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Air Quality Implications of Fast Growing Livestock and Compost Farming: Need for Bioaerosols Monitoring Networks

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Small airborne particles ranging from 0.02-100 µm in size having biological origin are referred as bioaerosols. These include fungi, bacteria, pollens, spores, algae, protozoa and viruses, lichen and mycotoxins.[1] Derived from plants and animals, these living or dead micro particles can be transported by air to a larger distance affecting air quality.[2] We get infected through inhalation. One interesting example of transmission through air inhalation is SARS COV-2 virus.[3-5] Sometimes their contributions reach upto 50% in the total aerosols.[6] Since, these particles are airborne, humans inhale these during breathing.[7] Residential and occupational buildings especially with insulation having poor ventilation are reported having human health effects. Sick building syndrome is more associated with health effects of bioaerosols. However, due to complex nature of human system, health risks due to the effect of the bioaerosols for bronchitis diseases, infections, allergies, and other illnesses are not properly understood. Impact of bioaerosols on crop has also been reported due to emerging fungal diseases having a possible threat to food security.[8]

Since, composting and livestock industries are considered as major sources of bioaerosols and both have expanded in recent decades, there is need to bother for their effect on the air quality. According to statistics, the compost market is likely to touch $10 billion global market by 2027 with a CAGR of 6.4% between 2021 and 2027. CAGR means compound annual growth rate which is used to measure the growth of a business during a specific period. This means it is rising very rapidly. Surprisingly, the Asia Pacific is expected to remain the largest region and witness the highest growth over next 5 years.[9] Due to side effects on human and soil health, the practice of organic food is becoming popular making composting also popular. In addition, during COVID-19 pandemic, so called caged in home humans started kitchen gardening, landscaping horticulture which are still continued, consuming a significant fraction of the total consumption of compost.[10] Similarly,

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Indian livestock market is projected to reach 188 million heads by 2026.[11] The animal husbandry market of India reached INR 1,085 billion in 2022 showing a CAGR of 7.4% for 2023-2028.

Bioaerosols are present in outdoor as well as indoor air. These are collected by using impingers, impactors, filtration samplers and electrostatic methods.[12-13] These are identified by using microscopy, cultivation, flow cytometry, polymerase chain reaction (PCR), adenosine triphosphate (ATP) bioluminescence, Matrix assisted laser desorption/ionization time of flight mass spectrometry (MALDI- TOF), Raman spectroscopy and Laser-induced fluorescence methods. Tropical environment has more prevalence of bioaerosols due to higher temperature and moisture content in the air. Outdoor bioaerosol concentrations have been reported higher monsoon season.[14] Indoor concentrations of bioaerosols are affected by the presence and number of residents, pets, relative humidity of the building, ventilation, cooking, waste disposal practices and disinfection attempts.[13] The prevalence of home dampness or molds has been reported an important public health issue in Canadian children.[15] Activities like speaking, cleaning, dusting, washing, coughing, and sneezing generate bioaerosols. High floor cleaning frequency and use of dehumidifiers were negatively associated with the presence of multiple indoor biocontaminants.[16]

Significantly higher concentrations of bacteria and fungi culturable bioaerosols were found at mountain site as compared to urban and seashore sites during April month in Korean Peninsula region.[17] Fungii were estimated as 805 102 and 75 CFU/m^3 at the mountain, urban and seashore sites respectively while bacteria were as 775, 232 and 150 CFU/m^3 at the mountain, urban and seashore sites respectively. Bacteria levels were drastically lower during February month at these sites. The colony forming units (CFU) of bacteria during February month were found as 70, 20 and 10 CFU/m^3 at the mountain, urban and seashore sites, respectively, indicating an important role of temperature and other meteorological factors which help in growth and dispersion of bioaerosols. In a study by Sjögren and co-workers,[18] the fluorescent biological aerosol particle (FBAP) number showed a very good correlation with ambient temperature. FBAP concentration was the highest during warm and dry weather conditions when release mechanism are dominated along with higher mechanical bioaerosol generation. In a study from China, the dominance of submicron particles of bioaerosols has been reported in northern China.[19] These workers found that $PM_{2.5}$ aerosol mass fractions was 2.4% and PM_{10} mass fraction was 4.8% of the their respective $PM_{2.5}$ and PM_{10} mass.

In a study at the Bhandewadi landfill site in central India, bacteria contributed 75% to 85% of total bioaerosols concentrations.[20] The dominance of *Bacilli* and *Gammaproteobacteria* bacteria along with *Cladosporium* and Aspergillus fungi has been reported in bioaerosols in south India.[21] A comprehensive review on pathogenicity, characterisation and impact of bioaerosols in India has been carried out by Behera and co-workers[22] describing concentrations of bioaerosols, type of bioaerosols, impacts on flora, fauna and atmospheric processes as reported by different workers.[23-30]

In spite of their human health impacts, we do not have universal standards of bioaerosols. However, different regulatory bodies have defined the prescribed limits e.g. 1000 CFU/m^3 by Occupational Safety and Health Administration (OSHAA), 800 CFU/m^3 by Ministry of Environment (ME) of Republic of Korea; 750 CFU/m^3 by Healthy Buildings International and 500 CFU/m^3 by the Environment Canada.[1] This emphasizes the need to discuss about the global standards of bioaerosols and scientific exercises to develop international standards for different categories of bioaerosols especially when the market of livestock and compost farming is expanding very fast. Consequently, bioaerosols concentrations are expected to increase affecting air quality across the globe. Since, bioaerosols impacts on human health are more prompt and possibly more severe in tropical climate, an appropriate attention is needed by the researchers and the regulatory authorities to monitor these through a systematic network of sites for their levels, species profiling, seasonal variation, sources and impacts on human health.

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