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Identification of Functional Food Components in By-products of Michigan Crops

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BE Graduate student Kathy Lai and Dr. Dolan showing dried grape pomace.

"Functional foods," or "nutraceuticals," are foods that provide a health benefit beyond basic nutrition. Functional foods have health-promoting or disease-preventing effects. Examples include omega-3 fatty acids (found in many fish, flaxseed oil, soybean oil, canola oil, and walnuts), which reduce risk of coronary heart disease; blueberries, which may have anti-aging effects; and lycopene in tomatoes, which has been associated with reduced risk of certain cancers. The U.S. functional food market, still in its infancy at $19.6 billion, grew 8.5% in 2001 and is expected to grow 7.5 % for the next few years. The size of the functional food markets overseas are $15.4 billion in Europe, and $11.8 billion in Japan.

Because of the enormous world-wide market potential for functional foods, and the recent knowledge that previously "common" foods may have unexpected health benefits, research and product development in this area has exploded. Companies are looking for ways to develop and add functional food ingredients to their products. Many of these functional foods are found in fruits, vegetables, and grains. Compounds found in plant foods are called "phytochemicals," from the root "phyt-" meaning "plant." Because Michigan is second only to California in the number of crops produced in the U.S., Michigan potentially has a large untapped source of phytochemicals. During processing of these crops, large quantities of culled, seconds, and inedible material are disposed of. Although the inedible portions may be aesthetically less pleasing, they can be a rich and inexpensive source of phytochemicals. Obtaining health-promoting compounds from previously unused crop materials could increase the profitability of Michigan farmers and processors, decrease cost of certain consumer food items, and possibly create a new functional foods market in Michigan.

MSU's GREEEN initiative has funded Dr. Kirk Dolan (assistant professor in food engineering) and Dr. Maurice Bennink (professor of nutrition, Dept. of Food Science and Human Nutrition) on a three-year project to identify potential health-promoting phytochemicals in Michigan-grown crops, and to develop a processing method for commercialization of the food components. Michigan growers and processors provided inedible and waste material from the following crops: blueberries, grapes, blueberries, cucumbers, green peppers, radishes, turnips, carrots, onions, and mint. Phenolic compounds have typically shown the most promise for providing health benefits. For each product, some phenolic compounds were extracted on a lab scale. Blueberries, grapes, and onions were identified as those crops having the highest phenolic content, as well as having a large source of inedible material in Michigan. Current work has focused on scaling up extraction methods for these three crops.

Nutrition graduate student Katie Barrett and BE Graduate Student Kathy Lai holding spray-dried powder (final product) and grape pomace (source). Behind them is a bench-scale vacuum evaporator used to concentrate liquid extracts from grape pomace, culled blueberries, and culled onions.

Michigan produces 86,500 tons of grapes annually, ranking fourth in the nation. Most of these grapes are pressed for juice, jam, and preserves, leaving about 15% of the total as inedible pomace (skins, seeds, and stems), which is hauled away as waste. Michigan produces 195 million pounds of onions annually, ranking 10th in the nation. Some of these are culled as seconds being aesthetically inferior for sale, but equal in phtyochemical content. Michigan produces 62 million pounds of blueberries, ranking first in the nation and supplying 45% of all blueberries eaten in the U.S. Culls that are somewhat green or hard are thrown away at the processing plant. Therefore, there is a vast source of by-product for each of the three crops.

Process Development and Scale-up

Inedible blueberries (left), grape pomace (top), and unmarketable onions (not shown) are processed into value-added liquid extracts (middle) or powdered ingredients (right).

Drs. Dolan and Bennink are developing a procedure to produce a commercial product by extracting, filtering, and evaporating to obtain a liquid concentrate. Alcohol and a commercial resin are used. From there, the liquid concentrate can be sold as-is as a base or ingredient for blueberry syrup, blueberry or grape toppings, fruit fillings for roll-ups or bars, onion flavor for soups or high-value premade dinners, or liquid ingredient added directly to an extruded product. A disadvantage of liquid product is that it must be kept in cold storage, and has higher shipping weight than solid product. The second option is to spray-dry the liquid into a powder ingredient for processors to add to extruded breakfast cereals, or to baked goods, drink mixes, snacks, etc. A disadvantage of solid product is that the high-temperature short-time spray-drying process will degrade some of the beneficial phytochemicals. Some companies are already selling high-priced powdered extracts from various berries as an ingredient.

Drs. Dolan and Bennink have already developed all laboratory procedures for identification of phenolic compounds and bench-scale evaporation and separation equipment. Large-scale evaporation and spray-drying is done in the MSU Dairy Plant. Economic analysis of the process will also be completed. This research is an example of building on the tradition of MSU transferring technology for the benefit of Michigan farmers, food processors, and ultimately consumers.

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