Basics of Probiotics and changing the microscopic environment (Microbiome) in air and water

Definitions:

The human **microbiome** is defined as the collective microbes which are composed of bacteria, fungi, protozoa and viruses that live inside and on the human body. The Human Microbiome is being researched extensively including the NIH launching the Human Biome Project in 2017. It has been determined that most of the microbes in the human microbiome do not cause disease. In fact, humans rely on microbes to perform many essential functions that the human body cannot perform ourselves. Microbes digest food to generate nutrients for host cells, synthesize vitamins, metabolize drugs, detoxify carcinogens, stimulate renewal of cells in the gut lining and activate and support the immune system. When the human microbiome is out of balance, is when pathogenic microbes take root, multiply and unbalance the numbers of good bacteria in the human. This unbalance can lead to issues from skin infections to urinary tract infections, to respiratory issues, to digestive issues. Using anti biotics and harsh sanitizing agents only exacerbate the issue.

Like the Human Microbiome the air and water that humans interact with, have also a distinct Microbiome. This includes the water we drink, the air we breathe and surfaces we touch.

For example, people in modern societies spend over 90% of their time indoors; thus, they are constantly exposed to contents present in their indoor air. Each cubic meter of air that we breathe contains thousands to millions of diverse microorganisms – fungi, bacteria, archaea, and viruses – aerosolized from humans and a variety of environmental sources, and influenced by factors including particle size, airflow, irradiation and humidity. Indoors, air is filtered and recirculated, and occupants and surfaces can act as sources and a landing area (biofilm) for further spreading to the air. Evidence is emerging that airborne microorganisms in indoor spaces can differ substantially from outdoor microbiomes, with less diversity and higher bacterial loads.

**Probiotics** are live bacteria and yeasts that are good for your health. We usually think of bacteria as something that causes diseases. But your environment is full of bacteria, both good and bad. (from Web MD). The history of probiotics can be traced to the first use of cheese, yogurt and fermented products, that were well known to the Greeks and...
Romans who recommended their consumption. The fermentation of dairy foods represents one of the oldest techniques for food preservation.

The probiotic concept in management of air and water Microbiomes

What we offer is a means of ‘microbial management’, in which no longer complete sterile environments are desired, but a stable and healthy microbial community is created. This can be achieved by means of probiotic micro-organisms. These are safe and useful bacteria or yeasts that are already known and exploited for years in food and health care for years.

In contrast to the rather stable and protective situation in the gut, environmental conditions in the air, water and surfaces may strongly fluctuate, thereby imposing strict survival demands on applied probiotics. Our products contain probiotic bacteria as a crucial ingredient, which possess the unique property of *sporulation*. This process makes it possible for our probiotics to survive harsh conditions and regain their activity as soon as environmental parameters improve. Without this feature it would be impossible to apply probiotics successfully for environmental or industrial process applications.

Mechanism of action: Competitive exclusion and quorum sensing

Bacteria, especially pathogens, have a strong tendency to develop resistance to any substance that might be detrimental or lethal to them. This phenomenon is currently flagrant in case of antibiotics and disinfectants. To avoid such resistance development, none of the Probiotic used in our products has any direct biocidal action towards other organisms. The mechanism of action is based on the principle of ‘*competitive exclusion*’.

The idea behind *competitive exclusion* is that during the application of probiotics a layer of probiotic bacteria is placed on the target surface, immediately occupying the ‘field’ by good bacteria. They will consume all remaining food sources, leaving nothing behind for potential pathogenic invaders looking for space and food. The probiotic bacteria are much more active in this competition and outdo all other bacteria. In heavily polluted environments the competitive exclusion itself will not be sufficient to induce a fast and strong effect. Another factor must be considered.

In heavy polluted air or water pathogenic bacteria have a survival mechanism called *quorum sensing*. The pathogenic bacteria when exposed to a threat such as chemical intrusion, lack of food, over population or an upset in their environment, they will go dormant in mass because of this communication. *Quorum sensing* is an extremely fast way of communication between bacteria, making use of numerous signal molecules. Probiotics applied to the pathogenic bacteria environment works because when
Probiotics are applied to a surface, a competition for space, food and moisture is established. This arrival of Probiotics in masse immediately results in the pathogenic bacteria, (by means of quorum sensing) will inform each other about these unfavorable conditions, leading to a dormant phase and their subsequent removal from the field.

The third consideration of the Probiotic effect is **Biofilm. Biofilms** are an accumulation of inorganic and organic materials that can attach to all surfaces. Bacteria, both pathogenic and non-pathogenic, are incorporated into a biofilm during a stepwise formation. With time and nutrients, a biofilm and the bacteria within the biofilm will grow and become strongly attached to the surfaces. On occasion, parts of the biofilm slough off into the surrounding environment. Our Probiotics with assist from natural enzymes and bio surfactants dismantle biofilm and prevents its reestablishment if the new microbiome is maintained.

The Probiotic approach to air, water and surfaces has three major advantages over chemical treatment or other treatment schemes:

- Provides a stable solution to problems with pathogens
- No pathogen resistance can be developed. The only demand set by this method is that the frequency of cleaning or application of fresh probiotics is kept constant
- Bio Film, the haven for pathogens, transmittal of disease and bio fouling is eliminated because Bio Film is dismantled and removed (consumed) by probiotics.
Example of Misting Probiotics in the Air

Test procedure
The concentrated sporulated probiotics were delivered into a 200 square foot room by fine particle misting for 30 seconds at 15 minute intervals. The device was running at 50% capacity at a rate of (1 ml/min). The area that the probiotics were delivered was in a 200 square feet room.
Total bacterial count was determined before starting and after 15, 30 and 45 minutes. The bacterial measurements were approx. 12 feet away from the misting device. The white colonies are the probiotic bacteria.

Results: After three misting runs, the air in the room was full with probiotics after 45 minutes. It is obvious that the Microbiome in the room has now changed to probiotics rather than potential pathogens. Approximately 1.5 ml of concentrated Probiotics changed the Microbiome in a 200 Square foot room (2400 cubic foot).

Conclusion: The benefits for the room microbiome changing to probiotics, is that there is a layer of probiotic bacteria on the room surfaces, immediately occupying the ‘field’ by good bacteria. The probiotics will consume all remaining food sources, leaving nothing behind for potential pathogenic invaders looking for space and food. Allergens, soil, biofilm, and odor are greatly reduced in the new microbiome.
Areas that Probiotics have been used in Industry successfully

- **Heating, Ventilation and Air Conditioning (HVAC)**
  - Eliminates Bio Odor sometimes called Smelly Socks syndrome in ductwork, coils and cooling water.
  - The Microbiome in can be controlled in ductwork, coils and cooling water using to eliminate pathogens such as Listeria, Legionella, and Salmonella.
  - Allergens such as dust mite and rodent excrement, pollen are microscopically cleaned from Duct Work and evaporative coils.
  - Smoke smell odor is removed from Duct Work and evaporative coils.
  - Scale and biofilm is removed from heat transfer surfaces providing dramatic energy savings.
  - Solution for Sick Building Syndrome (SBS) by improving the IAQ from pathogens and VOCs from synthetics in construction products.
  - Transit buses have used Probiotic cleaning and misting in AC ducts to control odor, and pathogens improving the IAQ.
  - Cleaning heat transfer surfaces of biofilm in heat exchanger tubes that use Glycols.

- **Cooling Towers, Plate and Frame Heat Exchangers and Chiller Tubes**
  - Heat Transfer surfaces are kept clean from scale and biofilm surfaces providing dramatic energy savings.
  - Microbiome of the water used in cooling can be managed to prevent pathogens like Legionella.

- **Agriculture**
  - Hog, Poultry, and Dairy farms use Probiotics to clean the air and water. Water lines are injected with Probiotics to eliminate bio fouling and pathogen loading. Barn cleaning with Bio Enzymatic Probiotic cleaners remove excrement and leave Probiotics on the surface. Fogging or misting in the air reduces Hydrogen Sulfide and ammonia fumes as well as air borne pathogens.
  - Fish Farms use Probiotics to eliminate Biofilm formation in ponds which cause pollution of filters, turbidity of the water and the development of pathogenic germs.
  - Benefits include faster grow rate, and reduced mortality.
Odor is controlled in the ponds, barn and environs
- Waste water in the deep pits, and waste ponds remains liquid with reduced odor
- Elimination of anti-biotics for animal treatment which greatly reduces the potential for anti-biotic resistant bacteria like MRSA
- Oil Eating bacteria have been used for years in cleaning up oil spills

**Waste Water**
- Drains and sumps in restaurants, cafeterias, and food processing facilities use microbes to clean out grease traps and control odor
- Ground Water and Soil is remediated by using beneficial microbes.
- Waste Water lagoons and oil spills are cleaned up by using microbes help breakdown of large waste oil molecules to smaller ones and are easily consumed (digested) into innocuous CO2 and soluble beneficial fatty acids.