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Use of natural plant volatiles to control potato postharvest diseases

The Situation

Idaho is the largest potato producer, fresh packer, and processor in the U.S. In 2010, the Idaho potato crop was valued at a record high of $915 million with growers producing 113 million hundred-weight (cwt) of potatoes. Of the 113 million cwt, 7.1 million cwt were lost due to disease and other factors such as shrinkage. This equates to $57.5 million lost due to diseases and other factors. Direct sales in 2002 from Idaho potatoes and processed potato products totaled $3.4 billion. In 2002, the total impact of the Idaho potato industry, including both direct and indirect (i.e. supporting) business activities, accounted for more than 5% of Idaho's gross state product, as well as 39,500 jobs, $6.7 billion in sales, and $1.3 billion of income within the state.

Nearly 60% of potatoes grown in Idaho are stored for 2 months or longer. Because of the value, and consequently the potential for economic loss, the control of storage pathogens has become increasingly important. Potatoes are susceptible to a variety of storage pathogens, including *Pectobacterium spp*. (soft rot), *Helminthosporium solani* (silver scurf), and *Colletotrichum coccodes* (black dot). These pathogens have become economically important in the table stock market because disease affected potatoes are rejected by processors. These pathogens cause blemish diseases that detract from tuber appearance (Figure 1). The blemishes compromise fresh packed potato quality, which results in downgrading shipments destined for the consumer market. It has been estimated that in a bad year losses from blemish diseases out of the total number of tubers going into storage may be as high as 30%.

Few effective fungicides are registered for direct application to tubers for control of these important pathogens in storage. This is mainly because there is a greater likelihood of direct human exposure to them than to chemicals that are applied solely to protect foliage. Furthermore, fungicides can leave significant residues in treated tubers, even after cooking. The development of novel methods for the control of postharvest diseases could reduce losses in storage and thus solidify and enhance the competitiveness of the Idaho potato industry in global markets, directly strengthening the economy of the state.

Figure 1. Blemish diseases on potato tubers. (a) Pit rot caused by Pectobacterium atrosepticum. (b) Black dot caused by Colletotrichum coccodes.

Our Response

Many naturally occurring plant volatile compounds are known for their anti-fungal properties. In 2009, a project was established in the Potato Pathology program at the Aberdeen R&E Center to discover novel compounds and methods for the control of potato postharvest diseases. With a small grant from the Idaho Potato Commission, several plant volatile compounds were tested for their antimicrobial properties

against the important potato blemish pathogens *P. atrosepticum*, *C. coccodes* and *H. solani*.

Acetaldehyde and 2*E*-hexenal are two well studied volatile organic compounds produced by bananas, tomatoes, and other fruits as aroma volatiles and are associated with a green or grassy smell. These two volatiles were selected for testing based on previous research showing their effectiveness at inhibiting growth of fruit rot pathogens.

Research in the Potato Pathology program showed that when cultures of the potato blemish pathogens were grown in an atmosphere containing 10 parts per million (ppm) of acetaldehyde in the air, acetaldehyde was not effective at inhibiting growth of the pathogens. This was surprising as a concentration of 1.7 ppm of acetaldehyde was shown to be capable of inhibiting the growth of the blueberry pathogen *C. acutatum* which is related to *C. coccodes*. However, our research found that 2*E*-hexenal is highly effective at inhibiting growth of cultures of the potato blemish pathogens. A concentration of as little as 5 ppm 2*E*-hexenal in air was capable of completely inhibiting growth of these pathogens (Fig 2). Furthermore, none of the pathogens resumed growth after being transferred to jars containing a volatile free atmosphere.

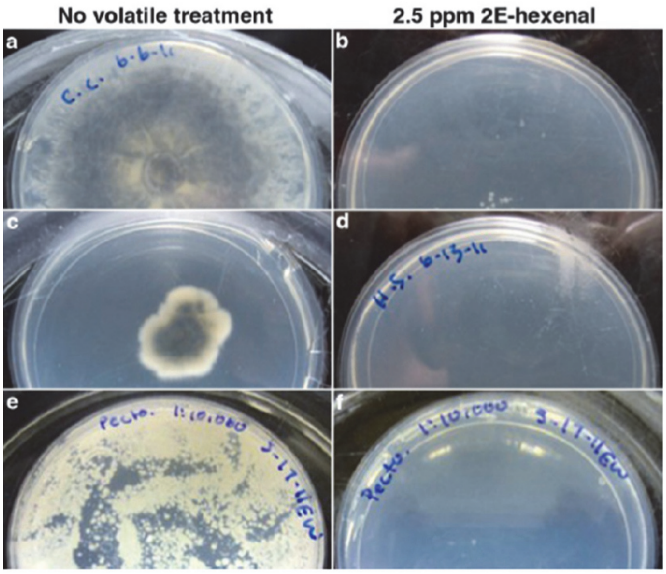

Figure 2. Control of blemish disease pathogens in vitro with 2E-hexenal. (a-b) Black dot (Colletotrichum coccodes). (c-d) Silver scurf (Helminthosporium solani). (e-f) Pit rot (Pectobacterium atrosepticum).

These results have important implications for the use of 2*E*-hexenal on a commercial scale. Since the volatile is microcidal, it means that tubers may only need to be treated once going into storage in order to provide season long control of the diseases. Research is now underway in the Potato Pathology program to determine the concentrations needed to effectively control these diseases on potatoes (*in vivo*) under realistic potato storage conditions and to develop the technology for commercial use.

Program Outcomes

Due to the total lack of current control options for potato storage pathogens the development of 2*E*-hexenal technology could have a very high market demand. As such, a patent application was filed by the University of Idaho's intellectual property office in August 2011 on the use of 2*E*-hexenal for control of potato storage pathogens. Furthermore, a partnership and exclusive licensing agreement has been established with a leading Idaho grower/shipping company based on their expressed interest in the further development of this technology to reduce the economic impact of disease losses in storage.

The use of naturally occurring volatile compounds to control potato blemish diseases is a potentially new method of controlling diseases without introducing fungicides onto the edible product. These compounds are ideal for this as they have already been approved as food additives by the FDA and are already incorporated in many foods to provide natural fruit aroma and flavor.

The benefits of this project will be threefold: processors can maintain the residue free, high tuber health standards demanded by supermarkets and consumers; the shelf life of potatoes in transit and on the supermarket shelf can be extended; and environmental problems that may result from using pesticides can be reduced. Furthermore, the technology being developed in the Potato Pathology program will not only be highly relevant to the potato industry in Idaho but also to all the other regions where potatoes are grown.

This research is part of the Masters thesis of Elisabeth Wood and was recently accepted for publication in the international journal *Biological Control*.

FOR MORE INFORMATION

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