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## New study adds to the benefits of eating your veggies

Mom may have been right all along, especially when we were hormone-raging teenagers: Eat your veggies and good things will happen.

In a new physiological study of birds, a researcher at ASU has found that carotenoids – the pigments that color carrots orange and corn yellow – have even deeper health benefits than originally thought. They appear to fight off the negative impacts that testosterone can have on an animal's health.

The



researchers – Kevin McGraw, an assistant professor in ASU's School of Life Sciences, and Daniel Ardia of Franklin and Marshall College in Pennsylvania – focused their work on zebra finches, a common domesticated pet bird originally from Australia. Carotenoids are known to play several key roles in birds and fish, including contributing to their bright colors, which acts as a signal to attract potential mates. They also act as an antioxidant in the body, which improves immune system function.

"Researchers in animal behavior often study what keeps sexual signals, such as bright colors or elaborate songs, 'honest,' or why all individuals cannot produce them *ad nauseam* and try to get mates," McGraw says. "The reason typically is that long tails and fancy dances incur costs. Testosterone, for example, has been thought of as a double-edged sword as it relates to sexual signals, because it enhances trait production but comes at a health price to the animal."

"This study shows that testosterone may not be as costly as previously thought, so long as animals can nutritionally offset the immune detriments of

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testosterone," adds McGraw, who studies the functions of naturally occurring chemicals in birds and their relationship to the birds' colors and health. "They may even experience a net health benefit as a result.

"In the case of the zebra finch, the cost is in the pigments – having enough of them to develop a red beak and enough to combat testosterone, which you also need to be red."

McGraw and Ardia describe their findings in a study, titled "Do carotenoids buffer testosterone-induced immunosuppression? An experimental test in a colorful songbird," in the current issue (June 6, 2007) of *Biology Letters*, a journal of the Royal Society, London.

The researchers experimentally examined the relationship between testosterone, carotenoids and immune state in 35 male and female zebra finches. They surprisingly found that when they administered testosterone implants to zebra finches, the implants acted as a stimulant to the birds' immune systems.

The researchers went on to show that carotenoids acquired from food and circulating through the blood were changing in ways that were linked to testosterone levels. Birds who were given additional testosterone depleted their carotenoid levels and became healthier, as if they were combating testosterone directly with antioxidants.

"These findings show that there are nutrient-specific mechanisms by which animals can avoid the immune costs of testosterone elevation and still keep their attractive and bright colors," McGraw says.

Most previous studies of this sort have focused on physiological or even genetic links between testosterone and health. McGraw says it is worth considering the implications for human nutrition and health.

"If testosterone is having immunosuppressive effects in human men, perhaps they, too, could benefit from increased carotenoid intake – say, by eating more corn," he says. "This study certainly opens the door for future work on nutritional and antioxidant therapy for the hormonally immunocompromised. The interface between diet and health in animals is a fascinating one. But we need a much better understanding of their interactions, as with testosterone, at the molecular level."

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