

SCD Probiotics

White Paper:

*Application of SCD Probiotics Technology
for Wastewater Treatment*

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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 *Rhodospseudomonas* spp.; and other beneficial bacteria such as *Bacillus* sp. This paper is written to explain the effects of SCD Probiotics Technology with wastewater issues. Specifically, this paper will explain SCD Odor Away™ and SCD Bio Klean™ as products used to treat wastewater.

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. With SCD Probiotics Technology, such as ProBio Balance™ Plus, the microbes are able to out-compete the harmful microbes in wastewater, such as hydrogen sulfide. In addition to competitive exclusion effects, SCD Probiotics metabolites and its chemical characteristics contribute to its antimicrobial properties and health benefits. Average pH of probiotic product ranges from 3.2-3.5. Some products with SCD Probiotics Inside microorganisms consortium can include, 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.

ProBio Balance Plus and Certification

ProBio Balance Plus is an enhanced phototrophic bacteria solution and therefore is more suitable for agricultural and environmental applications. 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). ProBio Balance Plus is certified with OMRI as “safe for use in organic production.” Go to www.omri.org for more information and to verify SCD’s registered status. Most of the raw materials used 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 these 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. ProBio Balance Plus has been 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 ProBio Balance Plus is enclosed.

ProBio Balance Plus is recommended for use in agricultural and environmental applications. It can be used to manufacture secondary products such as SCD Bio Klean and SCD Odor Away™ for specific wastewater applications. The secondary products are as follows:

SCD Bio Klean: This is an all-natural industrial cleaner containing exclusive microbes and their metabolites, which is recommended for treatment of industrial wastewater, grease, grime, and dirt. SCD Bio Klean is an environmentally safe and uniquely effective biological cleaner.



SCD Odor Away: This is an all-natural 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.

Wastewater Treatment

Wastewater Basic Information

Wastewater treatment facilities constantly battle problems with the treatment of sewage. Putrefactive odors are an obvious problem due to the waste being treated at the facilities. In response to the problem, some facilities use oxygen injections which aid in the reduction of hydrogen sulfide. These injections, however, do not work enough to completely eliminate the foul, putrefactive odors.

In wastewater facilities, solid organic, nitrogenous waste material (also known as sludge) is converted to ammonia through a process called mineralization, which causes the putrefactive odors. During mineralization, a substance is converted from an organic substance into an inorganic substance, therefore becoming “mineralized.” Sources of waste material (sludge) are fecal matter, the decay of plant and animal tissues, and the decay of excess food, all of which are concerns for wastewater facilities. 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. Furthermore, high amounts of chemical oxygen demand (COD), biological oxygen demand (BOD), and suspended solids (SS) result in water pollution which can kill plant and water life if the polluted water is pumped into a stream or river (Wididana, 2006).

Biological oxygen demand (BOD) is the procedure for determining how fast biological organisms use up oxygen in a body of water. Chemical oxygen demand (COD) is the amount of organic compounds in the water. Both are measures of water



quality and are frequently measured in wastewater treatment. The primary purposes of wastewater treatment is to remove the suspended and soluble organic constituents measured as chemical oxygen demand (COD) and biochemical oxygen demand (BOD) and to reduce fecal coliforms.

Coliforms are a broad class of bacteria which live in the digestive tracts of humans and animals. When coliform bacteria is found in tap water, its presence suggests a problem with the treatment system or in the pipes. Health problems that can result from this contamination include diarrhea, nausea, and vomiting (Environmental Protection Agency, 2001).

In the Total Coliform Rule, the EPA set the health goal for total coliforms at zero. The legal limit states that water treatment facilities must not find coliforms in more than 5% of the samples they take each month to meet the EPA's standards (Environmental Protection Agency, 2001).

In summary, sewage treatment is the process of removing both runoff (effluents) and domestic contaminants from wastewater. Treatment includes physical, chemical, and biological processes to remove physical, chemical, and biological contaminants. Its objective is to produce a waste stream (or treated effluent) and a solid waste or sludge suitable for discharge or reuse back into the environment. This material is often inadvertently contaminated with many toxic organic and inorganic compounds. Wastewater typically has a high level of pathogens, suspended solids (SS), protein, mineral salt, and chemical compounds. These pathogens make the treatment of wastewater extremely difficult without the use of chemicals. High contents of organic matter can lead to the formation of malodors as well as the degradation of sulphur, phosphate, and nitrogen. Malodors can lead to putrefactive odors as well as pollutants which can cause diseases that ultimately make the environment unsafe. It is clear that wastewater treatment can be a tremendous challenge. This application guideline explains



how SCD Probiotics Technology can be used to treat wastewater systems to decrease both harmful organic matters and pathogens, thus reducing odors.

Probiotics in Wastewater Treatment

The classical definition of the word “probiotic” is live microorganisms which, when administered in adequate amounts, confer a health benefit on the host. The concept of probiotics is being further expanded to imply the use of beneficial live microbial cultures applied to a system to increase health and performance. Many probiotic strains have a long history of safe use. Probiotics have been introduced into the wastewater industry for many years. When probiotics are added to wastewater, odor is not noticed, sludge is reduced over time, and levels of harmful organic compounds decrease. Many wastewater treatment facilities currently use various types of probiotics, but typically these probiotics only include a few strains. Examples of probiotics used in wastewater treatment are groups of the following microorganisms: *Bacillus*, *Phototrophic* bacteria, Lactic acid bacteria, and yeast.

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 tolerance 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, CO₂ (carbon dioxide) is formed. This 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 get carbon for their growth and development. Heterotrophic bacteria can reproduce in as little as 15 minutes to 1 hour (Biocon Labs, 2008). Heterotrophs such as *Bacillus* sp. are also highly resilient in the environment due to their 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 also very beneficial in the wastewater industry (Kobayashi and Kobayashi, 2002).

SCD Probiotics in Wastewater Treatment

SCD consortium probiotics coexist based on their metabolic properties. The yeast have 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 and they 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 Probiotic Technology continue to aid each other to stay alive and strong in their environment. Each group of microbes has unique properties which make SCD Probiotics Technology so effective.

Quang (2006) reported that the species in SCD Probiotics Technology, including *Lactobacillus* spp., Yeast (such as *Saccharomyces* sp.), *Rhodospseudomonas* spp. and other beneficial species, have shown to reduce total coliform counts in wastewater facilities by 80% after 4 months of treatment. This statistic shows a dramatic reduction in total coliforms. The metabolites from LAB have shown anti-microbial ability in some studies. Depending on the environment, nutrition, and type of species, the metabolites can produce lactic acid, acetic acid, ethanol, diacetyl, CO₂ (as carbonic acid), H₂O₂, reuterin, derivatives of lactic acid (hydroxyl lactic acid), and small peptides (such as bacteriocins) (Ray, 2000; Nes and Holo, 2002). These antimicrobial agents can either inhibit or kill



target microorganisms such as molds, yeasts, coliforms, vegetative bacteria, bacterial spores, and even viruses.

In one case, after replacing oxygen injections with SCD Probiotics Technology, the hydrogen sulfide levels decreased significantly and oxygen injections were discontinued (Boyd, 1999). The results seen included the immediate reduction of odors within 24 hours. This result is due to the ability of the microbes to degrade various organic compounds. Consortium microbes are able to digest organic compounds and release beneficial by-products.

By using SCD Probiotics Technology, Indonesia showed reductions of COD, BOD, and SS of 40%-50%, 42%-55% and 44%-71% respectively (Wididana, 2006). SCD Probiotics Technology was applied periodically every 10 days. The microbes were able to ferment the organic matter resulting in the formation of simpler organic compounds, such as amino acids, alcohols, sugars, and organic acids that are more beneficial and do not harm the surrounding environment. These new compounds reduce amounts of COD, BOD, and SS that typically would result in putrefactive odors.

The phototrophic bacteria in SCD Probiotics Technology also have an extremely important role in wastewater management because of their ability to degrade organic compounds. They can oxidize NH_3 , use the natural sunlight as a source of energy, and use CO_2 as a source of carbon (Wididana, 2006). By having multiple types of bacteria in one culture, SCD Probiotics Technology products are able to degrade various organic compounds rather than just one single strain of microorganism. When levels of BOD, COD, and SS increase, this increase indicates a decrease in oxygen which releases foul odors. When these levels are extremely high, the organic compounds cannot be degraded biologically alone (Wididana, 2006). SCD Probiotics Technology can aid in this problem by digesting the organic compounds and releasing beneficial by-products, such as amino acids. 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's products are liquid and have a consortium of 15 species or more depending on the product. SCD Odor Away and SCD Bio Klean both have 17 species and therefore are higher in efficacy because they can conform to many different environments. The liquid product is highly concentrated and is diluted in water prior to use. This dilution makes the product more efficient as it is ultimately less expensive. 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 wastewater treatment applications

- Achieve targeted reductions in water quality parameters such as BOD, COD and TSS.
- Reduce coliform counts in treated water
- Control odors in the wastewater distribution system and treatment plants.
- Reduce energy consumption in treatment plants
- Reduce sludge accumulation in the treatment plants.
- Reduce corrosion of plant and equipment and hence reduce maintenance costs.
- In certain situations, increase the through put of the treatment system.



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