Polymerization of natural compounds may offer food, safety, medical solutions

U.S. Army

NATICK, Mass. (Aug. 1, 2012) -- What if you could take a naturally occurring compound and make it stronger so that it could make food last longer, create better flame-retardant material, and possibly develop a cancer- fighting drug?

Research chemists at Natick Soldier Research, Development and Engineering Center believe they may have found an answer to this question. They took a naturally occurring phenolic-based compound and enzymatically polymerized it; this chemical process basically means the compound is reacted to form a long chain of repeating units.

"As you make this polymer chain longer, it becomes a more potent anti-oxidant than what you actually find in nature," said Nicole Favreau Farhadi, an NSRDEC research chemist. "(Due to the conjugation of this polymer, it) is more potent than its naturally occurring monomer."

Roughly 10 years ago, this process began to be used with epicatechin, an anti-oxidant found in green tea, white tea, red wine, and elsewhere in nature. Research chemists at Natick thought they could use this same tactic for other compounds, such as hydroxytyrosol, one of the most potent antioxidants found in olive oil.

Polymerization in this way is incredibly important because it is relatively simple, now that the process has been formulated, which means polymerizing on a mass scale is feasible.

"We reported in two patents the homo- and co-polymerization of hydroxytyrosol for possible application as an anti-oxidant for food, maybe even cancer drugs," said Ferdinando Bruno, also an NSRDEC research chemist.

'Anti-oxidant' seems to be a catch phrase used in magazines, news programs, diets, and even on food labels and elsewhere. This trend may be warranted, though, as free radicals tend to cause more harm than we realize."

"When we talk about anti-oxidants as (they) pertain to food, oxygen just wreaks havoc on it," Favreau said. "If you can eliminate or lessen the effect of oxygen on the food, then (it will) last longer. That's why anti-oxidants are so important. You've probably seen how we have oxygen scavengers in rations. The contents of these packets bind with the oxygen, therefore blocking reaction with the compounds in food that cause degradation."

A process known as Maillard browning sometimes occurs in food due to a reaction between a protein and a reducing sugar. In certain cases, this reaction is desirable,

such as with coffee or cocoa; but in baked goods and other items, this chemical process is not sought-after. The research chemists had been working on developing a model system that can test for Maillard browning inhibition, which basically involves combining a sugar and protein and adding heat until it turns brown.

When the polymerized and co-polymerized compounds were added to the food, the chemists realized that quercetin (another flavonoid compound found in red wine) co-polymerized with hydroxytyrosol was an anti-browning compound, as well.

"So it's kind of like twice the bang for the buck, because it's an anti-oxidant and anti-browning," Favreau said.

"And the radical that we want scavenged can stabilize in this structure," Bruno added.

"We have created this in a lab environment, we have analyzed it through high-performance liquid chromatography and ultraviolet-visible spectroscopy, we've done all the chemical analysis on it to say what it is and what it's doing," Favreau said. "So the next step is to put it in food, store it, do sensory testing, and continue our assessments."

Unfortunately, that's easier said than done. FDA approval is required to put these compounds into food; although it is a completely natural compound, it has been synthesized and is technically a new compound. FDA approval is costly, and Natick has done all of the initial lab requirements that need to be done prior to this next major step.

"However, the application for flame retardancy is now investigated as we speak at UMass Lowell with professor Ramanathan Nagarajan," Bruno said. "You want radical scavengers, where the oxygen fuels the fire. If you deplete the oxygen from the environment close to the material, it will not burn."

Flame retardant tests do not require FDA approval, since the compound is not being ingested. Furthermore, the Surgeon General has higher standards for the military's food as opposed to commercial food producers.

Both chemists noted that they often find industry and academic partners who are willing to collaborate with them to advance their research and development.

"We have seen a lot of outside interest for many other potential applications," Bruno said.

Given the incredible opportunities the polymerized compounds have to offer, there is a great hope at Natick that further research will be funded in order to more rigorously test these compounds and apply their full potential.

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