Exploring one of life's most valuable substances

Michael Staples
THIS WORLD

Have you ever stopped to think about polysaccharides?

Upon initial reflection one might conclude that such a topic is better left buried in the high school or university science labs. But nothing could be further from the truth.

Not only can they be found almost anywhere in everyday life, they have been described by some experts as one of the most valuable natural substances available to mankind.

Polysaccharides are relatively complex carbohydrate polymers or natural compounds, commonly found in plants, and made up of many sugar units joined together by glycosidic linkages.

Aside from being easily absorbed by the human body, they are capable of activating the body's natural immune system and have been shown to, among countless other things, slow the aging process and be of use in the fight against cancer.

One of the leaders in such work is the Centre of Excellence for Polysaccharide Research at the Friedrich Schiller University of Jena, Germany.

THE SECRETS OF POLYSACCHARIDES:

(SUBMITTED PHOTO)

Stephanie Hesse, an expert on structure analysis of modified bacterial celluloses at the Centre of Excellence for Polysaccharide Research at the Friedrich Schiller University of Jena, Germany, is shown working with nuclear magnetic resonance equipment. Nuclear magnetic resonance spectroscopy of liquids is an important analytical method in the field of cellulose chemistry.

According to Stephanie Hesse, an expert on structure analysis of modified bacterial celluloses at the centre, polysaccharide research is a wide field at the interface between polymer chemistry, analytical physics and biotechnology.

Celluloses, starches or dextrans (long chain glucose polymers) are completely biodegradable, renewable, and multifunctional resources that, aside from medical purposes, can be used for the manufacture of pulp and paper, textiles (such as rayon), packing fabrication, or even in the food industry for the preparation of thickening agents, said Hesse.

"The unique structure of polysaccharides, combined with such promising proper ties like hydrophilic (the ability to dissolve in water), biocompatibility (having the ability not produce a toxic response), and polyfunctionality (two or more functional groups), provides an additional and important argument for their study," Hesse said in an e-mail interview.

Hesse's work at the centre involves the design and the characterization of what is described as highly functionalized polysaccharide ester membranes and nanoparticles.

These membranes, said Hesse, are used in different areas of separation technology such ultra-filtration or reverse-osmosis (used by the Canadian military DART team in their water purification units), and in medicine, an example of which is hemodialysis.

Hemodialysis is a process used in treating human kidney failure.

When such an illness hits, the function of the kidneys can be copied by drawing blood from a patient and filtering it through a machine that eliminates impurities before returning it to the body.

To solve specific separation problems, however, membranes are necessary, which define structures and a chemical selectivity, Hesse said.

"The polymeric nanoparticles have gained considerable interest in the medical field - especially as carriers for drug targeting suitable for parenteral injection."

Parenteral injection is utilized when an individual is unable to eat or obtain required nutrients. It is capable of providing the human body with the necessary protein, vitamins, minerals, and other nutrients needed to survive.

Aside from parenteral delivery, polymeric nanoparticles are also capable of targeting specific drugs to combat abnormalities such as tumourous growths. By aiming medication at specific areas, it reduces the impact on other bodily organs.

Hesse said another area of recent polysaccharide research that is gaining in popularity is in the application of biomaterials, based on bacterial cellulose.

Bacterial cellulose has the potential to be used as dressing and in surgical materials, for tissue and neural coatings, or practice material for micro-surgical training.

"In addition to the development of tailored polysaccharide esters for the membrane formation and nano-structuring, we are going to investigate the crystallization and formation of nanostructures of bacterial cellulose in the near future."

Over the next 10 years, Hesse sees membranes for selective separation being prepared that will possess the capability of purifying protein solutions and/or to remove detergents from fermentation solutions.

"Up to now, there is no method known (of) how to remove foreign substances like tensides (which are needed during biosynthesis), used for the extraction of intracellular localized agents of recombinant micro organisms ... before the clinical application of that agent."

Hesse also sees a new type of nanoparticles based on well-defined polysaccharide derivatives, such as dextran esters, becoming accessible by a dialysis process.

Thomas Heinze, director of the Centre of Excellence for Polysaccharide Research, says increasing active interest by industry in the field of polysaccharides has been well manifested and is largely responsible for the centre's existence.

Polysaccharide molecules are amongst the key substances that make up the fundamental components of life, Heinze said.

"With the recent rapid advancements in molecular and supramolecular characterization; in developing adequate isolation procedures for structurally uniform samples; in understanding structure property relationships; in designing synthesis pathways for the controlled derivatization; and in adapting and developing analytical tools for these biopolymers, new opportunities for the use of polysaccharides and their semi-synthetic derivatives are now being considered," Heinze said.

The structural and functional properties of polysaccharides are often superior to synthetic polymers, he pointed out.

Some of these polysaccharides - in particular cellulose, starch and semi-synthetic derivatives thereof - are actively used in commercial products today, although many others still remain under utilized, Heinze said.

Michael Staples is a reporter/editor with The Daily Gleaner. He can be reached at: mstaples@dailygleaner.com.