for reduced growth and increased morbidity and mortality from respiratory disease and abscesses in animals and human being. The rapid industrialization, urbanization, unplanned and excessive exploitation ofnatural resources has been causing pollution problems in cities and towns of developing countries.

Keyword: Aerosol; Anthropogenic; Pollutants; ppm; VOCS.

INTRODUCTION

The earth's atmosphere consists of a mixture of gases. Some gases have a nearly constant concentration, while others are variable in both time and space. The most important gases are nitrogen (78.1%), oxygen (20.9%), argon (0.92%) and water vapour (variable 0.004 to 4%). The concentration of some other atmospheric gases is listed in Table 1 *(Builtjes, 2003)*.

Table 1: Chemical Compositions of Air

Gases	Symbol	Concentration (ppm)
Neon	Ne	18.2
Helium	He	5.2
Krypton	Kr	1.14
Xenon	Xe	0.09
Carbon dioxide	CO	280.0
Methane	CH_4	0.750
Nitrous oxide	N_2O	0.270

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Air pollution occurs when the air contains gases, dust, vapours or odours in harmful quantities, that can be harmto the health or well being of humans, and animals or that can damage plants and living creatures leads alteration in nutritive values of plants *(Singh et al., 2017)*. The substances that cause air pollution are called pollutants. Air pollutant can be defined as any substance emitted into the air from an anthropogenic, biogenic or geogenic source that is either not part of the natural atmosphere or is present in higher concentrations than in the natural atmosphere and can have harmful effects in the short or long term.

General air pollutants of anthropogenic origin present in the atmosphere have similar adverse effects on human and animal health, especially on the respiratory and cardiovascular systems. Air pollution has a significant impact on the health of agricultural workers and affects their job satisfaction *(Boivin et al., 2003)*. The impact of air pollution on human health is well understood and there is need of awareness about this. However, the effects of air pollution on animals, which are not yet recognised as sentient beings, are neglected.

The earliest reports associated with air pollution and livestock can be traced back to the 1930 by *Almquist et al. (1934)* in the United States to establish a link between air quality and animal health. Innes, 1936 established the relationship between the incidence of coughing and dust levels in pigs. Further reports on effect of air pollutants on animals viz. effects of dust on calves *(White, 1940)*, a case of H_2S gas poisoning in a cow *(Coghlin, 1944)* and a report on the death of chickens from silogas *(Peterson et al., 1949)*.

Air pollutants in general can be classified as primary or secondary type.

PRIMARY POLLUTANTS

Substances emitted directly from sources into the atmosphere. The most important primary pollutants known to cause damage in sufficiently high concentrations are the followings:

- Carbon compounds, such as CO, CO_2, CH_4 and VOCs (volatile organic compounds).
- Nitrogen compounds, such as NO, N_2O and NH_3
- Sulphur compounds, such as H_2S and SO_2
- Halogen compounds, such as chlorides, fluorides and bromides
- Particulate matter (PM or "aerosols"), either in solid or liquid form, which is usually classified into these groups on the basis of the aerodynamic diameter of the particles:

Particle Size (µm)	Specification	Remarks
11-100 µm	Inhalable	Easily enter into the nose and mouth
5-10 µm	Thoracic	Easily penetrate deep into the airways
2.6-4 µm	Respirable	Small enough to pass completely through the airways and enter the bloodstream.
0.2-2.5 µm	Fine	Greatest risk to health.
<0.1 µm	Ultra fine	Penetrate tissue and absorbed directly into the bloodstream

Secondary pollutants

These are not emitted directly from sources, but are formed in the atmosphere from primary pollutants (also called "precursors"). The main secondary pollutants known to cause damage in sufficiently high concentrations are the following:

- NO_2 and HNO_3, formed from NO.
- Ozone (O_3), formed by photochemical reactions of nitrogen oxides and VOCs (volatile organic compounds).
- Sulphuric acid droplets formed from SO_2 and nitric acid droplets formed from NO.
- Sulphate and nitrate aerosols
- Organic aerosols formed from VOCs in gas-to-particle reactions.

Sulphur dioxide (SO_2): This compound is colourless but has a pungent, choking smell. The main source of SO_2 is the burning of fuels containing sulphur (such as oil and coal). Exposure to SO_2 can irritate lung tissues and damage to the lung parenchyma. It also irritates the eyes, nose and throat. As part of acid rain, this rain acidifies lakes and rivers, destroys the life of plants and fish in lakes and rivers, removes mineral nutrients from soils, reduces forest and agricultural yields, and corrodes metals and damages building surfaces.

Nitrogen oxides (NO and NO_2): NO_2 is a reddish brown gas with a pungent odour. The main source of this gas is motor traffic and is involved in the formation of ozone in the troposphere. High concentrations can cloud vision and increase the risk of acute and chronic respiratory diseases. Nitrogen dioxide is a serious air pollutant and can cause pulmonary oedema (excessive accumulation of fluid in the lungs). It can also produce

photochemical smog.

Carbon monoxide (CO) - This colourless, odourless gas is produced by the incomplete combustion of fuels. Therefore, motor vehicles are currently the largest source of CO. Carbon monoxide is the most common fatal poisoning in many countries around the world. Exposure to carbon monoxide can be life threatening, causing poisoning of the central nervous system and heart, serious effects on the baby in pregnant women, headaches and dizziness and problems with oxygen supply to parts of the body.

Volatile Organic Compounds (VOCS) - Volatile Organic Compounds are defined as organic compounds that readily evaporate into the atmosphere. VOCs include a wide range of organic air pollutants, from pure hydrocarbons to partially oxidised hydrocarbons and organic compounds containing chlorine, sulphur or nitrogen. Some aromatic compounds such as benzene, toluene and xylene are potentially carcinogenic and can cause leukaemia. As promoters of ozone formation, VOCs can cause respiratory and other ozone-related problems. They may indirectly contribute to the problem.*(Kesselmeier, et al. 2000)*

COMMON AIR POLLUTANTS AROUND LIVESTOCK AND EFFECTS IN ANIMAL HEALTH

The effects of air pollutants and emissions on animal health have been conducted on various livestock farms. There are various air pollutants which affects the animal health.

Ammonia

Elevated ammonia levels leads to decrease in growth *(Charles and Payne, 1966),* feed consumption *(Lee et al., 2005),* health condition *(Veit et al., 1985),* and immune response *(Wei et al., 2015).* The higher concentration of atmospheric ammonia primarily acts as an irritant to the ocular and respiratory mucosa, affecting the course of infectious diseases by playing as a chronic stressor and reducing the growth of healthy young animals *(Lillie, 1972; Curtis, 1983). Drummond et al., (1980)* observed a 12% reduction in weight gain in young pigs which were exposed to 50 ppm air ammonia, but no respiratory lesions were observed. There is positive correlation between levels of ammonia in the air of the farm and incidences of arthritis, porcine stress syndrome lesions, and abscesses *(Donham, 1991).* There are five main mechanisms protecting the lung from foreign materials invasion which are cellular and humoral immunity, mucociliary transport, macrophage function, cough reflex and nasopharyngeal filtration. Out of these defence mechanisms, mucociliary transport and alveolar macrophage functions are the one which are most affected by ammonia and hydrogen sulphide air concentration *(Lillie and Thompson, 1972).* In poultry, ammonia is considered the most harmful gas in broiler houses *(Carlile, 1984).* An ammonia concentration of 50 ppm in the air over a prolonged period irritates the respiratory tract and predisposes chickens to respiratory infections with the additional risk of secondary infections and the development of ocular kerato-conjunctivitis at an ammonia concentration of 60 ppm in the air *(Hauser, 1988).*

Hydrogen Sulphide

Hydrogen sulphide is a potentially lethal gas produced by anaerobic bacterial decomposition of proteins and other sulphur containing organic matter. Large amounts of suddenly released H_2S during stirring or pumping of stored manure have resulted in animal deaths *(Hoff et al., 2006).* This colourless gas with the distinctive smell of rotten eggs is heavier than air and can accumulate in slurry pits, holding tanks and other low areas in a facility. Hydrogen sulphide is a serious air pollutant, with concentrations generally highest in pig barns incompared to poultry, dairy farms have higher concentrations of hydrogen sulphide.

Particulates or Dust

Fine particulate matter (PM), or simply dust, is a complex mixture of extremely small particles and liquid droplets in the air *(USEPA, 2010).* Fine particulate matter comes from two main sources: animals themselves *(e.g. skin, hair and feathers)* and animal feed *(Shen et al., 2019).* Animal barns are an important source of particulate emissions. Particulate matter concentrations in stables are high and are influenced by the type of housing and feeding, animal species and environmental factors. They are primarily caused by the increasing activity of the animals *(Maghirang et al., 1997).* Dust concentrations are usually higher in poultry houses than in those of other livestock species. Pig barns usually have higher dust concentrations than cattle barns. Dried faeces are heavily contaminated with microbes and microbial by products. Animals and workers in nursery and farrowing pens would be exposed to greater concentrations of faecal dust than in fattening farms where feed dust predominates

(Donham, 2000).

Bioaerosols and Endotoxins

Air quality, as defined by ventilation parameters, influences aerosol dispersion of potential viral and bacterial pathogens that colonise over the epithelium of the respiratory tract. The concentration of endotoxin in the atmosphere of housing facilities is of greater importance for animal health.

Endotoxin is a phospholipid-polysaccharide macromolecule that forms the cell wall of Gramme-negative bacteria. It is released when the integrity of the cell wall is disrupted. A typical range for endotoxin in the atmosphere of a closed building is 150-1000 units. The maximum concentration of exotoxin for pig health has been reported to be about 150 units. Endotoxin is a potent pro-inflammatory substance and is thought to play an important role in respiratory disease in people working in animal farms.

CONCLUSION

The common air pollutants present in atmosphere have similar adverse effects on human and animal health. Scientific studies on the effects of air pollutants on the health and productivity livestock, indicate ammonia and hydrogen sulphide are two important inorganic gases that affect the respiratory system in various ways and many more other health effects including arthritis. Particulate matter (dust) and Bio aerosolsare associated with reduced growth and increased morbidity and mortality from respiratory disease and abscesses. Thus these associated adverse effects needed to be addressed in context of animal health as well as the labourers involved in livestock farming.

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