SCD Probiotics

White Paper

Application of SCD Probiotics Technology
For Odor Control: Specifically SCD Odor Away™

SCD Probiotics Technology

Background

Sustainable Community Development, LLC ("SCD"), based in Kansas City, Missouri, USA, is a company specializing in natural microbial-based products and services for human health, agriculture industry, industrial waste management, and environmental sustainability. Through 10 years of research and development, SCD has selected 14 different microbial strains for production of various probiotic products. These include lactic acid bacteria such as *Lactobacillus* spp. and *Streptococcus sp.*; yeast such as *Saccharomyces* sp.; photosynthetic bacteria such as *Rhodopseudomonas* spp.; and other beneficial bacteria such as *Bacillus* sp. This paper is written to explain the effects of SCD Probiotics Technology with odor issues. Specifically, this paper will explain SCD Odor Away™ as the product used to decrease odor.

In essence, SCD Probiotics Inside is a technology consortium of lactic acid bacteria, phototrophic bacteria, nutritional yeast, and other beneficial microorganisms. SCD's consortium culture synergistically works to inhibit the growth of pathogenic harmful bacteria through competitive exclusion. Competitive exclusion is when two species compete for a single source of food. The microbe with the more efficient absorption system will acquire most of the food, grow faster, reproduce faster, and eventually displace the microbe that absorbs food slower and thus cannot grow as fast. SCD products such as SCD Odor Away will competitively exclude the harmful putrefactive bacteria in the environment which lead to odors, thus reducing the odor. In addition to competitive exclusion effects, the metabolites produced by the consortia and its chemical characteristics contribute to antimicrobial properties and health benefits. Average pH of the product ranges from 3.2-3.5. Some products with SCD Probiotics Technology microorganisms consortium, for instance, *Lactobacillus acidophilus, L. bulgaricus, L. casei, L. fermentum, L. plantarum, Rhodoseudomonas palustris, Saccharomyces*

cerevisiae, Streptococcus thermophilus, etc The above-mentioned microorganisms have been known to be associated with human foods and are ubiquitously used to manufacture dietary supplement probiotic products for human, animal, and aquaculture health.

While the traditional meaning of the word "probiotic" is applied to human and animal digestive microorganisms, SCD is on the cutting edge of developing technology to apply the concept of "probiotics" to many fields globally including wastewater treatment, odor control, environmental bioremediation, agriculture, pest control, mold remediation, industrial and home agriculture, aquaculture, gardening, prevention of skin diseases, turf grass, composting, and other fields.

SCD Probiotics Technology and Certifications

All SCD products are manufactured under high and strict quality control standards. Products are manufactured in a food grade facility utilizing food grade equipment, raw materials, and utensils. SCD complies with the Food Grade current Good Manufacturing Practices (cGMP) Guidelines enforced in the United States by the Food and Drug Administration. GMP guidelines provide a system of processes, procedures and documentation to assure the product produced has the identity, strength, composition, quality and purity that it is represented to possess. Information about SCD Probiotics Technology can be found at www.SCDProbiotics.com

Organic Materials Review Institute (OMRI) provides certifiers, growers, manufacturers, and suppliers an independent review of products intended for use in certified organic production, handling, and processing (Organic Materials Review Institute, 2006). OMRI's services are directed to all aspects of the organic industry with a primary focus on the decision makers who deal with the compliance status of generic materials and brand name products. With the OMRI *Generic Materials List* and OMRI *Products List,* OMRI provides guidance on the suitability of material inputs under the

USDA National Organic Program standards (Organic Materials Review Institute, 2006). Many SCD products are certified with OMRI as "safe for use in organic production." Please visit **www.omri.org** for more information and to verify SCD's registered status. Most of the raw materials used in to manufacture SCD products are GRAS (Generally Recognized as Safe). Furthermore, most of the SCD microbial species are ubiquitously used in the manufacturing of probiotic dietary supplement products for human, animal, and aquaculture health. Some of the microbial species are known for usage in waste and bioremediation applications. In essence, they are known to be safe and are harmless to the environment.

SCD's compliance with the above-mentioned regulatory agencies illustrates the safety and quality of the products manufactured as well as the routine testing that has been conducted over the past two years. SCD products are routinely tested both in-house and by third party independent laboratories for the incidence of pathogenic activity, heavy metals, and mycotoxins. Certificate of analysis of one of the products, ProBio Balance™ Plus is enclosed.

ProBio Balance Plus is recommended for use in agricultural and environmental applications. It also can be used to manufacture secondary products such as SCD Odor Away for specific odor control applications. The secondary product is as follows:

SCD Odor Away: This is an all-natural, safe, biological odor reducer containing exclusive microbes and their metabolites. SCD Odor Away is environmentally safe and distinctly effective at decreasing odors in livestock lagoons, holding areas and pens, waste treatment facilities, and composting operations. The following will explain the usage of and probable results for SCD Odor Away when used for odor control.

Probiotics and Odor Control

Odor control treatment is a challenge in various industries, as previously mentioned. High contents of organic matter can lead to the formation of malodors and the degradation of sulphur, phosphate, and nitrogen. Malodors can cause putrefactive odors as well as pollutants, which can lead to diseases and ultimately make the environment unsafe. Examples of areas where odor is a challenging issue include wastewater treatment, livestock facilities, poultry and swine farms, compost facilities and sewage/trash dumps. SCD Probiotics Technology, specifically SCD Odor Away, has the ability to solve this issue by digesting harmful organic compounds and breaking them down into smaller, less volatile compounds which are actually beneficial to the environment. A more detailed explanation of how the beneficial microbes of SCD Probiotics Technology work is explained below.

The microbes in SCD Odor Away are a consortium of microbes that are able to coexist together based on their metabolic properties. Yeast has the ability to assimilate glucose as a substrate and produce pyruvic acid through metabolism of the saccharide decomposed system. Pyruvic acid can be used as a substrate of microaerobic lactic acid bacteria. In this way, if the lactic acid bacteria using the metabolite of yeast multiply, the formed lactic acid becomes the substrate of photosynthetic bacteria which can be multiplied. Yeast then uses the saccharides formed by this photosynthetic bacteria as a substrate and can multiply repeatedly. This process shows how the microbes in SCD Probiotics Technology continue to aid each other to stay alive and strong in the environment. Each grouping of microbes has unique properties which make them effective and contribute to the effectiveness of SCD Probiotics Technology in fighting odor. The lactic acid bacteria (LAB) produce lactic acid as the major metabolic end product of carbohydrate fermentation. LAB are also characterized by an increased tolerance to a lower pH range. This enables LAB to outcompete other bacteria in a natural fermentation, as they can withstand the increased acidity from organic acid

production. Through the metabolism of LAB, CO_2 (carbon dioxide) is formed. The carbon dioxide is used by other species in the consortia as a source of energy to their own metabolic systems, e.g. phototrophic bacteria.

The yeast and phototrophic bacteria are known as heterotrophic bacteria, meaning they use organic substrates to obtain carbon for their growth and development. Heterotrophic bacteria can reproduce in as little as 15 minutes to 1 hour. In most industries where odor is a concern, there is a high amount of organic and waste materials which convert to ammonia through a process called mineralization. This process causes the putrefactive odors. During mineralization a substance is converted from an organic substance into an inorganic substance, therefore becoming "mineralized." Sources of such waste material are from fecal matter. When there is no organic nitrogen source present in a system, heterotrophic bacteria utilize ammonia and break it down into less harmful compounds which are not putrefactive. *Bacillus* is resilient in the environment due to its heat-resistance characteristics and spore-forming abilities, which help to increase shelf-life. Phototrophic bacteria (or PNSB) are capable of using both organic and inorganic materials as hydrogen donors throughout their growth cycle. The ability of PNSB species to use hydrogen sulfide, which is toxic, and convert it into nonpoisonous compounds is highly beneficial in the odor control industry.

Wastewater treatment is another example where odor issues become problematic. Facilities constantly battle problems with the treatment of their sewage. Putrefactive odors are an obvious problem related to the waste being treated at the facility. These odors are created by harmful pathogens and increased levels of biological oxygen demand (BOD), chemical oxygen demand (COD), and suspended solids (SS). BOD is the procedure for determining how fast biological organisms use up oxygen in a body of water. COD is the amount of organic compounds in the water. Both are measures of water quality and are frequently measured in wastewater treatment. When these levels increase, their presence indicates a decrease in oxygen which releases foul

odors. By using SCD Probiotics Technology, such as SCD Odor Away, wastewater treatment facilities have shown a drastic decrease in odor within 24 hours. This odor reduction is attributed to the decrease in levels of BOD, COD and SS, which all decrease as the beneficial microbes absorb toxic gases and harmful compounds and convert them into organic acids to eliminate foul odors.

SCD Probiotics Technology Odor Control Case Studies

SCD Odor Away was applied to landfill leachate for bench testing in order to study its efficacy in combating odor. The study was performed using Surface Flux Chamber Testing by a third party independent laboratory. This technology quantitatively measures flux of odor and VOCs at the test surface. Flux chamber sampling was performed on untreated and treated leachate waste material. In brief summary, SCD Odor Away was effective for odor control. Overall odor control efficiency of 96% has been observed using the official USEPA surface emission isolation flux chamber (flux chamber) operated following the USEPA protocol. The results of the quantitative analysis of odor emissions indicated control efficiencies of 76% after the initial application (within 1 hour of application), 93% after 48 hours, and 96% after 8 days.

Sewage odor reduction in Queensland, Australia was tested with SCD Probiotics Technology. Hydrogen sulfide dropped below 1ppm within 24 hours of inoculation. This study reported a significant initial drop of water borne hydrogens, resulting in the reduction of foul odors as generated from ammonia, hydrogen sulfide, etc. (Boyd, 1999). It is known that phototrophic microbes (also known as PNSB) use hydrogen donors in photosynthesis via their chemotrophic mechanism. In addition to the phototrophic bacteria in SCD Probiotics Technology products, lactic acid bacteria also are capable of converting carbon molecules into organic acids such as lactic acid. These organic acids have antimicrobial effects against putrefactive microorganisms.

Chantsavang et al. (Unpublished data) studied the application of consortium probiotic technology for swine waste treatment. The experiment was conducted at the experimental pig farm of the Animal Science Department Kasetsart University in Bangkok, Thailand. The model farm represents most medium-sized farms. Manure is first manually scraped onto the concrete floor and dried; the remaining manure and the pigs are washed daily with a pressure hose. The resultant slurry is flushed into a sedimentation tank and the overflow is discharged directly into an effluent-holding pond where the solids accumulate.

After washing the facility with probiotic liquid solution for 7 days, samples of the treated water and manure were collected in the same manner. For the washed water and drinking water treatments, samples were taken after probiotic liquid solution had been used for 7 days. It was found that washing pig pens with probiotic liquid solution could improve the quality of pig wastewater. The dissolved oxygen (DO) in treated wash water was 1.3 ppm at site 1, while DO was not detected at site 2. The CO_2 content decreased from 123 ppm to 47 ppm at site 1 and from 446 ppm to 215 at site 2 after 7 days of treatment.

The reduction in total volatile solids (TVS) of treated wash water was 30% at site 1 and 89% at site 2. This reduction is associated to some extent with malodors in animal wastes. Most people working and living near the pig farm have been convinced by experience that the probiotic treatment can effectively control odor problems. In this study, the treated dry pig manure was essentially odorless. In summary, results of chemical analyses show that consortium probiotics technology is practical for treating the pig wastewater. The reduction in BOD was found to be 91% at the high solids concentration site (site 1) and 46% at the dilute concentration site (site 2). It was found in this study that washing the pigs and the pens daily with probiotic liquid solution could satisfactorily control odor problems.

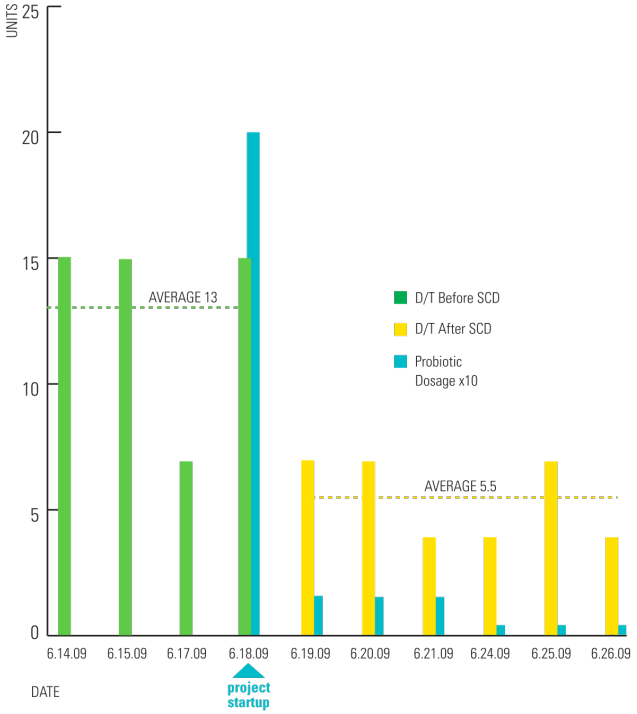
Studies were conducted to determine the effect of probiotics technology for wastewater treatment around the world (Wood et al., 2004, Sun et al., 2006). In essence, studies indicated reductions in BOD, COD, pathogens, and total coliforms in wastewater treated with probiotics solution. Wood et al. (2004) applied probiotics solution at a rate of 1:10,000 to the wastewater. Foul odors and total coliform were reduced significantly when wastewater was treated with probiotics solution. Average sulfide removal as well as sulfates removal were significantly increased by 70% and 110% respectively (Wood et al., 2004). In addition, probiotics treatment significantly decreased ammonia in the water at the plant influent from an average of 1244 mg/l to 194 mg/l and at the plant effluent from 614 mg/l to 214 mg/l. Average fecal coliforms removal at the plant was significantly increased by 3 times after treatment with probiotics (Wood et al., 2004).

A study conducted in Cebu, Philippines indicated that foul odors on a swine farm were greatly reduced after one year of continuously incorporating both consortium probiotic feed and drinking water for the swine and by mixing probiotic liquid solution for cleaning pens. An average of 67% of the evaluators rated the pigpen tested as odorless: 23% rated it slightly odorous; 10% rated it moderately odorous; and none gave a score of strongly odorous.

Recent trials using SCD Probiotics Technology for odor reduction in a dairy manure lagoon indicated that SCD Odor Away could be used to manage odor from the waste lagoon. The trial dairy farm had 450 dairy cows with a waste lagoon capacity of 1.1 million gallons. Prior treatment data was taken 4 times before initial introduction of SCD Odor Away. Dilution threshold ratio (D/T) results after treatment were then taken six times. In general each day, D/T data was taken either from 10am-12pm or 2-4pm at the same location each time.

Prior treatment data ranges were from 7 D/T-15 D/T (Figure 1). Within a day after initital treatment, data remained at 7 D/T and dropped to 4 D/T after the lagoon

had been treated for three days. As a result, dosage application was adjusted to maintenance application level (1:5,000), which started on June 22nd, 2009. D/T data was taken again on June 24th, 2009. Average D/T results prior to the treatment was 13 D/T, while after treatment data averages 5.5 D/T. This change represents approximately 2.36 fold in D/T reduction.



To summarize, certain groups of SCD Probiotics Technology are capable of shifting the microbial ecology balance by converting organic compounds into mineral nutrients. This conversion results in the prevention and neutralization of odor-causing organic compounds, as evidenced by significant decreases in water borne hydrogens and foul odors generated from ammonia, hydrogen sulfide, mercaptans, etc. (Kobayashi and Kobayashi, 2002). Principle chemical reactions are carbon decomposition via both respiration and fermentation, nitrification/de-nitrification (such as ammonia to nitrate)

and sulfate reduction (sulfate to sulfite). Furthermore, SCD Probiotics Technology has been known to be higher in efficacy than typical competitive products. Most probiotics are single strains in a dehydrated powder form and are highly expensive. SCD Probiotics products are liquid and have a consortium of 15 species or more depending on the product. SCD Odor Away contains 17 species and therefore is higher in efficacy because it can conform to many different environments. The liquid product is highly concentrated and is diluted in water prior to use. The dilution process makes the product more efficient because it is inexpensive. As with any product, there is an initial cost to begin treatment, but in the end the product averages out to be highly cost-effective. For example, if the price of a 275 gallon tote is $5,000, this amounts to $4.69 per liter. Once diluted in water, the cost becomes anywhere from $0.23 to even less than $0.01 per liter before the cost of water. SCD Probiotics Technology is both highly efficient and affordable, making it consumer friendly.

SCD Probiotics Technology Benefit Analysis

The successful application of SCD Probiotics Technology is expected to have the following impact on odor treatment applications:

- Achieve targeted reductions in odor quality parameters (scentometer D/T).
- Control odors in the wastewater distribution system, treatment plants, and livestock operations.
- Reduce energy consumption in treatment plants
- Reduce sludge accumulation in treatment plants.
- In certain situations, increase the throughput of the treatment system.
- Improve overall surrounding air quality.