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Bio aerosols and its Relation with Bioterrorism

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Review Article

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ABSTRACT

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INTRODUCTION

Bio aerosols are airborne particles that are biological in origin. Exposures to bio aerosols in the occupational environment are associated with a wide range of health effects with major public health impact, including infectious diseases, acute toxic effects, allergies and cancer. The behavior of bio aerosols is governed by physical principles of gravitation, electromagnetic radiations, turbulence and diffusion. Bio aerosols include bacteria, fungi, mycotoxins, yeasts, molds, pollen and viruses.

Bacteria

Bacteria are present in huge number on the earth. Nearly 150,000 known species of bacteria are present. Bacteria are prokaryotic which are single celled micro-organisms reproduced by simple cell division. Microorganisms are all around and within us [1]. Putting numbers into perspective, the global human population is approximately 6 billion people. This is comparable to the number of microorganisms in approximately 1 g of soil. So, it should not be a surprise that humans are exposed to bio aerosols constantly. Bacteria are often maligned as the causes of human and animal disease [2]. The cell structure is simpler than that of other organisms as there is no nucleus or membrane bound organelles. Bacteria are classified into 5 groups according to their basic shapes:spherical (cocci), rod (bacilli), spiral (spirilla), comma (vibrios) or corkscrew (spirochaetes) [3]. They can exist as single cells, in pairs, chains or clusters. Bacteria reproduce by binary fission. In the process of reproduction, single cell divides into two daughter cells. Binary fission begins with DNA replication which divides into two replicates [4-6]. Each daughter cell is a clone of the parent cell. Bacteria can form endospores which are highly dominant in nature and these are resistant in to conditions such as heat, UV radiation, disinfectants. These conditions supporting to bacteria finds us very difficult to kill [6-9]. There are many bacteria which produce endospores like Bacillus anthracis. Bacteria are so widespread that it is possible only to make the most general statements about their life history and ecology. They may be found on the tops of mountains, the bottom of the deepest oceans, in the guts of animals, and even in the frozen rocks and ice of Antarctica [10-13]. One feature that has enabled them to spread so far, and last so long is their ability to go dormant for an extended period. Bacteria are placed in 3 groups based on their response to oxygen [13-15]. Aerobic, Anaerobic, Facultative anaerobes which can live with or without oxygen. Aerobic can survive in the presence of oxygen to continue their growth and existence. Anaerobic bacteria, these cannot tolerate oxygen. These type of bacteria lives underwater sediments. Bacteria are classified based on source of energy. These are divided into two categories, heterotrophs and other is autotrophs. Heterotrophs, generally these are dependents on others for food [15-18]. These type of bacteria relays on fermentation or

respiration. On the other hand, autotrophs which has the ability to prepare their own food. These may be fueled by light energy(photoautotrophic), or by oxidation of nitrogen, sulphur and other elements [19,20].

Fungi

The kingdom fungi include most important organisms. Fungi are important organism which is distinct from plant and animals such that they have been allotted a kingdom of their own classification on the earth. These fungi can of single celled organisms or a huge multi cellular organism [21-24]. Fungi are mostly found on land mainly in soil or on plant material than in sea. Decomposers are the group of micro-organisms which are mostly seen in soil and on the dead plant material to play an important role in cycling carbon and other elements [25-29]. Nearly 99,000 known species of organisms of the kingdom Fungi, which includes the yeasts, rusts, smuts, mildews, molds, and mushrooms. There are also many fungus like organisms, including slime molds and oomycetes (water molds), that do not belong to kingdom Fungi but are often called fungi. Many of these fungus like organisms are included in the kingdom Chromista [30-35]. Fungi and fungi are two different things. The Fungi with capital F refers to evolutionary groups that includes moulds, yeast and mushrooms but not slime moulds and water moulds. And the other one with lower case, these refer to artificial group which includes moulds, yeast, mushrooms, slime moulds and mushrooms [36]. In 1969, when fungi are classified into distinct group, all the people know that fungi are plants. Most recently, when comparing DNA and cell structure, we have learnt that fungi are mostly related to animals than plants [37]. The only common thing which plants and fungi correlated is they don't move but scratch biological surface [38]. Compare to all the organisms, fungi have some specialty, Fungi 'eat' by releasing enzymes outside of their bodies that break down nutrients into smaller pieces that they can then absorb. This feeding strategy means that Fungi always live in and on their food [39,40].

Mycotoxins

Mycotoxins are secondary metabolites which are produced by the organisms in fungi kingdom. These organisms are commonly known as molds. These organisms have a capability of causing the diseases. Mycotoxins have pharmacological activities such as antibiotics, promoters, many different types of drugs. Most of the organisms are used as chemical war fare agents. This review focuses on the most important ones associated with human and veterinary diseases, including aflatoxin, citrinin, ergot akaloids, fumonisins, ochratoxin A, patulin, trichothecenes, and zearalenone. The mycotoxins of most concern from a food safety perspective include the aflatoxins (B1, B2, G1, G2 and M1), ochratoxin A, patulin and toxins produced by Fusarium moulds, including fumonisins (B1, B2 and B3), trichothecenes (principally nivalenol, deoxynivalenol, T-2 and HT-2 toxin) and zearalenone [41-45].

Killing Mycotoxins

Mycotoxins aren't alive like mold spores. "Killing mycotoxins", it really means breaking down mycotoxins and their toxicity so that they are no longer dangerous to humans. Bleach with 5% sodium hypochlorite is one of the methods to kill trichothecene including aflatoxin [29]. One of the important fact which I want to share in this review is it takes fire at 500 degrees Fahrenheit (260 degrees Celsius) for half an hour or fire at 900 degrees Fahrenheit (482 degrees Celsius) for 10 minutes to destroy trichothecene mycotoxins and ozone is supposed to kill all the mycotoxins. Like mold spores, mycotoxins are too small for us to see with the naked eye [24-26]. Mycotoxins are as small as 0.1 microns. Mold spores are between 1 and 20 microns. Human hair, for comparison, is about 100 microns thick [30].

Molds

Molds are microscopic fungi that live on plant or animal matter. Molds are fungi that can be found both outdoors and indoors. They grow best in warm, damp and humid conditions. Molds produce and release millions of spores small enough to be air-, water-, or insect-borne. They can also produce toxic agents known as mycotoxins. Spores and mycotoxins can have negative effects on human health. Molds can cause health problems [21]. For those people who are affected by mold exposures there can be

a wide variation in how they react. People at greatest risk of health effects are individuals with allergies, asthma, sinusitis, or other respiratory conditions, as well as infants and children, elderly people, and pregnant women [24,25]. In addition, individuals with a weakened immune system are at risk. Inhaling or touching mold or mold spores may cause allergic reactions or asthma attacks in sensitive people. Molds can cause fungal infections. In addition, mold exposure may irritate your eyes, skin, nose, throat, and lungs. Molds are part of the natural environment. Outdoors, molds play a part in nature by breaking down dead organic matter such as fallen leaves and dead trees, but indoors, mold growth should be avoided. Molds reproduce by means of tiny spores; the spores are invisible to the naked eye and float through outdoor and indoor air. Mold may begin growing indoors when mold spores land on surfaces that are wet. There are many types of mold, and none of them will grow without water or moisture.

Clean up Guidelines

1. Fix plumbing leaks and other water problems as soon as possible. Dry all items completely.
2. Scrub mold off hard surfaces with detergent and water, and dry completely.
3. Absorbent or porous materials, such as ceiling tiles and carpet, may have to be thrown away if they become moldy. Mold can grow on or fill in the empty spaces and crevices of porous materials, so the mold may be difficult or impossible to remove completely.
4. Avoid exposing yourself or others to mold.
5. Do not paint or caulk moldy surfaces. Clean up the mold and dry the surfaces before painting. Paint applied over moldy surfaces is likely to peel.

Yeast

Yeasts are eukaryotic microorganisms which are classified in the fungi kingdom with 1500 species described at present. Yeast are single-celled fungi. As fungi, they are related to the other fungi that people are more familiar with, including:edible mushrooms available at the supermarket, common baker's yeast used to leaven bread, molds that ripen blue cheese, and the molds that produce antibiotics for medical and veterinary use [34]. Yeast cells are egg-shaped and can only be seen with a microscope. It takes 20,000,000,000 (twenty billion) yeast cells to weigh one gram, or 1/28 of an ounce, of cake yeast. The word "yeast" comes from Old English gist, gyst, and from the Indo-European root yes-, meaning "boil", "foam", or "bubble". Yeasts are chemoorganotrophs, as they use organic compounds as a source of energy and do not require sunlight to grow [36-37]. Yeasts are very common in the environment, and are often isolated from sugar-rich materials. Examples include naturally occurring yeasts on the skins of fruits and berries (such as grapes, apples, or peaches), and exudates from plants (such as plant saps or cacti). Yeasts, like all fungi, may have asexual and sexual reproductive cycles. The most common mode of vegetative growth in yeast is asexual reproduction by budding [38].

Uses

The useful physiological properties of yeast have led to their use in the field of biotechnology. Fermentation of sugars by yeast is the oldest and largest application of this technology. Many types of yeasts are used for making many foods:baker's yeast in bread production, brewer's yeast in beer fermentation, and yeast in wine fermentation and for xylitol production. So-called red rice yeast is actually a mold, Monascus purpureus. Yeasts include some of the most widely used model organisms for genetics and cell biology [40].

- Alcoholic beverages
- Beer
- Wine
- Baking
- Bioremediation
- Industrial ethanol production

- Nonalcoholic beverages
- Nutritional supplements
- Probiotics

Viruses

Viruses are strange things that straddle the fence between living and non-living. On the one hand, if they're floating around in the air or sitting on a doorknob, they're inert [41-45]. They're about as alive as a rock. But if they come into contact with a suitable plant, animal or bacterial cell, they spring into action. They infect and take over the cell like pirates hijacking a ship. Viruses cause a number of diseases in eukaryotes. In humans, smallpox, the common cold, chickenpox, influenza, shingles, herpes, polio, rabies, Ebola, hanta fever, and AIDS are examples of viral diseases [46-49]. Even some types of cancer -- though definitely not all -- have been linked to viruses. A virus is basically a tiny bundle of genetic material—either DNA or RNA—carried in a shell called the viral coat, or capsid, which is made up of bits of protein called capsomeres [50-53]. Some viruses have an additional layer around this coat called an envelope. That's basically all there is to viruses. Viruses can transfer genetic material between different species of host, they are extensively used in genetic engineering [54-58]. Viruses also carry out natural "genetic engineering": a virus may incorporate some genetic material from its host as it is replicating, and transfer this genetic information to a new host, even to a host unrelated to the previous host. This is known as transduction [59]. However, viruses tend to be somewhat picky about what type of cells they infect. Plant viruses are not equipped to infect animal cells, for example, though a certain plant virus could infect a number of related plants. Sometimes, a virus may infect one creature and do no harm, but cause havoc when it gets into a different but closely enough related creature [60].

BIOTERRORISM

Bioterrorism is terrorism where there is the intentional release of biological agents (bacteria, viruses, or other germs) [61-67]. A bioterrorism attack is the deliberate release of viruses, bacteria, or other germs (agents) used to cause illness or death in people, animals, or plants. From the beginning of history, records are replete with examples of biological or chemical materials being used in warfare. Chemical and biological warfare can be loosely defined as the tactical use of chemicals, pathogens, or toxins during military operations to harm (kill, injure, incapacitate, damage) an adversary (personnel, animals, or plants) [68-72]. Biological warfare is known as germ warfare. Mostly infectious agents are used such as bacteria, viruses, and fungi with the intent to kill or incapacitate humans, animals or plants as an act of war. Bioterrorism agents can be separated into three categories, depending on how easily they can be spread and the severity of illness or death they cause. First category agents are considered the highest risk and third Category agents are those that are considered emerging threats for disease [73-75].

First:

In this agents which are used have highest risk to the public:

- They can be easily spread or transmitted from person to person.
- They result in high death rates and have the potential for major public health impact.
- They might cause public panic and social disruption.
- They require special action for public health preparedness.

Second:

In this, agents have the second highest priority.

- They are moderately easy to spread.
- They result in moderate illness rates and low death rates.
- They require specific enhancements of CDC's laboratory capacity and enhanced disease monitoring.

Third:

In this, agents have the priority because these are collected for mass spread in future and cause diseases.

- They are easily available
- They are easily produced and spread
- They have potential for high morbidity and mortality rates and major health impact.

BIO AEROSOLS AS AGENTS OF BIOTERRORISM

Several pathogenic bioaerosols are currently considered to be potential agents of bioterrorism. There are many pathogens that can be transmitted via the airborne route. The airborne transmission of pathogens can be quick and effective, especially in indoor scenarios, causing heightened concerns about their potential use [76-80].

Perhaps the most infamous bioaerosol in contemporary times is the spore of the bacteria Bacillus anthracis. The spore formation makes the pathogen resistant to inactivation, and the release into a building with central air quickly contaminates the entire structure [81-84].

Another pathogenic bioaerosol of concern is smallpox. Although it was once presumed to be eradicated following a successful global immunization campaign, many countries maintained small stocks for scientific purposes. In the wrong hands, the pathogen could be dangerously potent, especially considering that smallpox immunizations have not been required in the US since the mid-1970s [85-87].

People are not the only direct targets of bioterrorism. Airborne crop pathogens also have the potential to devastate countries. Recall the horrendous effect of the fungi in Ireland during the Irish Potato Famine. Although crops and economies are more diverse in present time, the destruction of a portion of a large crop in America could still prove devastating [88].

CONCLUSION

Bio aerosols are ubiquitous parts in our daily life. Bacteria, Fungi, molds, mycotoxins, yeast and viruses are all types of everyday bio aerosols which humans always encounter [89-90]. More extreme types of bio aerosols are pathogenic bacteria and viruses, including influenza, SARS, and anthrax. Health risks and welfare effects associated with pathogenic bio aerosols necessitate accurate sampling methods be available, including impaction, impingement, and filtration [91-93]. Recent and historic events which are related to bio aerosols has raised the awareness of human interactions with them and lead to an increased quest for knowledge of their behavior [94,95].

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