Research offers means to detoxify mycotoxin-contaminated grain intended for ethanol, animal feed

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Using barley as the raw material for ethanol production results in an additional product – dried grains for animal feed. But the presence of a fungal pathogen sometimes found in barley can result in a lethal toxin, called mycotoxin, in the animal feed. Now, Virginia Tech and Agricultural Research Service, USDA researchers have shown that newly developed transgenic yeast used during fermentation will help modify the mycotoxin in the animal feed product to a less toxic form. The research is published online in the September issue of *Biotechnology for Biofuels*.

New varieties of hulless winter barley have almost as much starch as corn and can be grown at times and in places where corn cannot, offering a flexible resource. When processed for ethanol, the versatile grain also provides a wholesome animal feed – unless contaminated. Of particular concern are trichothecene mycotoxins, which inhibit protein synthesis, an essential function of all tissues. The result can be immune system suppression and reproductive problems. Animals usually refuse to eat infected grain; otherwise death would be the eventual result.

"So we decided to see if the toxin could be modified to a less toxic product during fermentation," said Piyum A. Khatibi of Long Island, .N.Y., at that time a Ph.D. student in plant pathology, physiology, and weed science in the College of Agriculture and Life Sciences at Virginia Tech.

Khatibi was working on the problem of trichothecene contamination of grains with David Schmale, associate professor of food safety and plant biosecurity in the college, and plant breeder Carl Griffey, professor of crop and soil environmental science in the college. Griffey's barley team has developed resistant varieties of barley, as well as high starch varieties. The Virginia Tech barley team, made up of Wynse Brooks, research associate; Mark Vaughn, research specialist; and Greg Berger of Schulenburg, Tex., a Ph.D. student, all in crop and soil environmental sciences, has been collaborating with Kevin Hicks, team leader, and John Nghiem, chemical engineer, at the USDA Agricultural Research Service Sustainable Biofuels research team in Wyndmoor, Pa. – a partnership that began in 2001.

The Virginia Tech and USDA researchers decided to go after the most common mycotoxin in barley, deoxynivalenol (DON).

Previous research on a fungus (Fusarium graminearum) that produces DON in barley has identified several genes that convert trichothecenes to less toxic products. The research team selected two of these genes (TRI101 and TRI201), introduced them into a laboratory yeast strain (RW2802), and compared the results to commercial yeast that has been optimized to produce fuel ethanol. The researchers fermented four varieties of barley that Griffey's team created for biofuel use, hulless Eve and VA06H-25 and hulled Thoroughbred and Price.

Measurements of the resulting mash and animal feed revealed that DON had indeed been converted to a less toxic form (3ADON) during fermentation, with the transgenic yeast expressing either TRI101 or TRI201. The researchers wrote, "We found large reductions in DON via conversion (52.4 percent to 58.1 percent) during fermentation of the hulless barley line VA06H-25, which contained the highest levels of DON in its starting ground grain."

"But in all cases, using the yeast with the added genes resulted in decreased DON as it was converted to the less toxic form (3ADON)," said Khatibi.

"To our knowledge, this is the first detailed report of yeast expressing a DON modification enzyme during barley ethanol fermentation," said Schmale.

Khatibi said, "This study sets the foundation for modifying mycotoxins during fermentation and provides a model for future work when we find an enzyme that can actually destroy the toxin."

The research was supported by Schmale and Griffey's grants from the USDA, Virginia Agriculture Council, and Maryland Grain Producers Utilization Board.

The project was part of Khatibi's dissertation research. He graduated in August and is now a postdoctoral associate working in Schmale's lab continuing his work in mycotoxin detoxification.

More information: "Conversion of deoxynivalenol to 3-acetyldeoxynivalenol in barley derived fuel ethanol co-products with yeast expressing trichothecene 3-O-acetyltransferases," The article is posted at www.biotechnologyforbiofuels.com/content/4/1/26

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