

# Native foods are key to preserving rodent gut bacteria in captivity

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A white-throated woodrat with prickly pear cactus. Credit: Margaret Doolin

As Rodolfo Martinez-Mota well knows, from the cactus spines in his clothes and skin, white-throated woodrats love to eat prickly pear cactus (from the *Opuntia* genus). They like the cactus so much that their gut

microorganism community, or microbiome, is specially equipped to break down toxins in the cactus.

But Martinez-Mota and his colleagues in the University of Utah School of Biological Sciences also know that if the woodrat is in captivity and is eating an artificial diet, that finely tuned gut microbiome changes. In a paper published in the *International Society for Microbial Ecology Journal*, the research team reports that the native gut microbiome can be preserved in captivity by continuing to feed the [animals](#) their native foods instead of an artificial diet.

"We found that these changes can be avoided by providing wild diets to [captive animals](#)," Martinez-Mota says. "Our results also show that commercial diets are the main driver that induces microbial changes in captive rodents. We could hypothesize that the same applies to other captive animals."

## Collection

The study was conducted in the lab of distinguished professor Denise Dearing, director of the School of Biological Sciences. Dearing has been studying several woodrat species for more than 20 years, learning about their adaptations to their harsh desert environment. Different woodrat species have adapted to detoxify the poisonous compounds in juniper, creosote and other desert plants.

When studying woodrats in her lab, Dearing and her students noticed that, after leaving their natural environment, the woodrats' gut microbiomes changed, becoming less diverse. There's a lot we still don't know about the connections between gut microbiology and health, but a less diverse microbiome is generally a bad thing. "However, we did not know what specific factors caused major microbial changes in previous experiments, which limited our conclusions," Dearing says. They

suspected that diet may have been a primary factor.

Similar changes in gut microbiota have been seen in other mammals, with researchers offering various possible explanations, including diet. But so far, no other studies have isolated the effect of diet on mammals in captivity.

So, Dearing, postdoctoral fellows Martinez-Mota and Teri Orr and University of Pittsburgh collaborator Kevin Kohl designed an experiment to monitor woodrats' gut microbiomes in the lab, eating different diets. They found a population of woodrats near Castle Valley, Utah, with a diet that could be easily collected and transported to the lab: [prickly pear cactus](#).

"This dietary specialization, and the feasibility to collect cacti in the natural habitat and recreate the wild diet in the laboratory, provided the conditions to have the perfect animal model system to test our hypothesis," Dearing says.

## **A prickly problem**

Overall, they collected twelve woodrats. "The trapping of woodrats is always an adventure!" Martinez-Mota says. Woodrats are also often called packrats, he says. "They collect all sorts of things from railroad spikes, to bones, to paws of other animals. It's always interesting to see what they have collected," says Dearing.

The team collected cacti as well, feeding them to the woodrats en route to Salt Lake City. To prevent any injury to the rodents, the team despined the cacti. Martinez-Mota also despined the cacti in the lab, and still found spines in his clothes several weeks after the experiment had ended. In the wild, Dearing notes, the woodrats despine the cacti themselves and line their nests with the spines to deter predators. "It's

ironic that the woodrats have co-opted the defense of their food, spines, to protect themselves," she adds.

In the lab, half of the woodrats received artificial diets (commercial high-fiber rabbit chow) while the other half received prickly pear collected from the wild.

## **A community's diversity**

After three weeks, the research team looked at the results. On beginning the artificial diet, the chow-fed group lost more than a third of their bacterial gut species, including some in the *Bifidobacterium* and *Lactobacillus* genera (plural of genus).

"Both bacterial genera are associated with detoxification of the plant toxins ingested by the woodrat," Martinez-Mota says. "Thus, we could hypothesize that some functions of the woodrat core microbiome were compromised when animals fed on artificial diets."

Taking the place of the lost genera were already-established microbial communities such as Clostridiales, Ruminococcaceae and Lachnospiraceae, all involved in metabolizing nondigestible carbohydrates like the fiber in the chow. By the end of the three-week experiment, the chow-fed woodrats had gained back around 10% of their gut diversity.

In contrast, the cactus-fed group retained around 90% of their original microbiome diversity throughout the experiment. It's not always possible to know exactly what an animal is eating in the wild, the researchers say, but if that diet can be reasonably approximated in captivity, the animal's gut is likely to remain diverse—and healthy.

So, what does this mean for zoos and pet owners?

"People who maintain wild animals in captivity should supplement animal diets with [food items](#) that resemble food consumed in the wild," Martinez-Mota says. "If supplementing a [diet](#) with wild food is not possible, then food items with similar nutritional/chemical composition should be provided."

**More information:** Rodolfo Martínez-Mota et al, Natural diets promote retention of the native gut microbiota in captive rodents, *The ISME Journal* (2019). [DOI: 10.1038/s41396-019-0497-6](https://doi.org/10.1038/s41396-019-0497-6)

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