Neu5Gc in red meat and organs may pose a significant health hazard

19 October 2016

An uncooked rib roast. Credit: Michael C. Berch/Wikipedia

Neu5Gc, a non-human sialic acid sugar molecule common in red meat that increases the risk of tumor formation in humans, is also prevalent in pig organs, with concentrations increasing as the organs are cooked, a study by researchers from the UC Davis School of Medicine and Xiamen University School of Medicine has found.

The research, published in *Glycoconjugate Journal* Sept. 9, suggests that Neu5Gc may pose a significant health hazard among those who regularly consume organ meats from pigs.

Neu5Gc is naturally found on cell surfaces in most mammals but not in humans. It gets incorporated into human cells by eating meats, organs and some dairy products.

Previous studies have shown when Neu5Gc is incorporated into human tissues, the immune system recognizes it as a foreign threat, producing antibodies to counter it. Repeated consumption of these meats then causes chronic inflammation, which has been known to increase risks of tumor formation. Neu5Gc has been linked to cancer as well as cardiovascular and other inflammatory diseases, including some bacterial infections.

The UC Davis and Xiamen University study is the first to find Neu5Gc in substantially higher levels in pig organs, including the spleen, lungs, heart, kidney and liver, than in skeletal muscle, which cooking of the meat exacerbates.

"We were rather surprised that organ meats from pigs have alarmingly high levels of Neu5Gc," said co-author Frederic A. Troy II, professor and chair emeritus in the Department of Biochemistry and Molecular Medicine and adjunct professor at Xiamen University School of Medicine.

"Although we do not know quantitatively what levels trigger an immune response, if you're going to eat organ meat, you're going to have a potentially greater risk of certain inflammatory diseases," he said.

The risk of Neu5Gc toxicity is particularly high in China and other countries where people tend to consume large amounts of organ meat. In the U.S. and other western nations where there has been a rise in the culinary "nose-to-tail" movement in recent years, more chefs are cooking all parts of animals. Given the results from this study, the authors urge people to be cautious about the types of meats they ingest.

Troy and colleagues recently reported high levels of the free form of another sialic acid, Kdn, in breast, cervical, liver, lung, throat, ovarian and uterine cancers. They also showed that a polymeric form of Neu5Ac, a polysialic acid, is a metastatic factor when expressed on the cell surfaces of a number of human cancers.

For the current study, the researchers assessed the levels of three sialic acids ? Neu5Ac, Neu5Gc and Kdn ? located at the end of sugar chains frequently attached to glycoproteins and gangliosides in

cellular membranes.

Glycoproteins, such as polysialylated neural cell adhesion molecules (NCAMs), have many functions during brain development that modulate cell-cell adhesive interactions involved in synaptogenesis, neural plasticity, myelination and neural stem cell proliferation and differentiation. Gangliosides serve as markers for cellular recognition and modulate axon-myelin interactions, axon stability, axon regeneration and modulate nerve cell excitability.

The researchers measured sialic concentrations in pig spleens, kidneys, lungs, hearts, livers and muscle at three, 38 and 180 days (adult) of age. Compared to skeletal muscle, the concentrations of Neu5Gc were high in all organs, particularly heart, spleen, kidney and lungs. Cooking increased sialic levels in most organ tissues.

Though the study was conducted in pigs, these results have ramifications for organ meat from other animals.

"The basic, fundamental biochemical pathways for synthesis and metabolism of the sialic acids are essentially identical processes common in all evolutionary species from 'bacteria to brains,' Troy said. "Therefore, the translational aspect of our findings to other mammalian species is essentially a given from a biochemical perspective."

In contrast to mice and rats, neonatal pigs are genetically closer to humans, and share similar physiology and anatomical structures with human infants. Importantly, the piglet brain more closely resembles the human brain in anatomic structure and developmental growth patterns, Troy added.

The study also sheds light on the developmental biology of sialylation, as the molecular mechanisms regulating the age-related developmental expression and function of the sialic acids are poorly understood.

"Our new findings show that there are clear changes in levels of these sialic acids in young and adults pigs as a function of aging, a finding that is neither well understood nor has been previously reported," he said.

While it's long been known that sialic acids have higher concentrations in animal meats, no one had ever precisely measured their concentrations in specific organs. To some degree, this was a result of technology.

"This study would not have been possible if not for the high sensitivity afforded by LC mass spectrometry," Troy noted. "This advance in structural analysis thus allows studies that could not have been done five or 10 years ago."

More information: Suna Ji et al, Developmental changes in the level of free and conjugated sialic acids, Neu5Ac, Neu5Gc and KDN in different organs of pig: a LC-MS/MS quantitative analyses, *Glycoconjugate Journal* (2016). DOI: 10.1007/s10719-016-9724-9

Provided by UC Davis