Hummingbird metabolism unique in burning glucose and fructose equally

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Professor Kenneth Welch and his team found that hummingbirds can burn fructose equally as well as glucose, which is something other invertebrates cannot achieve. Credit: Ken Jones

Hummingbird metabolism is a marvel of evolutionary engineering. These tiny birds can power all of their energetic hovering flight by burning the sugar contained in the floral nectar of their diet.

Now new research from the University of Toronto Scarborough shows they are equally adept at burning both glucose and fructose, which are the individual components of sugar; a unique trait other vertebrates cannot achieve.

"Hummingbirds have an optimal fuel-use strategy that powers their high-energy lifestyle, maximizes fat storage, and minimizes unnecessary weight gain all at the same time," says Kenneth Welch, assistant professor of biological sciences at UTSC and an expert on hummingbirds.

Welch and his graduate student Chris Chen, who is co-author on the research, fed hummingbirds separate enriched solutions of glucose and fructose while collecting exhaled breath samples. They found the birds were able to switch from burning glucose to fructose equally as well.

"What's very surprising is that unlike mammals such as humans, who can't rely on fructose to power much of their exercise metabolism, hummingbirds use it very well. In fact, they are very happy using it and can use it just as well as glucose," says Welch.

A ruby-throated hummingbird takes a drink of nectar from a feeder tube in Professor Kenneth Welch's lab at the University of Toronto Scarborough. Credit: Ken Jones

Hummingbirds require an incredible amount of energy to flap their wings 50 times or more per second in order to maintain hovering flight. In fact, if a hummingbird were the size of a human, it would consume energy at a rate more than 10 times that of an Olympic marathon runner. They are able to accomplish this by burning only the most recently ingested sugar in their muscles while avoiding the energetic tax of first converting sugar into fat.

From an evolutionary perspective the findings make perfect sense, says Welch. Whereas humans evolved over time on a complex diet, hummingbirds evolved on a diet rich in sugar.

"Hummingbirds are able to move sugar from their blood to their muscles at very fast rates, but we don't yet fully understand how they are able to do this," he says.

Humans are not good at burning fructose because once ingested much of it gets taken into the liver where it's turned into fat. The prevalence of high fructose corn syrup found in products like soda pop is also strongly linked to a rise in obesity rates.

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On the other hand because hummingbirds burn sugar so fast that if they were the size of an average person they would need to drink more than one can of soda every minute even though it's mostly made of high-fructose corn syrup.

"If we can gain insights on how hummingbirds cope with an extreme diet then maybe it can shed some light on what goes wrong in us when we have too much fructose in our diet," says Welch.

More information: The research will appear in the upcoming edition of the journal *Functional Ecology* and is currently available online.

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