BC FoodWeb

Peer-reviewed research

Food-safe additives protect ‘Ambrosia’ apples in storage

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KEY TAKEAWAYS

This study tested food-safe additives as accessible, low-cost options to manage post-harvest diseases in stored ‘Ambrosia’ apples.

- **Baking soda and calcium chloride reduced the number of apples affected by two out of three post-harvest diseases. Their level of control was similar to the commercial fungicide, *Scholar*.**
- Beneficial bacteria also showed promise. Some strains controlled post-harvest diseases and performed similarly to commercial fungicides and biocontrol products during storage. More research is needed to understand when these bacteria work best and whether they are suitable for commercial use.

Production Type
- Tree fruit

Practice Benefit(s)
- Disease management
- Improved fruit quality

Research Location
- Okanagan, BC

Key Terms
- *Food additives*: Substances commonly used in food processing and handling to enhance food safety, shelf life, appearance, flavor, or texture (e.g., food coloring).
- *Biocontrol agent*: Living organisms or natural products used to manage pests or plant diseases as an alternative to synthetic chemicals. A common example is the use of lady beetles to control aphids.
- *Strain*: A type of microorganism within the same species that has slightly different characteristics. This is similar to how Gala and Honeycrisp are different kinds of apples, but both are still apples.

How can this research be used?

Food-safe additives, like baking soda and calcium chloride, can be considered for use in cold storage facilities to control post-harvest diseases. These additives are generally regarded as safe and have few regulatory restrictions. They are already applied in BC orchards to improve fruit firmness and extend shelf life. Additional crop-specific adaptation may be required for best performance on stored apples, which was not explored in this study.

Why was this research done?

This research was done to find alternatives to fungicides for managing three post-harvest diseases in apples. These post-harvest diseases were grey mold (*Botrytis cinerea*), blue mold (*Mucor piriformis*), and Mucor rot (*Penicillium expansum*), which commonly cause apple decay in storage and can lead to significant losses for BC growers. While fungicides are used to manage these diseases, some are developing resistance and there is growing pressure from consumers to reduce the use of chemicals on food.

The study explored whether accessible, low-cost food-safe additives already used in the produce sector, alone or combined with beneficial bacteria (*Pseudomonas fluorescens*), could control three kinds of post-harvest diseases on 'Ambrosia' apples.

What was the outcome?

Researchers tested beneficial bacteria and food additives, alone and in combination, to control grey mold, blue mold, and Mucor rot on stored 'Ambrosia' apples. These were tested using standard practices of dunking and evaluated under commercial cold storage and controlled-atmosphere (CA) storage. Disease control was based on how many apples developed signs of decay. Results are summarized below and in Table 1.

Grey mold

Food-safe additives were most effective against grey mold. **Baking soda reduced the number of apples affected by grey mold by nearly 100%, performing just as well as the commercial fungicide, Scholar. Calcium chloride also provided strong control of grey mold, reducing the number of affected apples by about 95%.** Salicylic acid reduced grey mold too, but less than baking soda and calcium chloride. In controlled-atmosphere storage, all three bacterial strains (1-112, 4-6, and 2-28) controlled grey mold similar to the commercial product BioSave.

Blue mold

Food-safe additives varied in their ability to control blue mold in cold storage. **Baking soda reduced the number of apples affected by blue mold by about 35%, while calcium chloride reduced the number of apples affected by blue mold by about 75%.** The only treatment that matched the control of Scholar was the combination of beneficial bacteria Strain C (*P. fluorescens* 4-6) with baking soda. In controlled-atmosphere storage, each strain of beneficial bacteria (1-112, 4-6, and 2-28) alone reduced blue mold similar to BioSave.

Mucor rot

Mucor rot was the most challenging disease to control. In cold storage, baking soda and calcium chloride alone provided minimal control. The only treatment that reduced the number of apples affected by Mucor rot at levels similar to Scholar was the combination of beneficial bacteria Strain C (*P. fluorescens* 4-6) with baking soda. In controlled-atmosphere storage, none of the bacterial strains effectively controlled the occurrence of Mucor rot, and food-safe additives were not evaluated under those conditions.

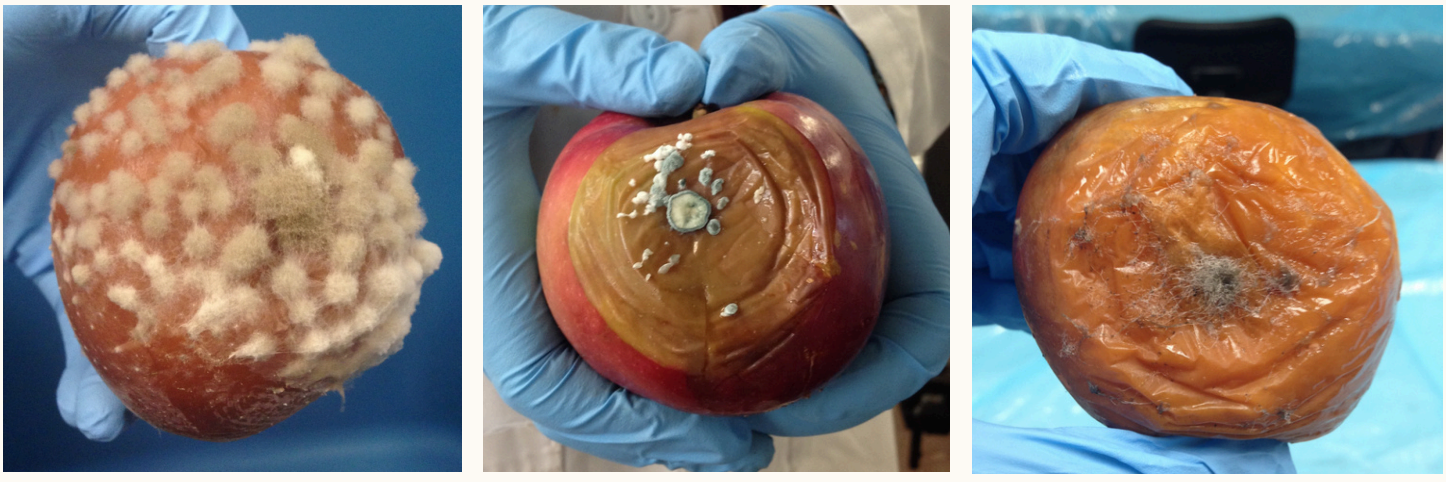

Figure 1. Three common post-harvest diseases on 'Ambrosia' apple. Grey mold (left), blue mold (middle), and Mucor rot (right). Photo by R. Wallace, AAFC.

Table 1: The percentage of moldy apples after 15 weeks in cold storage at 0 °C. Pecentage represents the average of 30 apples for each treatment. For example, 70% means that 21 out of 30 apples were moldy. Treatments with lower percentages resulted in fewer moldy apples.

Treatment	Gray mold (% of moldy apples)	Blue mold (% of moldy apples)	Mucor rot (% of moldy apples)
Control	70	65	87
Baking soda (SBC)	0	42	60
Bacteria strain 4-6	2	33	87
Calcium chloride (CaCl2)	3	17	63
Scholar	5	2	42
Salicylic acid (SA)	10	53	97
BioSave	77	67	97

What's next?

Further testing is required to determine the most effective application method for beneficial bacteria (*P. fluorescens*) to stored apples. Also, more work is needed to improve the control of Mucor rot, where none of the beneficial bacterial strains or food-safe additives were found to be effective.

How was the research done?

We conducted this study in 2016 at the University of British Columbia (Okanagan) and in commercial apple storage facilities in Lake County, BC.

We tested three strains of *Pseudomonas fluorescens* to see whether this beneficial bacteria could control three post-harvest diseases on 'Ambrosia' apples. These were grey mold (*Botrytis cinerea*), blue mold (*Mucor piriformis*), and Mucor rot (*Penicillium expansum*). **The three strains of bacteria were A (1-112), B (2-28), and C (4-6).**

Each strain of bacteria was tested on its own and in combination with food-safe additives already used in the produce sector by packers, including **baking soda (0.5% w/v), calcium chloride (1.0% w/v), and salicylic acid (0.01% w/v)**. The treatments were also compared with a registered biocontrol product (BioSave) and a commonly used fungicide (Scholar).

We used both laboratory experiments and storage trials at a commercial packinghouse. For the storage trials, we wounded apples to mimic infection sites, treated the apples with bacteria and/or food-safe additives by dunking them for one minute, and then exposed them to the fungal pathogens. We stored the fruit for 10-15 weeks at 0°C in either commercial cold storage or controlled-atmosphere storage. Controlled-atmosphere storage uses lower oxygen and higher carbon dioxide levels to slow apple aging and extend storage life. We measured how many apples developed decay and how severe it was.

About this brief

This brief was prepared by Nisa Chavez from the BC Food Web team, with the help of Rhiannon Wallace and Louise Nelson, and is based on the following scientific journal article:

- Wallace, R. L., Hirkala, D. L., & Nelson, L. M. (2019). Pseudomonas fluorescens and low doses of chemicals inhibit postharvest decay of apples in commercial storage. *Canadian Journal of Plant Pathology*, 41(3), 355-365. https://doi.org/10.1080/07060661.2019.1605539

Want to learn more?

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