Sugarcane Molasses By-Product Used to Increase Fertilizer Efficiency

NICE3

Current trends in world population growth indicate that the demand for food will steadily increase, creating a greater demand for fertilizers. In addition, fertilization of forest biomass was identified recently as the most cost-effective option for mitigating global warming. However, the fertilizers used in agriculture and other applications are a source of nitrogen pollution of the environment, and fertilizer use is limited in several countries.

The dilemma created by this situation could be resolved by increasing the efficiency of nitrogen fertilizers, thereby reducing the amount of nitrogen leached into ground water. With the help of a NICE³ grantfrom the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency, Michigan Biotechnology Institute (MBI) and several partners plan to develop a method to increase fertilizer efficiency through the bioconversion of low-value molasses by-product to plant biostimulants.

■ **Challenge:** Currently, crops only use 50% 70% of applied fertilizer; the remainder flows through the soil or is lost in other ways, contributing to environmental pollution. The agri-chemical industry is aware of numerous products that claim to promote plant growth while reducing the amount of fertilizer needed. However, these products have not been developed commercially because of their inconsistent performance and complex formulation. Developing a cost-effective method to manufacture a consistent product should change the perception and value of these products.

Solution: Maximum plant growth depends on the availability of 17 essential nutrients. However, simply providing plants with these nutrients is often not enough. Certain compounds in soil must also be present to facilitate nutrient assimilation by the plants. Research has shown that specific fermentation products may facilitate uptake in plant tissue when added to fertilizers.

MBI, along with several state and industrial partners, is developing a method to convert by-products from sugarcane into specific fermentation products. The 3-year project has three phases. The first objective is to develop a cost-effective chromatographic process for separating sugarcane molasses into sucrose and raffinate. The second phase will focus on developing a process for producing and recovering plant biostimulants from the chromatographic raffinate stream. Finally, the biostimulants will be tested in controlled laboratory, greenhouse, and field trials.

Energy Savings: Application of the fermentation products could reduce the use of nitrogen fertilizers by 10%-50%. The new technology would save 547 billion Btu (577 terajoules) each year in energy from fertilizer production. The average energy savings from reduced fertilizer use alone through the year 2010 would be more than 100 trillion-Btu (106 petajoules) annually.

■ **Environmental Benefits:** The use of nitrogen fertilizers could be reduced by as much as 50%, minimizing leaching into ground water, and the rapid increase in atmospheric levels of carbon dioxide could be reversed by the increase in vegetation possible with this technology.

■ **Economic Savings:** Hawaiian molasses currently yields a net profit of $2.75 million annually. Using the proposed technology, that amount could soar to about $10.7 million. Furthermore, an increase of just 33% in fertilizer efficiency will reduce the amount of plant nutrients used by 10 million tons (9 megatonnes)/yr, resulting in a savings of $6 billion annually This proposed technology could reduce total annual costs by $21 million compared to the current technology.

■ **Applications:** In addition to potentially increasing crop yields, converting low-value sugarcane molasses by-product to plant biostimulants could have a significant effect on the viability of the U.S. sugar industry. This technology could also be used in forest fertilization, which may have an important role in mitigating global warming.

■ **Regional Utilities:** Lansing Board of Water and Light (electricity), Consumers Power Company (gas).

Partners: Michigan Biotechnology Institute, Uniroyal Chemical, Galbraith Laboratories, Hawaiian Commercial and Sugar Company, Cherry Marketing Institute, Michigan State University Department of Agricultural Engineering

SIC Code: 8733

Cost: $812,116 (Industry share: $434,174)

Energy Savings: 547 billion Btu (577 terajoules)/yr

Environmental Benefits: Nitrogen fertilizers reduced by 50%; decreased carbon dioxide emissions; molasses waste reduction

Economic Savings: $21 million/yr

National Impact (2010): 100 trillion Btu (106 petajoules) saved/yr

Applications: Agricultural, horticultural, and sugar industries; manufacture of fertilizers and plant biostimulants

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NATIONAL INDUSTRIAL COMPETITIVENESS
through
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Better Tasting Pizza Sauce Using an Energy-Saving Osmotic Filtration System

NICE³

Tomato puree and tomato paste are the main ingredients in a wide variety of food products from pizza sauce to catsup. To make these and other tomato products, U.S. food processors must evaporate more than 13 million tons (12 megatonnes)/yr of waterfrom fresh tomatoes. Currently, industry uses energy-intensive, double-effect evaporators to dewater the fruit.

Osmotek, Inc., in Corvallis, Oregon, has developed an energy efficient method for dewatering tomatoes using direct osmosis concentration and solar evaporation (DOC/SOLAR). Osmotek is a recipient of a grant from the NICE³ program, sponsored by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency. The company will use these funds to demonstrate membrane filtration technology in pilot-plant andfull-scale operation.

■ **Challenge:** The tomato processing industry has been skeptical about the use of membranes. Several years ago, reverse osmosis systems were aggressively marketed to the industry. However, these systems required large amounts of electricity and had membrane fouling problems. The tomato processing season lasts approximately 50 to 90 days/yr; therefore, reliability is of utmost importance. Any downtime impacts production and leads to tomato spoilage.

■ **Solution:** Osmotek developed a low-cost membrane filtration module that can produce high-viscosity purees without clogging the filter membrane. The company modified reverse osmosis membranes for DOC applications to produce higher quality concentrated tomato purees and pastes.

In a direct osmosis system, solvent (water) diffuses through a semipermeable membrane from a low solute solution (tomatoes) to a high solute solution (concentrated salt brine). The greater the difference in the concentrations of the solutions, the faster the water diffuses through the membrane.

DOC uses modified reverse-osmosis membranes that allow small amounts of sodium to cross into the product and remove water much faster. The DOC process makes a more flavorful, thicker puree or paste with more vitamins than purees from evaporator systems.

In double-effect evaporators, the tomatoes are heated during processing. In the DOC / SOLAR system, the only heat required is for reconcentrating the brine. Because tomatoes are grown in hot, dry regions, the sun provides all the energy needed (through solar evaporation) to reconcentrate the brine.

Osmotek will combine its DOC membrane modules with a solar evaporation system in a three-phase program. The first phase will demonstrate a system that contains a 2500 lb (1136 kg)/day tomato processing unit with a 0.03-acre (0.0l-ha) evaporation tank at The Sabroso Company in Sandy, Oregon. The second phase will scale up to a 25 ton (23 tonne)/day unit with a 0.25-acre (0.l0-ha) evaporation tank at Tri-Valley Growers' facilities-in Modesto, California. The final phase will develop products that take advantage of the higher quality of the cold concentrated sauce.

■ **Energy Savings:** Most of the energy consumed in tomato processing is used for running the double-effect evaporators, which are eliminated in the DOC /SOLAR system. Osmotek estimates that a plant producing catsup or tomato paste from 125 tons (113 tonnes) /day of tomatoes could save 150 million Btu (158 gigajoules)/yr. The company estimates that 25% of the tomato processing industry could be using this technology by 2010.

■ **Environmental Benefits:** The double-effect evaporators are powered by natural gas or diesel fuel. By not burning these hydrocarbons, producers can reduce CO_2 and NO_x emissions by 237 lb (108 kg)/ton and 0.82 lb (0.37 kg)/ton of water removed, respectively.

■ **Economic Savings:** Yearly operating costs for a DOC/SOLAR system will be an estimated $30,800 less than those for a double-effect evaporator for a 10,000 lb (454.55 kg)/h water removal unit.

■ **Applications:** Once the technology is perfected, any fruit or vegetable processing plant that performs product concentration should be able to apply this technology.

■ **Regional Utilities:** Portland General Electric Company, Northwest Natural Gas Company.

Partners: Osmotek, Inc.; The Sabroso Company; Tri-Valley Growers; Oregon Department of Energy's Conservation Resources Division

SIC Codes: 2033, 2037, 5142, 3556

Cost: $1,084,739 (Industry share: $670,545; state share: $19,000)

Energy Savings: 1.5 million Btu/ton (1.6 gigajoulesl megatonne) of water removed

Environmental Benefits: CO_2 emissions reduction of 2371 lb/day/ton (1078 kg/day/0.9 tonne) of water removed

Economic Savings: $30,800/yr/10,000 lb (454.55 kg)/h water removal

National Impact (2010): Energy savings of 4.0 trillion Btu (4.2 petajoules)/yr; CO_2 emissions reduction of 1.2 million tons (1.1 megatonnes)/yr

Applications: Tomato, fruit, and cold concentrate processing

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