Researchers uncover what makes some chickens more water-efficient than others

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Credit: U of A System Division of Agriculture

In the first scientific report of its kind, researchers in Arkansas have shown that chickens bred for water conservation continued to put on weight despite heat stress that would normally slow growth.

Research by the Arkansas Agricultural Experiment Station indicates the specially-bred line of chickens developed by Sara Orlowski could save growers thousands of gallons of water and thousands of pounds of food each month without sacrificing poultry health. Orlowski is an associate professor of poultry science with the University of Arkansas System Division of Agriculture.

As global population increases and usable water diminishes due to climate change patterns, scientists with the Division of Agriculture are looking for ways to raise the world's most popular meat protein using fewer resources.

The study showed that a broiler chicken's physiology could be significantly improved to convert food and water to body weight even with three weeks of heat stress.

Results from the study were published in *Physiological Reports*. The article is titled "Effect of heat stress on the hypothalamic expression profile of water homeostasis-associated genes in low- and high-water efficient chicken lines."

Sami Dridi, professor of poultry science specializing in avian endocrinology and molecular genetics, was responsible for conducting the experiment and the driving force in writing the paper, and Walter Bottje was professor of poultry science for the experiment station.

Now in its fifth generation of selection, the high water-efficient line has been measured to consume significantly less water than standard broiler lines in use today. From the time they were hatched to one month old, the high water-efficient line drank 1.3 pounds less water, and about 5.7 ounces less feed, which calculates to a 32-point improvement in water conversion and six-point improvement in feed conversion when compared to a random-bred control line.

While it may not seem like a huge difference, modern chicken houses hold on average 20,000 to as many as 50,000 birds. Although chickens consume more as they grow, the difference for that month of growing equates to 7,800 fewer gallons of water and 17,800 pounds less feed to grow 50,000 water-efficient chickens.

In some conditions, the high water-efficient chicken had food conversion ratios that were just as good or better, and their water conversion ratio was about 55 to 65% better, according to Dridi.

Bottje said these recent results from the ongoing research are promising, but the group aims to investigate other physiological characteristics of the high water-efficient line, such as meat quality and gut integrity.

Thirst control

The hypothalamus is the part of the brain that controls thirst. One of the study's findings was that the hypothalamus of water-efficient chickens differed from the other chickens when exposed to heat stress. The investigation revealed potential molecular signatures for water efficiency and heat tolerance in chickens.

The researchers devised a study that induced heat stress for groups of chickens by increasing the ambient temperature to mimic a summer season in Arkansas. The heat-stress cycle began when the birds were 29 days old. The environment was also kept between 30 and 40% relative humidity.

Dridi ran a parallel study comparing data on the divergent lines of chickens.

What they found was surprising.

"What the most interesting thing from that study, when it comes to live performance, is that the heat-stressed birds from the high water-efficient line consumed less water than the non-heat stressed birds from the low water-efficient line," Orlowski said.

Water is critical to raising chickens. They can go several days without food, but only a few hours without water at high temperatures, Dridi said.

Dridi said high humidity, which would be over 70% for chickens, also induces similar heat stress because the chickens cool themselves by breathing. Dridi's studies on poultry house sprinkler systems kept the humidity lower than the industry standard method and used significantly less water than evaporative cooling cells.

"With water sprinkling systems that can save up to 66% water usage in a poultry house, the water conservation of poultry could be improved by a magnitude of three- to four-fold by having chickens that consume less water and still retain growth," Dridi said.

Project development

Dridi said the idea for water-efficient chickens came from looking at the differences in chicken lines bred as far back as the 1950s. Dridi and other researchers wanted to see how much genetic differences there were between jungle fowl and modern breeds.

Before they could breed water-efficient chickens, though, they had to reliably measure the amount of water chickens drank.

Orlowski was a Ph.D. student when her graduate research team developed a novel low-flow water monitoring system in collaboration with Siloam Springs-based companies Alternative Design and Cobb-

Vantress Inc., a primary broiler breeder company. The tool was essential to accurately measure water intake for individual birds in real time.

"When we first started this project in 2018, we evaluated one of our broiler lines, a non-selected control population, and we characterized them for water intake," Orlowski said. "And within that population there was a variability for water intake. From there, we were able to take our most water-efficient families and our least water-efficient families, establish our research populations and continue to select from there."

A base population of chickens that were not selected for high or low water-efficiency was kept as a control group to compare changes in each generation, Orlowski noted.

Bottje and Dridi said the work done by Orlowski in selecting the divergent lines of chickens was the most important factor of this experiment. Orlowski said water efficiency in the high water-efficient line is continuing to improve with each succeeding generation. She ranks the water efficiency trait as "moderately heritable."

"There's no reason that it will not work for all poultry operations, including turkeys, quail and ducks," Dridi said.

More information: Loujain Aloui et al, Effect of heat stress on the hypothalamic expression profile of water homeostasis-associated genes in low- and high-water efficient chicken lines, *Physiological Reports* (2024). DOI: 10.14814/phy2.15972

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