

Bioaugmentation of Treatment System for Skatole Degradation: Bioremediation Potential for Odors Reduction at Livestock Operations

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Species: Swine and poultry
Use Area: Manure Treatment
Technology Category: Biological Amendment
Air Mitigated Pollutants: Odors

Description:

Animal waste disposal and odor control have become a major issue for animal production facilities. As an attempt to improve efficiency and profit margins, many livestock operations have become large concentrated rearing facilities. As a result, many concerns over potentially adverse environmental impacts from these operations have arisen. While there are many important issues that drive these concerns, the emission of malodorous compounds is undoubtedly the foremost factor driving public awareness of this matter. Odor management has become a crucial issue for the livestock industry. Many have attempted to mitigate malodorous emissions by utilizing technological techniques such as scrubbers. However, these techniques may not be cost effective since scrubbers may require expensive solvents. Here, we demonstrate that bioaugmentation of bioreactor with enrichment cultures and with a pure culture of *Rhodococcus* sp. isolated from swine lagoon is a viable alternative in reducing skatole, a main malodorous compound in swine effluent. We found that bioreactor amended with pure culture can degrade skatole as well as the enriched mixed culture after certain lag period. Pure culture bioreactor required longer lag time than the mixed culture. Thus, bioaugmentation of treatment systems with indigenous populations may increase the efficiency of treatment systems and provide a simple, cost-effective bioremediation potential in reducing malodors emission at livestock facilities.

Mitigation Mechanism:

Malodorous compounds are produced from fresh feces and from waste receptacle. Although the volatile compounds emitted from concentrated animal feeding operations are diverse, a limited number of these may be responsible for malodor (Williams, 1984; Hobbs et al., 1995; Zahn et al., 2001). Some of the most offensive compounds such as skatole, indole, cresol, and other phenolic compounds are products of the anaerobic metabolism of aromatic amino acids (Elsden et al., 1976). They are often cited as being the major malodors from livestock operations. Besides having characteristics of fecal odors, these compounds also have low thresholds for olfactory detection. By having treatment systems (e.g., bioreactors, biofilters, or bioscrubbers) that utilize microorganisms with specific enzymes for degrading these malodorous compounds, the resulting air quality around livestock operations would become less offensive. By bioaugmenting the treatment systems with specific degraders, a specific malodorous compound could be targeted which would improve the efficiency of the treatment systems.

Applicability:

Bioaugmentation is suitable for any treatment systems such as bioreactors, biofilters, and scrubbers. In turn, these systems could be utilized at livestock operations such as swine and poultry houses.

Limitations:

Dealing with living organisms requires the right environmental conditions for growth and sustainability. For example, the right pH (usually neutral), ambient temperature, sufficient amount of essential nutrients and oxygen are required for these aerobic skatole degraders. They are substrate-specific organisms. In addition, potential competition from indigenous species may limit their effectiveness.

Cost:

The cost of bioaugmentation of a treatment system is dependent upon the type of the treatment systems. These microorganisms can be easily isolated and cultivated from contaminated sites. The extent of the cost would fall mostly on the purchase of nutrients for growth. In most cases, the required nutrients for growth could be obtained from the target pollutants themselves (e.g., emissions from swine or poultry wastes).

Implementation:

The data given in this section show the degradation of skatole and p-cresol as a co-substrate in a bioreactor setting. These microorganisms can be used in biofilter and scrubber settings as well.



Figure 1. Bioscrubber setup (lab scale)



Figure 2. Bioreactor setup (lab scale)

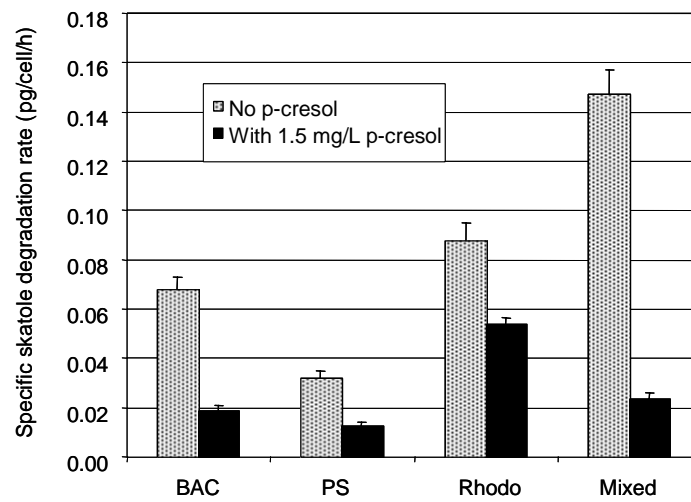


Figure 3: Effect of p-cresol on skatole metabolic flux for different archetypes fed 1 mg/L skatole at $D=0.25h^{-1}$. (BAC=*Bacillus sp.*, PS=*Pseudomonas stutzeri*, Rhodo=*Rhodococcus sp.*, and Mixed=*Mixed culture*)

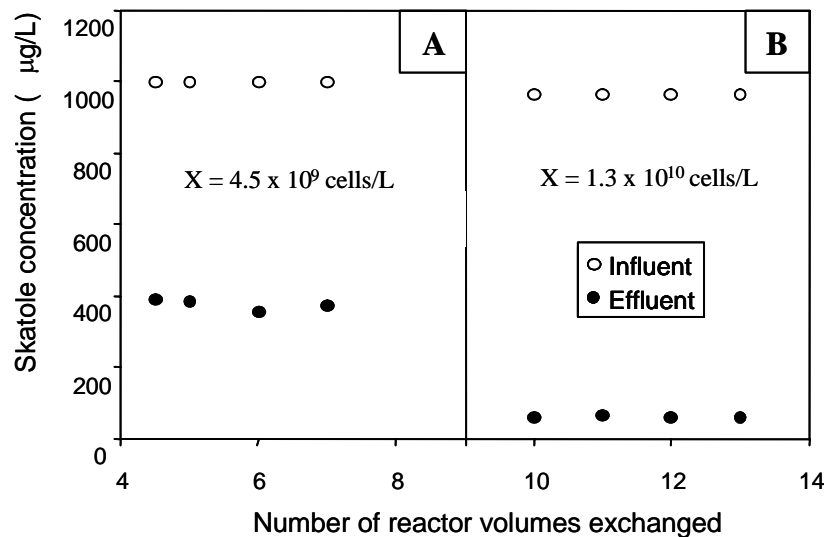


Figure 4: Skatole degradation by *Rhodococcus sp.* at 20 °C. The addition of p-cresol at 1.5 mg/L (Panel B) enhanced the degradation of skatole due to an increase in the microbial concentration (X).

Technology Summary:

Bioaugmentation of treatment systems (i.e., bioreactors, biofilters, or scrubbers) could increase/improve treatment efficiency and provide a simple, cost-effective bioremediation potential in reducing malodors emission at livestock facilities. Use of microorganisms such as these skatole degraders could effectively target the pollutant of interest. However, this could limit the technology in its applicability for general application since it is very substrate/pollutant specific. Nevertheless, this technology is simple to utilize, cost-effective, and applicable in most treatment systems.

Additional Resources:

Literatures on environmental microbiology.

Acknowledgments:

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