Scientists spice up genetic research through habanero peppers and AI

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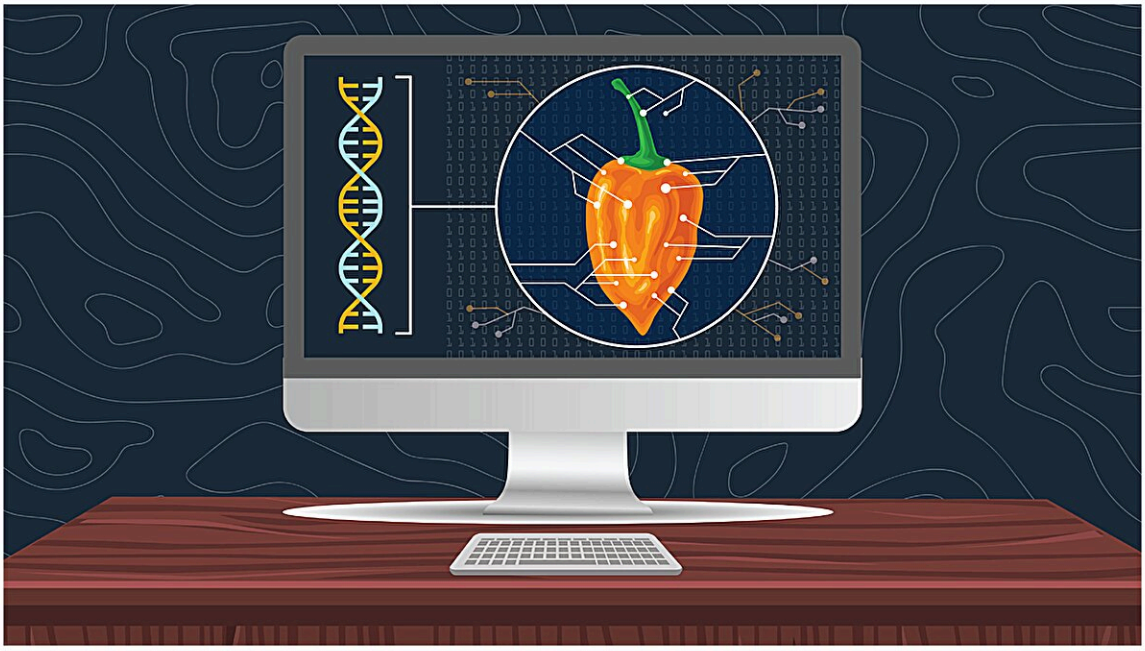

Computer scientists at West Virginia University are exploring the role artificial intelligence may play in genome manipulation. Their current study uses AI to try to control the size, color and taste of genetically modified habanero peppers, while future applications for the research include using AI to prevent or treat diseases like cancer by manipulating genes. Credit: WVU /Savanna Leech

An artificial intelligence study at West Virginia University is focused on

habanero peppers for now, but project lead Donald Adjeroh said the work could one day support prevention or treatment of genetic disease.

Adjeroh and his team are developing artificial intelligence capable of predicting the effect of genetic modifications on an organism. Currently, they're exploring AI's ability to predict key attributes of habanero peppers, such as size, color and taste, and later to facilitate control of those attributes through genome manipulation.

"We'll be applying AI models to the challenge of crop phenomics—predicting flavor and taste for several varieties of peppers," said Adjeroh, professor and associate chair for faculty development and research at the WVU Benjamin M. Statler College of Engineering and Mineral Resources. "However, the basic techniques we develop in that context have potential in other key areas, such as human health."

The three-year project will use genetically modified habaneros grown by partner Umesh Reddy's West Virginia State University lab to test the predictions of AI models developed at WVU by Adjeroh and Professor Gianfranco Doretto, Adjeroh's colleague in the Lane Department of Computer Science and Electrical Engineering.

Doretto noted the partnership with WVSU, one of two historically black colleges and universities in West Virginia, "allows us to grow a network of interdisciplinary collaborators across the state, focused on leveraging AI for the common good. We're working together to test our findings in very relevant use case scenarios, but we're also involving underrepresented communities in pushing our AI knowledge forward in areas related to pattern association discovery."

"Pattern association discovery" refers to the larger context of this research, which is concerned not only with producing the perfect pepper, but more broadly with solving a machine learning problem that involves

finding patterns across "loosely coupled domains," two areas—like genetic code and level of spiciness—that overlap in complicated, hard to map ways.

Adjeroh said he believes an AI capable of identifying the patterns governing relationships between a habanero's heat and its double helix may be able to find patterns across other complexly related datasets too.

"In this particular project, we're focusing on the habanero, and we're going from the genes of the pepper to characteristics like its size, color and so on. We could also focus in similar ways on a genetic disease like cancer. In the human genome, we have about 30,000 genes. Not all of them are involved in cancer, but a lot of them are. Some of them enhance other genes, and some of them suppress other genes," Adjeroh said.

"When one gene is enhanced and another is suppressed, it might lead to some type of cancer. If you give us the genomes of people with a certain type of cancer, we can try to start to understand how these enhancement and suppression signals could play a role."

In human disease, as in agriculture, a third factor, the environment—an organism's food, water, air, etc.—modulates the relationship between genes and disease. "It's difficult and complex," Adjeroh acknowledged. "But we know that with AI and machine learning, if you give us enough data, we can start teasing out some of these relationships."

He and Doretto are using computational methods to look at the genes that determine the nature of a pepper. Peppers can be "engineered" through modifying, enhancing or suppressing certain genes, so they are identifying which genes should be manipulated if, Adjeroh speculated, a farmer wants to make peppers that are redder, because people tend to like red peppers better than green ones, or peppers that are bigger,

because that may be more cost effective or marketable.

"We are figuring out which regions are relevant to which attribute, so that if you modify the gene this way, it affects the pepper that way," he explained. "We'll use AI methods to predict what the response will be, based on the genomic data we have, and then WVSU will go to the lab to validate that through biological experiments."

Once the researchers have established how to use a habanero's genotype to engineer its "phenotype"—its observable characteristics like size, shape or color—they will investigate the relationship between the phenotype and how spicy human taste testers perceive its flavor to be.

According to Adjeroh, "Some of a habanero plant's genes might determine how spicy the peppers are going to be, but spiciness always involves the human element. Saying something is very spicy or not so spicy involves how you or I feel about spicy things. But there are also chemical elements in the pepper that can tell you something about spice levels. There is an issue of human perception, which varies from one person to the other, and there's also quantitative analysis that establishes spiciness based on some of the metabolites that are in a pepper."

Adjeroh noted that WVSU has already been working on habanero peppers by growing and sequencing the genomes of about 240 pepper plants.

"They have consumer panels that evaluate their pepper outputs," he said. "We're going to use those panels to collect data on perceptual thinking about the spiciness and flavor of the peppers with AI-altered genomes."

Provided by West Virginia University