An Alternative, Low Cost Means of Heating Water Used in Vegetable Seed Sanitation

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Abstract

Some bacterial plant pathogens can infect crops through seeds, causing a major problem for vegetables. Bacterial diseases spread quickly, are not easily managed, and can vary in severity. Currently, there are not many tools to manage bacterial diseases other than prevention. Therefore, it is important to sanitize seeds prior to planting to reduce the risk of seedborne bacterial diseases. The best way to do this is by applying a hot water treatment to the seeds to kill bacteria before planting. However, water baths are prohibitively expensive for many vegetable growers. There is a need to find a more cost-effective way to conduct these treatments. The Sous Vide Precision Cooker could be a less expensive option for growers than water baths. The purpose of this research was to determine if this immersion heater was as effective as a commercial water bath in preventing seed borne bacterial diseases. Various vegetable seeds (tomato, pepper, cucumber, and cabbage) were sanitized with water heated using the precision cooker versus a commercial water bath. Both non-inoculated seeds and seeds inoculated with *Clavibacter michiganensis* subsp. *michiganensis*, *Xanthomonas euvesicatoria*, *Pseudomonas syringae* pv. *lachrymans*, or *Xanthomonas campestris* pv. *campestris* were tested. Seeds were evaluated after treatment for viability and germination rate. We hypothesized that water heated in the Anova Sous Vide Precision Cooker was as effective in preventing seed borne bacterial diseases as a water heated in a commercial hot water bath. There were no significant differences in viability or germination rate of non-inoculated seeds treated with water heated by either method. There was some statistical significance in viability with the inoculated pepper and cabbage seeds. This study was beneficial because it provides growers an alternative, low cost method to sanitize seeds and to better manage the spread of seedborne bacterial diseases in their crops.

Introduction

Bacterial diseases can be very destructive to a variety of plants, specifically vegetables. Such diseases include bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*), bacterial spot (*Xanthomonas euvesicatoria*), angular leaf spot (*Pseudomonas syringae* pv. *lachrymans*), and black rot (*Xanthomonas campestris* pv. *campestris*). Therefore, there is a need for preventing the pathogens from entering the fields before planting. Internal and external bacterial seed contaminants can be killed using a hot water seed sanitation treatment. This is typically done using a precision water bath because water temperature must be tightly controlled: high temperatures may damage seed, while temperatures lower than the optimum may not kill the bacterial pathogens. However, hot water baths are extremely expensive for most growers. Therefore, there is a need to find alternative equipment to heat water at a lower cost. By testing seeds that have been treated using water heated with the Anova Sous Vide Precision Cooker for germination and viability, we have determined that the Precision Cooker provides an alternative low cost option for growers. The precision cooker is smaller, portable, and easier to store than a water bath, and can be controlled by an app on a cell phone. Thus, the Anova Sous Vide Precision Cooker is a good substitute for a water bath.

Materials and Methods

This experiment was conducted in a laboratory setting. Tomato (‘Super Sweet 100’, ‘Cherokee Purple’, and ‘Mt. Fresh Plus’), pepper (‘Intruder’, ‘Red Knight’, ‘King Arthur’), cabbage (‘Red Express’, ‘Tendersweet’, and ‘Farao’), and cucumber (‘Harmonie’, ‘Lemon’, ‘SV4719CS’) seeds were tested. One set of seeds were treated either with a hot water bath or the precision cooker or left untreated. Another set of seeds were inoculated with *Clavibacter michiganensis* subsp. *michiganensis*, *Xanthomonas euvesicatoria*, *Pseudomonas syringae* pv. *lachrymans*, or *Xanthomonas campestris* pv. *campestris* and then treated the same way. Three replications of 25 seeds, for each variety, were treated by placing them in plastic cups with a mesh cover and then placing them in water, with the precision cooker, at 37.7°C for 10 minutes for pre-warming. The temperature was then adjusted to the recommended temperature (Miller and Ivey, 2005), dependent on the seed type (Table 1). Seeds were left in the water during the transition. Once the desired temperature was reached, the seeds were incubated in the hot water for the recommended time (Table 1). For the water bath, seeds were wrapped loosely in a mesh cloth and pre-warmed for 10 minutes at 100°F. They were transferred to another water bath at the recommended temperature and time (Table 1). Seeds heated using either method were removed and placed in cool water for 5 minutes, then placed on a screen to dry. Dried seeds were placed on water agar or Nutrient Broth Yeast (NBY) medium to germinate and test for viability. Three replications of 25 untreated seeds were placed directly on the media for testing. Seed infestation was tested by observation of the presence or absence of bacterial contamination around the seed. Analysis of variance (ANOVA) with at a 95% confidence level was used for statistical analysis.

Seed	Temperature		Minutes
	°F	°C	
Cabbage	122	50	25
Cucumber	122	50	20
Pepper	125	51	50
Tomato	122	50	25

Table 1: Recommended times and temperatures for hot water seed treatment (Miller and Ivey 2005)

Results

There were no significant differences in germination of non-inoculated seeds treated with water heated with the precision cooker, water bath, or the untreated control. There were also no significant differences in germination between treatments for any of the inoculated seeds. There were no significant differences in bacterial seed contamination for inoculated tomato or cucumber seeds between treatments. However, there was significantly less seed contamination in ‘Tendersweet’ cabbage when hot water-treated by either method than non-treated. Non-inoculated ‘King Arthur’ pepper seeds displayed a significantly lower amount of bacterial contamination when treated with water heated in the water bath compared to the precision cooker and untreated samples. Charts 1 - 4 show the mean comparisons of the varieties and treatments for each crop for the non-inoculated seeds. Charts 5 - 8 show the mean comparisons of the varieties and treatments for each crop for the inoculated seeds.

The second experiment showed mostly the same results but with a few differences. There were no significant differences in germination between each treatment for inoculated or non-inoculated seeds of each crop/variety. There were no significant differences in 'Harmonie' cucumber and 'Cherokee Purple' tomato seeds in bacterial contamination between treatments. However, 'Tendersweet' cabbage seeds had a significantly lower amount of bacterial contamination when treated with the precision cooker or the water bath compared to the untreated seeds. For 'King Arthur' pepper, the precision cooker-treated seeds had significantly lower bacterial contamination (Chart 16), than the control group. Charts 9 - 12 show the mean comparisons of the various varieties and treatments for each crop for the non-inoculated seeds for the second experiment. Charts 13 - 16 show the mean comparisons of the various varieties and treatments for each crop for the inoculated seeds for the second experiment.

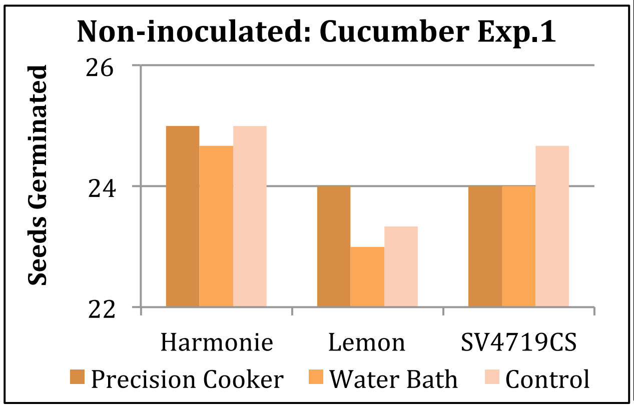
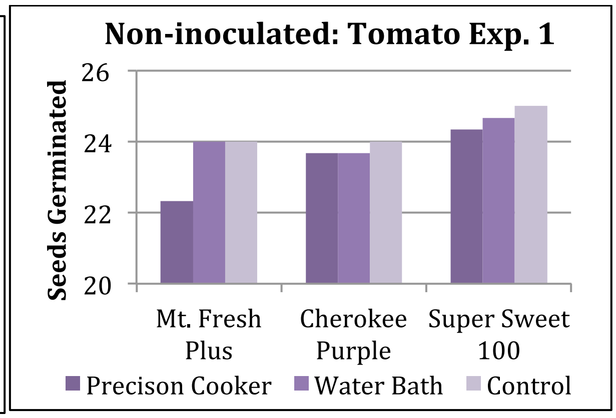


Chart 1



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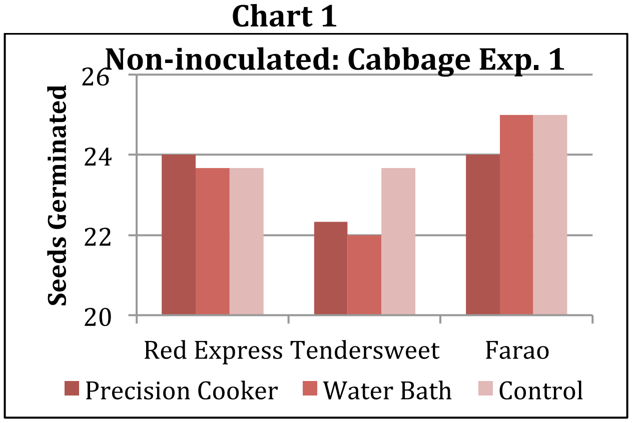

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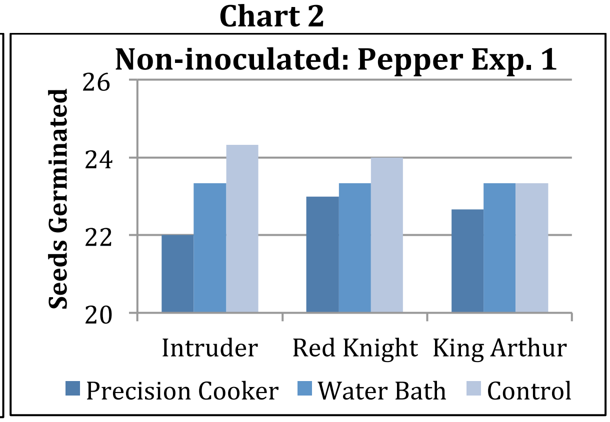

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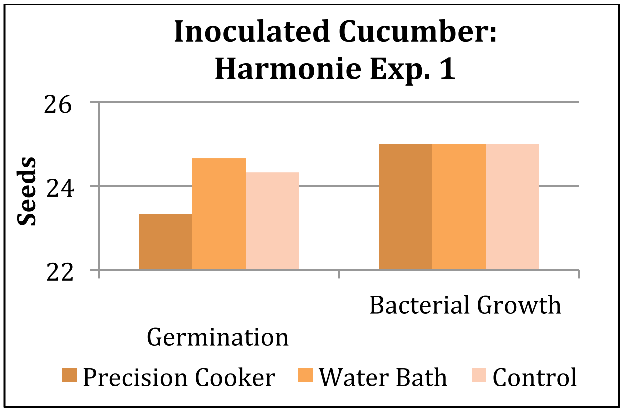

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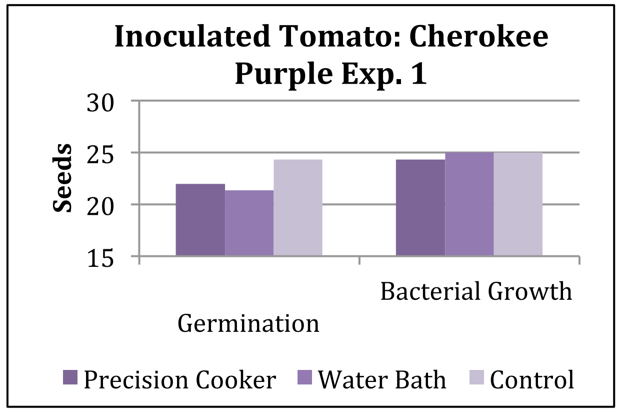

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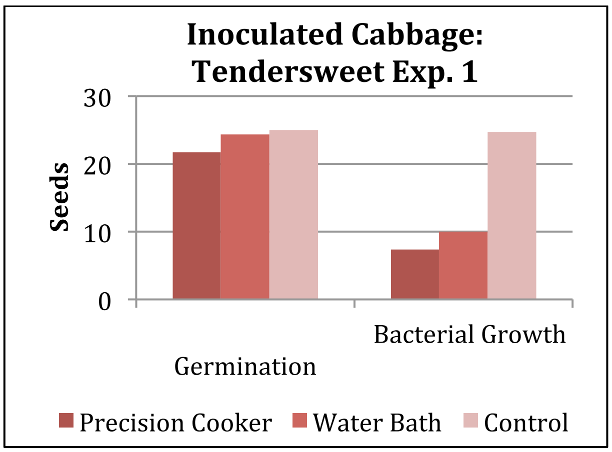

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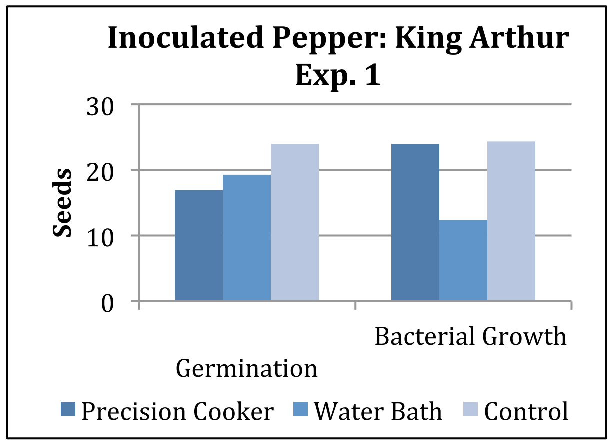

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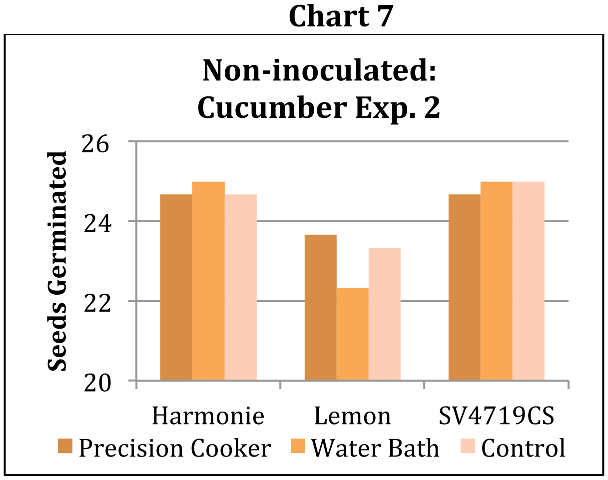

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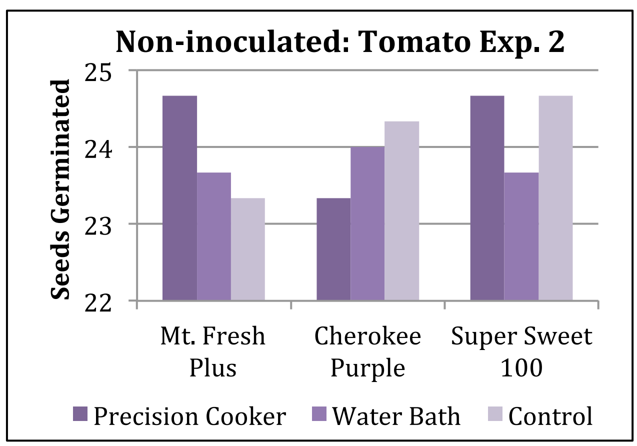
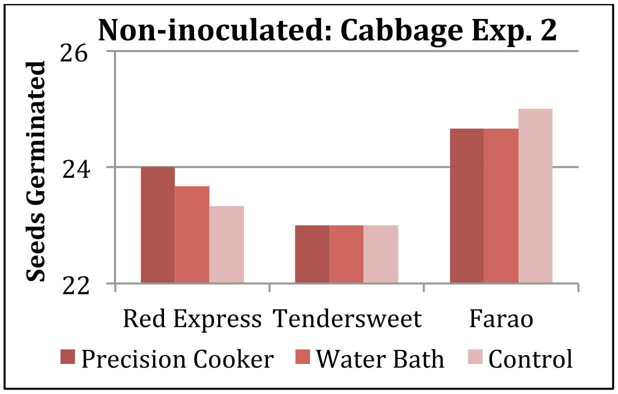


Chart 10



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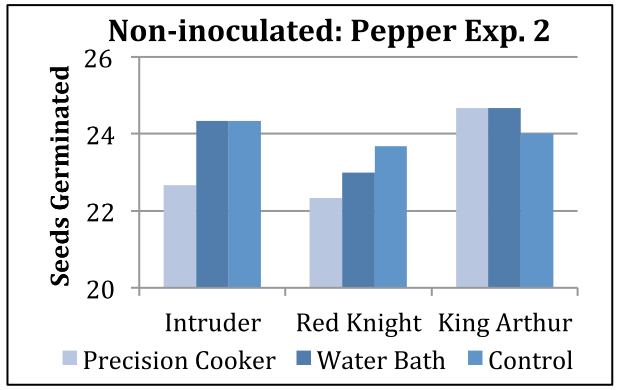

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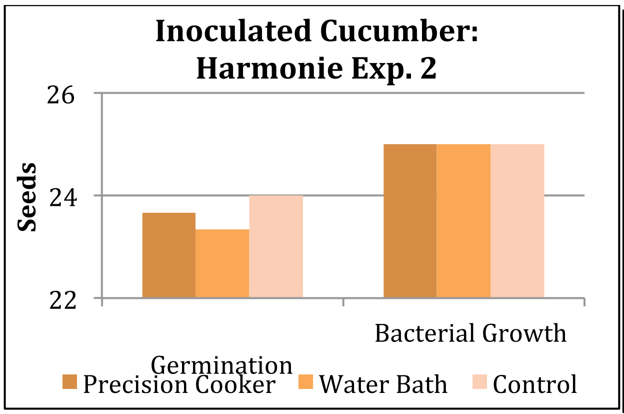

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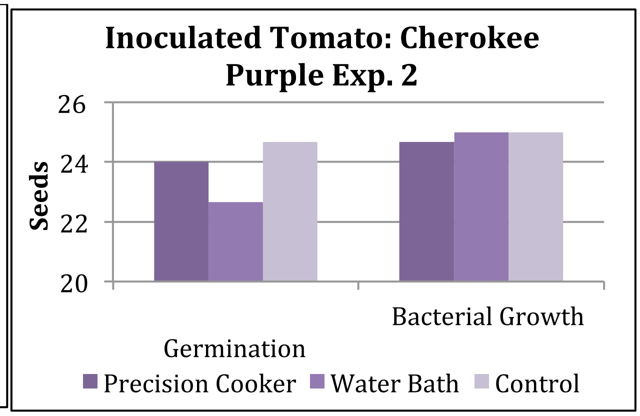

Chart 14

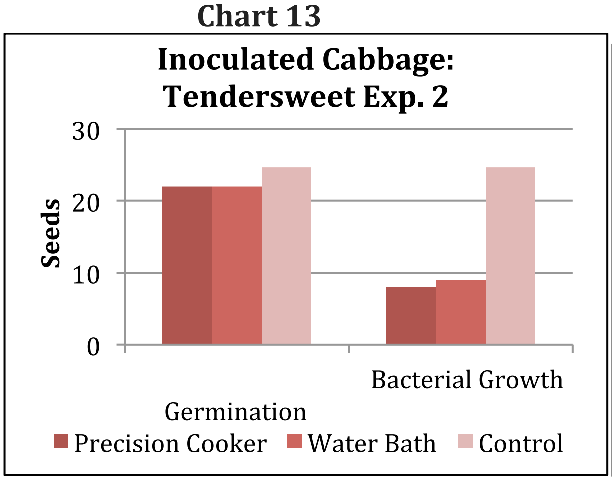

Chart 15

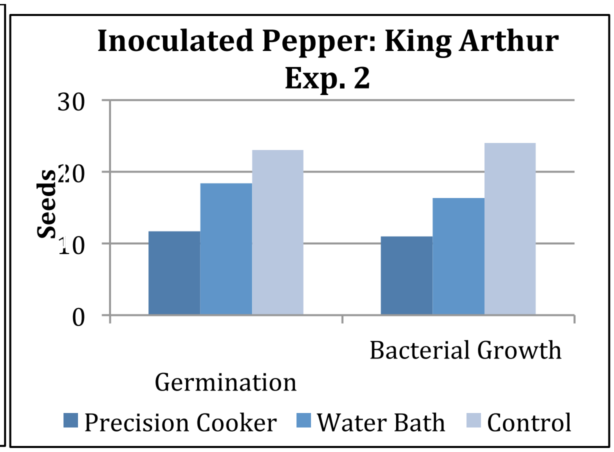

Chart 16

Discussion

The results of this study indicate that the Anova Sous Vide Precision Cooker heats water as effectively and consistently as a precision water bath. It can be noted that there was less fungal contamination on seeds treated with water heated with the precision cooker than seeds treated with the water bath or not treated. Therefore, it can be concluded that the Anova Sous Vide Precision Cooker is an effective substitute for hot water baths used in sanitizing seeds to reduce seed borne bacterial diseases.

References

Miller, S. and Lewis Ivey, M. (2005) Hot Water and Chlorine Treatment of Vegetable Seeds to Eradicate Bacterial Plant Pathogens. *The Ohio State University Extension Factsheet*. HYG-3085-05.

Nega, E., Ulrich, R., Werner, S., & Jahn, M. (2003). Hot water treatment of vegetable seed-an alternative seed treatment method to control seed-borne pathogens in organic farming. *Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz*, *110*(3), 220-234.