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Poultry dust and risks associated with public health

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Abstract
The growing demand for economical and safe meat and egg supply has led to rapid development of the poultry industry. The emergence of industrial farming and the intensification of farm operations have promoted the growth of the poultry industry around the world. Air emissions generated by poultry production are numerous. Dust may contain microorganisms, including end toxins, fungi, and bacteria, that may affect living things when inhaled. Ammonia (NH_3) emissions have the potential to contaminate surface waters and are an environmental concern on both a local and global scale. Farmers are occupationally exposed to many respiratory hazards at work and display higher rates of asthma and respiratory symptoms than other workers. Dust is one of the components present in poultry production that increases risk of adverse respiratory disease occurrence. Most poultry producers are already aware of the hazard of poultry dust to worker's health and the need to ensure that exposure is kept as low as reasonably practicable.

Keywords: poultry, particulate matter, public, health risk

1. Introduction
Poultry farm businesses are associated with a number of local and regional environmental impacts. Poor manure management practices give rise to soil and water pollution. The use of pesticides and insecticides adversely affect the quality of nearby surface and ground water resources (Environmental, Health, and Safety Guidelines for Poultry Production, 2007). odour emissions, due to release of gases including ammonia (NH_3) and hydrogen sulfide (H_2S), along with some volatile organic compounds (VOCs), significantly affect the environment and health of poultry workers. Confinement areas with high concentration of poultry or other livestock have been associated with frequent complaints of odour nuisance, which has been linked with health symptoms, including headache, irritation of eyes, nose and throat, and drowsiness. The main air pollutants - collectively referred as bio-aerosols - present in poultry production and hatcheries include poultry dust (mainly produced from microorganisms and their metabolites), pathogens, endotoxins, as well as NH_3 and carbon dioxide (CO_2), as a consequence of excreta decomposition, respiration of poultry and other operations in the animal confinement buildings. Dust or Particulate matter (PM) is a major problem in intensive system of housing in poultry farm. Poultry dust is a mixture of bird feed, bedding material (eg wood shavings/shreds or straw), bird droppings, feathers and dander (dead skin), dust mites and storage mites, and micro-organisms such as bacteria, fungi (moulds) and endotoxins (cell wall components of bacteria). Particulate matter is generally categorised on the basis of the size of the particles (for example PM10 are particles with a median aerodynamic diameter of less than 10 µm). Particulate matter comprises primary particles emitted directly into the atmosphere and secondary particles formed by chemical reactions in the air. Both short-term and long-term exposure to ambient levels of particles is associated with respiratory and cardiovascular illness and mortality, as well as other ill-health effects. When birds or human being expose to this particulate matter that causes adverse effect on both the birds & human being.

2. Dust and poultry house
Dust is fine particles of solid matter. It generally consists of particles in the atmosphere that come from various sources such as soil, dust lifted by wind etc. Poultry dust may vary in composition from pure wood dust to a complex mixture of organic and inorganic particles, faecal material, feathers, dander (skin material), mites, bacteria, fungi and fungal spores, and endotoxins depending on the type of birds, the work activity and the point in the growing or production cycle.

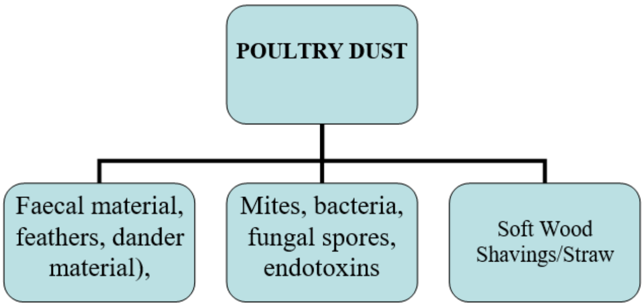

Fig 1: (Components of poultry house dust)

3. Origin/sources of particulate emissions from poultry farms

In terms of the sources of particulate matter within poultry farms, "dust from poultry houses mainly originates from feathers, skin particles and used litter, and to a lesser extent from feed, bedding, micro-organisms and fungi". "There are several sources of the enrichment of airborne particulate matter within livestock buildings. The feed itself and the feeding process may contribute to 80 to 90 % of the total dust generation. Bedding materials like straw or wood shavings can also have extraordinary effects on the particle concentration in the livestock air. Depending on the type and the amount of litter and its spreading, its contribution can be between 55 and 68 % of the total airborne particulates observed. Dust in the poultry house is of both organic and inorganic origin, with birds and their shedding being the main source [6]. The inorganic dust originates from building materials such as concrete, metal, mineral or fiberglass insulation, or material such as soil particles brought into the house by the fresh air supply. In a study of a broiler facility, calcium from the feed was found to be the most common inorganic dust component [7]. Magnesium, copper, iron, lead, were other feed or cage components found in the airborne dust. However, in general, publications considering dust in animal housing have focused on organic dust. Included in the organic dust of poultry houses are feather and skin particles, feed components, dried faecal matter, melds, fungi, bacteria and bacterial endotoxins, and viruses [8]. Koon *et al.* [11] found that the organic dust from caged layers consisted of two distinct types of particulate matter. The bulk of the matter was flat, flaky, and cellular in structure, with a diameter from 1 to 450 µm, some containing droplets of oil, and was identified as skin debris and feed particles. The other matter was long, cylindrical particles with nodes and internodes, identified as broken feather barbules. Both types of dust contained electrostatic charges, causing them to clump and form aggregates. The dust contained approximately 92% dry matter, of which 60% was crude protein, 9% fat, 4% cellulose, and the rest ash and hydrocarbons.

Table 1: (Dust Exposure in Typical Farm Tasks) 9

Activity	Total inhalable dust (mg/cum) Bacterial Levels
Laying down litter	
Whole straw by hand	84.5
Wood shreds by machine	34.8
Populating houses	
Point of lay of hens	23.8
Day old chicks	5.5
Routine housing cleaning(cage)	4.0
Catching /depopulating	10.4
Litter/manure removal	94.7
Final house cleaning	
Cages	67.9
Bran	107.7

4. Composition of dust

Dust can be categorised into non-viable and viable particles. Non-viable particles are sterile and are of an inert organic or mineral nature whereas viable particles can be airborne microbes varying in size from 0.1 /mm in the case of single virus particles to particles of 50-100 jum in diameter consisting of aggregates of bacteria or the larger fungal spores. In the case of viruses and bacteria, however, these are usually present in the air attached to, or embedded in, larger particles of organic matter which can be of 100 fini or more in size. Dust particles can also act as airborne transport vehicles for gases which condense or react with them. Only a small proportion of the viable microbes in the air is present in particles of less than 5 ßm. Surveys have shown that the bulk of airborne microbes are present on particles of 5-20 /xm and mainly 10 fim.

5. Activities generate poultry dust

People working in poultry houses breathe in many different airborne particles, which together are called poultry dust. What poultry dust is made up of depends on several things, eg the growing or production system, the type of housing, the type and age of the birds and the work itself. There are several typical activities that create airborne poultry dust, capable of causing respiratory disease:

- Laying down bedding.
- Populating poultry houses with young birds.
- Routine crop maintenance and cleaning.
- Catching poultry (depopulation).
- Litter/manure removal.

6. Factors Affecting Particulate Emissions from Poultry Farms

Factors affecting particulate emissions from poultry farms include type of bird, type of housing system, type of ventilation, bedding materials, litter condition, air temperature, humidity, flow rate, type and amount of feed and animal activity level. Others parameters that affect particulate emission:

1. Physical density and particle size distribution of livestock related particulate matter

- Type of housed animals
- Type of feeding system (dry vs. wet, automatic vs. manual, feed storage conditions)

- Type of floor (partly or fully slatted)
- The use of bedding material (straw or wood shavings)
- The manure system (liquid vs. solid, removal and storage, manure drying on conveyor belts)
- Periods of empty livestock building due to cleaning and disinfection procedures vs. continuously rearing systems)
- Secondary sources due to farmers' activities (tractors, walking through the building to check on livestock)
- Animal activity (species, circadian rhythms, young vs adult animals, caged vs aviary systems)
- Ventilation rate (summer vs. winter, forced vs naturally ventilated)
- Geometry and positions of inlets and outlets (re-entrainment of deposited particles caused by turbulence above the surfaces within the building)
- Indoor climate in the building (temperature and relative humidity)
- The time-period of housing (whole year vs. seasonal housing)
- The management (all-in and all-out systems, with
- Cleaning practices (forced air vs. vacuum).

7. Consequences for birds

A) Health

Dust may have direct and indirect negative health effects and, thus, affect welfare [17]. Airborne microorganisms are frequently attached to dust particles. These microorganisms may be directly pathogenic or release toxins, meaning that dust in a poultry house may serve as a pathogen disseminator in addition to making the animals more susceptible to normally non- or low-pathogenic microorganisms. Broilers raised on litter were also observed to have a higher incidence of lung damage ascribed to infection than that of broilers raised on netting floors [16]. Microorganisms following non-respirable dust clogging up the birds' head may cause infections in the nares and upper respiratory tract [16]. Many of the organic dust particles are antigenic and can activate both the innate and the adaptive immune systems. This antigenicity may result in an inflammation of the exposed areas. Antigens and allergens that can induce allergic reactions include mites, pollen, fungi, and even components of animal origin in the farm environment [13, 19, 20]. Human and animal studies have demonstrated that exposure to organic dust can sensitize the lungs and may lead to hypersensitivity reactions [14, 21] and respiratory diseases. Dust may impair lung clearance mechanisms and depress immune response to infection [21, 22]. Micheland Hedonic [15] found pulmonary lesions of para bronchitis satthe end of laying period to be more extensive and severe in birds in aviaries than in caged hens. This was thought to be a result of the differing dust concentrations, with respective maximum levels of 31.6 mg/m3 and 2.3 mg/m3. Riddell *et al.* [22], found that when comparing warm (27 ˝C) and cool (16 ˝C) poultry houses, more than 50% of the broiler chickens in warm rooms had microscopic lesions in the bronchi of their lungs, whereas fewer than 5% of chickens in cold rooms had such lesions. Large dust particles were visible in some of the lesions. The increased incidence of lung lesions in chickens from warm rooms was interpreted to be due to mouth-breathing rather than being a result of the higher dust levels in the air of the rooms. The mouth-breathing allowed the dust to penetrate deeper into the respiratory system by bypassing the natural filtration of the sinuses. Dust might make the respiratory system more susceptible to even non-pathogenic microorganisms. Oyetunde *et al.* [23] showed that normally harmless E. coli had pathogenic effects on the respiratory system of four-week-old chicks when combined with sterile dust with a mean concentration of 101 mg/cm3 to 103.72 mg/cm3. Interestingly, despite the fact that Madelinand Wathes [16] found a higher load of dust and microorganisms in litter houses, and also a higher incidence of lung damage and living microorganisms Animals 2015, 5504 present in the broilers' lungs at necropsy, there was no significant effect on mortality. Actually, the birds raised on litter tended to have lower mortality. More air sac lesions and even lower mortality was found for turkeys kept on litter [24].

B) Behaviour

No studies have been found describing the effects of dust on poultry behaviour. However, it cannot be ruled out that birds, like humans, experience discomfort when dust clogs the upper respiratory passages and causes irritation of the eyes and nose.

C) Production

Whereas high production does not necessarily imply good welfare, reduced production may indicate a welfare problem [17]. Only one study has been found dealing with the effect of dust on production parameters. Madelin and Wathes [16] found significantly better food utilization in broiler chickens kept on litter compared to a netting floor, despite a higher load of dust and microorganisms in litter houses.

8. Effects of poultry dust on human health

Epidemiological studies have shown that acute and chronic respiratory disease symptoms are prevalent in poultry-farm workers due to exposure to environmental conditions and live birds in confinement buildings. Hypersensitive lung diseases, such as extrinsic allergic alveolitis, and other acute respiratory symptoms (coughing, wheezing, and respiratory distress) have been associated with the inhalation of organic dust for prolonged exposure periods. Chronic respiratory disorders are also prevalent among poultry-farm workers, with 'ODTS (organic dust toxic syndrome)' and asthma being the most common. The type of health response depends on the level and frequency of exposure. It is reported that 20% of the poultry-farm workers suffer from acute respiratory disorders, exhibiting symptoms such as wheezing, cough, phlegm, and sputum. Physical hazards present in the work environment of poultry farms include heat stress, heat exhaustion, high noise levels, heat-induced dermatosis, high temperature and humidity in indoor confinement buildings. Chemical hazards result in acute and chronic respiratory diseases due to poultry dust exposure, skin and eye diseases due to the exposure to toxic gases originating from manure handling operations, immune diseases, and exposure to detergents, pesticides and disinfectants.

8.1 Occupational asthma [4, 11]

Some occupational respiratory diseases affect the tubes that carry air in and out of the lungs (our airways). Occupational asthma is an example of this sort of problem. It is caused by an allergy to something in the workplace, eg poultry dust. This type of allergy usually takes several months or even years to develop, and may also cause eye and nasal symptoms at work. Occupational asthma causes the airways to swell and tighten; leading to symptoms of coughing, wheezing, chest tightness or breathlessness at or after work. If these symptoms are better on non-work days (like weekends, rest days or holidays) then occupational asthma needs to be strongly considered. As well as causing asthma, working with poultry dusts can also worsen symptoms in people who already have asthma.

8.2 Symptoms Of asthma
Poultry workers often have breathing problems at work such as:
- coughing;
- bringing up phlegm;
- shortness of breath;
- wheezing; and
- chest tightness

9. Control of poultry dust [10]
The control of dust can be divided into two categories:
- Control at source
- Control at exhaust

9.1 Control of dust at source
Some of the dust control at source methods, i.e. those used inside a poultry building, are limited in the amount of dust they can remove. It is therefore debatable how practical or economical it is to use control at source abatement techniques as specific 'stand-alone' dust control methods in a poultry house. Many techniques may well already make a contribution to dust control where they are part of normal flock management techniques. Most farmers already ensure that good quality feed pellets are fed to birds using modern feeders that do not break up feed and are not over-filled. They also properly clean houses and equipment on a regular basis. Dust extracted bedding material is commonly used because it is better for the birds, more bio-secure and affordable.

9.2 Control of dust at exhaust
Dust particles that have not been trapped or eliminated at source may become airborne within the building and ultimately exhausted to atmosphere by the ventilation system. Since in many poultry houses air is exhausted via the fans, there is an opportunity to either vent exhaust air at high velocity or trap dust as this air leaves from these exhaust locations by using 'end of pipe systems'. These typically consist of either passive air-cleaners or active systems, such as wet cleaning or air scrubbers. Exhaust cleaning systems have been proven to be an effective way of reducing not only dust, but also ammonia emissions from livestock housing, both in trials and in the commercial industry. However, they require a significant capital outlay on systems with high air change rates and may have high running costs.

9.3 Control measures for public
- Follow good working practices set up by your employer.
- Report symptoms of respiratory ill health to your employer.
- If you are concerned, see your doctor.
- Wear the correct Respiratory Protective Equipment (RPE) for the job (eg dust masks; air-fed hoods, visors, helmets etc).
- If you use RPE which relies on a good face seal to be effective (eg disposable dust masks, half and full-face masks), then your respirator must be face-fit tested.
- Facial hair affects the performance of close-fitting respirators, so faces should be clean shaven for the best performance.
- Ensure you know how to wear your RPE correctly.
- Check the fit of your RPE before use. Follow the manufacturer's fitting instructions on how to correctly put on the RPE and check the fit.
- Don't remove your RPE during the work activity. Wear the RPE all the time when working in a dusty area. Don't lift the RPE away from your face to talk or to take a deep breath while doing the job, you will lose the protection.

10. Conclusion
People working in poultry houses breathe in a host of different airborne particles, which collectively are referred to as poultry dust. Birds are also affected by the ill effect of the dust particle. Therefore, preventive measures should taken at the managemental level for the optimum production and good health of birds. Although many epidemiological studies have associated daily exposure to various pollutants in poultry production facilities with consequent impaired respiratory health of workers, production efficiency has improved in the recent years and it is considered highly significant for quality management. Respiratory diseases are preventable. There are simple, cost-effective steps employers and workers can take to avoid respiratory disease at work, using the avoid, protect and check approach.

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