

FINAL PROJECT REPORT

Project Title: Enhancing shelf life and quality of 1-MCP treated sliced pears

PI: Amit Dhingra
Organization: Washington State University
Telephone: 509 335 3625
Email: adhingra@wsu.edu

Cooperators: Crunch Pak: Tony Freytag and Ozgur Koc; WSU: Christopher Hendrickson, Ph.D., Seanna Hewitt, Scott Mattinson and Frank Younce

Total Project Request: Year 1: \$33,727

Other funding sources

Agency Name: Crunch Pak

Amt. awarded: \$18,000

Notes: Based on estimates provided by Ozgur Koc at Crunch Pak, each experiment of sliced pear project costs them approximately \$1500. The plan is to have 12 different samples/treatments resulting in a total in kind support of \$18,000.

Agency Name: NIH Protein Biotech Training Program

Amt. awarded: \$52,234

Notes: Support for Seanna Hewitt, Ph.D. student includes stipend, travel, medical, tuition and fees.

Total Project Funding: \$33,727

Budget History:

Item	2014
Wages ^a	19,760
Benefits	7967
Supplies ^b	3500
Travel ^c	1500
Miscellaneous ^d	1000
Total	33,727

Footnotes:

- Wages and benefits as partial support for a student to conduct the experiments.
- Support for procuring chemical compounds (RCs) and experiment associated consumables
- Support for travel to Crunch Pak facilities from WSU Pullman
- Partial support for covering the cost of 1-MCP treated fruit

OBJECTIVES

This project addresses the following 2013-2014 priority: “Value added programs such as fresh sliced pears have great potential in getting more pears to our consumers with the convenience they demand” and near term priority: “MCP use and its associated effect on pear conditioning at the consumer level”.

The objectives of the proposal were:

1. Evaluate the quality and shelf life of sliced pears derived from 1-MCP treated fruit with and without treatment with the ripening compounds and identify the optimal ripening compounds and corresponding concentrations.

One of the five ripening compounds, RC2, was found to be most effective. RC2 overcame the inhibition of ripening in 1-MCP treated sliced pears. As part of the quality analysis, total soluble content, flesh firmness, physical appearance, ethylene and CO₂ release was measured over a period of 21 days.

2. Evaluate the optimized ripening compound concentrations in partnership with Crunch Pak.

This part of the work was performed by Crunch Pak. They added RC2 to their polymers directly and the fruit was packed and quality control was performed by their staff. A total of 4 trials have already been completed with several more trials planned in the next few months.

SIGNIFICANT FINDINGS

The goals of each objective were completed. While this was not a part of the original objectives, we conducted a non-trained consumer taste panel at the annual 2014 WSHA meeting with highly encouraging results.

- One of the five ripening compounds, RC2, was found to be most effective in inducing ripening in 1-MCP treated sliced pears as measured by release of ethylene and carbon dioxide. Visible compositional changes, including increased browning at high RC2 levels – an indicator of ripening, was observable.
- RC2 treatment of 1-MCP treated sliced pears resulted in immediate activation of aromatic pathways as evident from qualitative analysis. This could also have implications in sliced apple industry.
- Interestingly, prior treatment with 1-MCP ensured uniformity of the sliced product when RC2 was applied. When the non-1-MCP treated fruit was sliced and treated with RC2, the quality of the finished product was found to be highly variable.
- Very firm 1-MCP treated Bartlett fruit with an average firmness of 17 lb developed the characteristic pear aroma after RC2 treatment and softened to flavorful product within a few days while in the 2 oz. Crunch Pak bag.
- The shape of the D’Anjou pears is more amenable for slicing compared to Bartlett.

- Preliminary taste panel at the annual WSHA meeting in Kennewick indicated that RC2 treatment of even the unconditioned sliced D’Anjou pears enhanced the overall acceptance, flavor and texture of the product.
- A sliced pear product doesn’t need to be soft and juicy as expected in the case of the whole fruit.

RESULTS & DISCUSSION

As the desire for convenience foods increases, so too does the demand for sliced fruit. The market for fresh, sliced pears is particularly promising; however development of suitable methods of shelf life extension of pear has proven challenging. The aim of our ongoing research is to provide a platform from which the sliced pear industry can better provide pear consumers access to the fruit with the convenience that they demand.

This project involved slicing of 1-MCP treated fruit and its subsequent treatment with the ripening compounds that were identified previously in the program. We also evaluated non-1-MCP treated fruit that had not met its conditioning requirement. Evaluation of fruit in the latter category was not part of the original plan due to limitation of resources however this experiment was driven by the commercial availability of fruit of desirable firmness. It was interesting to note that RC2 was able to compensate for lack of cold requirement for conditioning to ripen. It implies that the non-1-MCP treated fruit can be utilized for slicing soon after harvest. Further, 1-MCP treated fruit can be utilized for slicing late into the season extending the market window for producing sliced product. Crunch Pak cited this as a highly desirable factor for any commercial entity to get involved in producing sliced product.

In experiments conducted concurrently at WSU and Crunch Pak, 1-MCP-treated Bartlett and D’Anjou fruit were sliced and treated with RC2. Product quality analysis at Crunch Pak revealed that 1-MCP-treated Bartlett pears sliced at 17 lb firmness, treated with the appropriate concentration of RC2, and stored at 6 deg C (42.6 deg F) over a period of 21 days developed desirable flavor and softened while in a 2 oz. bag. The fruit met the quality standards established by McDonald’s and the slices were able to outlast the necessary two weeks shelf life in bags (Table 1). The two week threshold is a market requirement for a sliced product to be successful. In fact, the sliced pears lasted well into the fourth week after being packaged in Crunch Pak 2 oz. bags. Crunch Pak is interested in performing large scale trials.

Release of ethylene and carbon dioxide evolution was measured using gas chromatography as well as with an on-loan CID Biosciences hand held instrument (Figure 1). Treatment of fruit with RC2 resulted in an overall increase in release of ethylene and carbon dioxide. There was a four-fold change in ethylene release which is both an indicator and inducer of ripening (Figure 1A). A 1 to 1.5-fold increase in carbon dioxide evolution was also observed. The experiment was replicated 3 times and each replicate consisted of six 2 oz. bags.

In addition to the analysis of ethylene and carbon dioxide levels, firmness and brix change was also measured (Figure 2). While the changes in these two parameters are not highly pronounced, they are effective in contributing to a favorable organoleptic experience as was evident from a non-controlled taste panel performed at the annual WSHA event in Kennewick, WA.

A total of 47 respondents participated in the sliced pear tasting panel (Table 2). Out of the 47 participants only one respondent reported no change in the organoleptic profile of the fruit. Treatment of fruit with RC2 at 2% enhanced the overall acceptance and taste/flavor of the product. Texture was most acceptable at 3% RC2 treatment, with 2% RC2 treatment following close behind. The controls

performed best in terms of the appearance. However, repeat purchase is not dependent on appearance alone as has been extensively documented in literature. There is a need to perform controlled and non-controlled taste panels. For this a collaboration has been established with Carolyn Ross and Karina Gallardo who perform such analysis and panels on a routine basis.

In summary, our data and preliminary taste panel survey has established the feasibility of the sliced pear product. With support from large scale market trials, economic analysis and controlled taste panel surveys enough data can be generated to attract the slicing entities to produce sliced pears for the larger market. This is also expected to increase the utilization of fruit that falls in the 120 to 135 box size range which is currently underutilized or culled.

Figure 1: Change in ethylene and carbon dioxide evolution in sliced pears treated with RC2.

A and B: measurements were performed on the gas chromatography equipment. Fold-change in ethylene and carbon dioxide levels is shown. The x-axis represents the percentage of RC2 used. The dry and wet annotation refers to the condition, where no (dry) or extra (wet) volume of non-browning-RC2 solution was included in the 2 oz. bag. A four-fold change in ethylene release is discernible from this data.

C and D: measurements were performed with the on-loan CID Biosciences hand-held device.

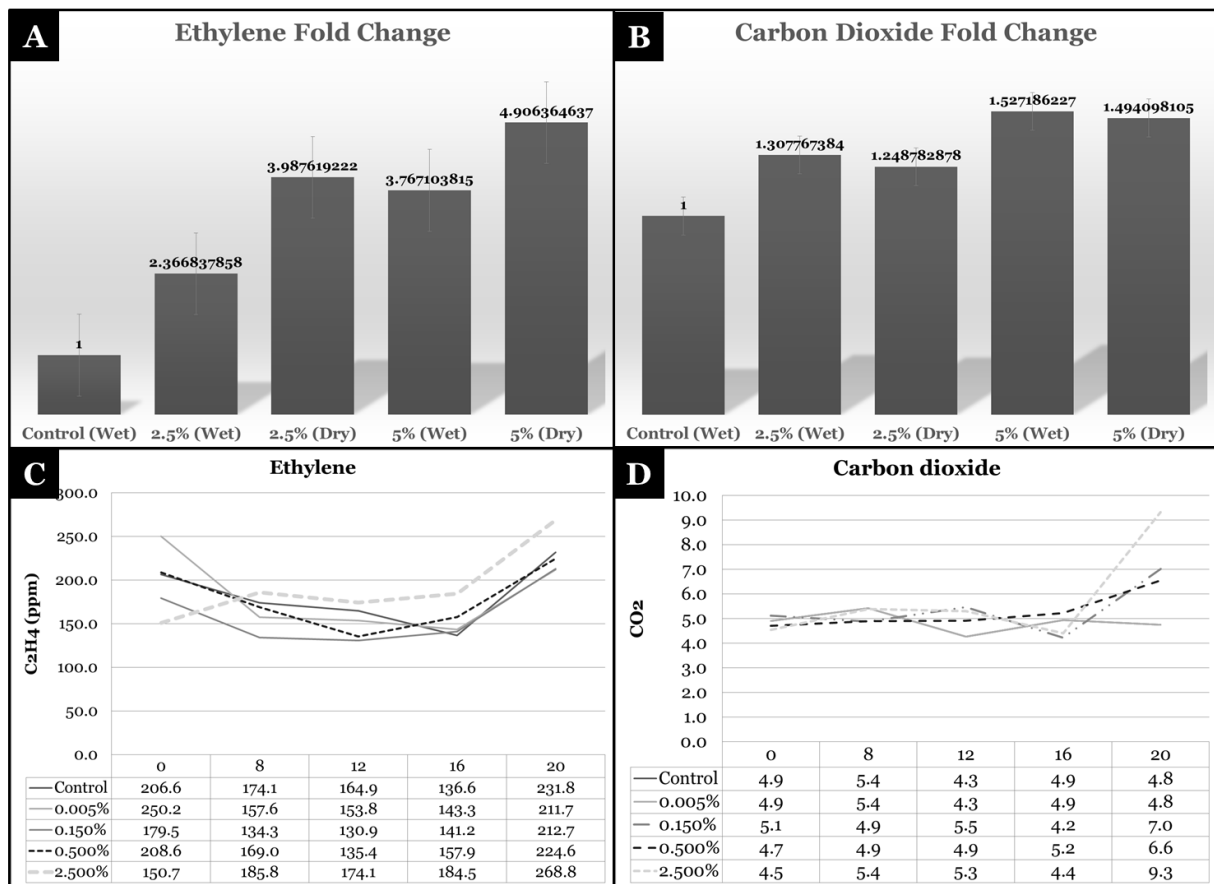


Figure 2: Change in fruit firmness and soluble solid content.

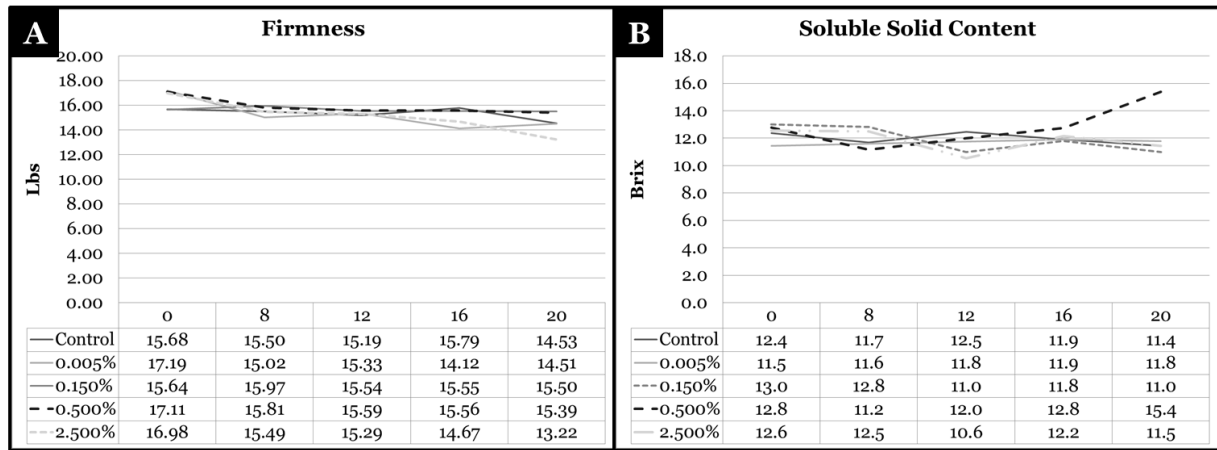


Table 1: Quality control data based on McDonald's standards generated at Crunch Pak. RC – Ripening compound.

Day	Control (No RC)		0.5% RC		2.5% RC	
	Firmness	Flavor	Firmness	Flavor	Firmness	Flavor
7	Very firm and crunchy	Little to none	Very firm and crunchy	Little to none	Very firm and crunchy	Little to none
10	Very firm and crunchy	Little to none	Still very crunchy; Less firm than control	No noticeable difference in flavor from control	Less firm than control; Still very crunchy	Slightly more flavor than control
14	Very firm and crunchy	Little to none	Less firm than control; Still crunchy	Slightly more flavor than control	Slightly less firm than 1.5%	Juicier than 0.5% RC; Slightly better flavor
17	Very firm and crunchy	Little to none	Less firm than control	Slightly more flavor than control	Still firm, but less so than control	Some flavor development
21	Very firm and crunchy	Little to none	Still firm and crunchy	Some flavor	Less firm than control; Still crunchy	Similar flavor to 1.5% RC; Moderate amount of juiciness

Table 2: Ranking for overall acceptance, appearance, taste/texture, and texture of sliced pears. A total of 47 respondents comprised of this consumer survey. 46 individuals were able to distinguish a difference between treated vs. control samples.

	Ranking			
	Overall acceptance	Appearance	Taste/Flavor	Texture
Most acceptable	2%	Control	2%	3%
	Control	1%	3%	2%
	3%	2%	Control	Control
Least acceptable	1%	3%	1%	1%

EXECUTIVE SUMMARY

Application of 1-MCP has accrued large benefits to the apple industry however its application to pears has been hampered by the lack of predictable ripening post 1-MCP treatment. This confounds the existing issue of stagnant pear consumption. A boost in consumption of pears is urgently required to catalyze the reinvigoration of the pear industry. Pears are constantly competing against foods that offer convenience and 'on the go' consumption such as berries, sliced products, packaged ready to eat vegetables etc. More than ever there is a need to develop strategies to produce and deliver a consistent quality pear and if the factor of convenience can be added, that can push the static consumption line.

As part of ongoing research on topmost priorities in pear research, we first developed the genome information and then utilized the information on physiology guided activity of pear specific genes that are involved in ripening to identify potential ripening compounds that can reverse the impact of 1-MCP. The mode of application of these ripening compounds on whole fruit are currently being investigated. In the meantime, we have established that the benefits of these compounds can accrue in the area of sliced pears. Currently pears are valued at about \$400 M and every 1% of the market share for sliced pears adds \$4 M to the value of pears. With the increased demand for convenience foods, a market share of 10% for sliced pears is foreseeable in the near future. This can boost the consumption of pears which has been a long desired goal of the U.S. pear industry.

Commercial trials with Crunch Pak and preliminary taste panel surveys have met or exceeded the standard expectations. There is a need to perform market scale trials and also evaluate the economics of what prices sliced pears command in the market since they will be a novelty product. To continue this work additional support has been requested in the form of a new proposal.