Springboro Tree Farms ~ Sweet Life Science

UV Treatment of Apple Cider

Introduction

Apple cider is an ancient beverage enjoyed by hundreds of millions of people for thousands of years. The earliest records of apple farming date to 1300 BC in Egypt. And we know that apple cider was very popular in England when the Romans first sailed to the British Isles in 55 B.C. So it's been around a long time.

We've always enjoyed fresh apple cider. We typically make about 50 gallons per year to share with friends. But this ancient beverage now has a modern-day image problem.

In September 1997, the FDA past regulations that require cider producers to have a proven process to mitigate the presence of pathogens in cider --- or, they must label their product as "not been pasteurized" and "can cause serious illness in children, the elderly, and persons with weakened immune systems."

As a result, pasteurization is the technology the industry turned to during the 1990s…and in our opinion the taste of apple cider was changed (not for the better) throughout the nation.

For small batch hobby level producers, pasteurization equipment and the alternative technologies (UV systems designed for apple cider) are far too expensive.

Our Goal

So while we can't produce cider commercially, we did want to see if we could deploy the UV technology we use in our maple syrup making process to reduce bacteria counts and thereby improve shelf live and palatability of the cider we make for family and friends.

Here's an overview of how we make cider, the testing we did, the methodology we used and what we learned.

From Apples to Cider - Pressing

Our apple cider is made from apples that are freshly picked from the tree – never off the ground. See our related Sweet Life Science article for an overview of our orchard management efforts.

The apples are then washed in tap water and agitated in a food grade stainless steel sink, hand-cut into chunks, and immediately processed into cider using a hobbyist small-batch, hand-turned apple cider press.

The chunks are macerated by a hand-turning wheel that grinds the apple chunks and releases some apple juice…with the ground apple pieces collecting in a coarse cheesecloth-like bag held in a bucket shaped by a wooden staved (vertically slotted) collecting container (part of the overall apple cider press). Apple juice continues to run from the ground pieces until the bag is filled, at which time, the top of the bag is folded atop the apple pieces and a pressing board is lowered onto the apple chunks using a hand-turned crank, that looks like a large threaded screw with a circular pressing board attached at the end.

The screw with the pressing board is turned by hand onto the apple pieces to extract as much apple juice as possible. The remaining relatively dry apple pomace is then returned to the woodlot as a food source for animals – including the bees that call Springboro Tree Farms home.

Collected apple juice is passed through a simple stainless steel food grade wire sieve and collected into 5 gallon food grade plastic buckets.

We then pass the raw apple cider through a stainless steel sieve for a second time; bottle it and immediately place it onto a freezer (or refrigerate if we plan to consume it right away. We do this because raw apple cider must be consumed fairly quickly and must be refrigerated as the fermentation process starts immediately, which will turn the sweet cider into “hard”, and non-consumable apple cider vinegar.

The UV opportunity

All the naturally occurring sugars in the apple juice become yeast food. Naturally occurring yeasts convert sugars to alcohol in apple cider, thus the cider “hardening” process begins. Commercial cider operations selling to supermarkets typically pasteurize the juice (i.e., heat it to 160 F) at this point to kill any microbes that could over time cause the apple cider to turn “hard”. A full hardness of apple cider results in apple cider vinegar that is also a commercial food product. However, in the interest of maintaining a pure, unadulterated table-ready product for drinking, that may extend shelf-life a bit longer, we employ another novel step prior to bottling in new plastic jugs: a UV Treatment.

Ultraviolet has been used for years to disinfect and sanitize drinking water, wastewater, air, and food contact surfaces—and was approved by the Food and Drug Administration (FDA) for the “cold pasteurization” of juice.[i] It is a safe procedure for reduction or elimination of many natural food pathogens for human consumption.

A few years ago we purchased a Sap Steady Junior UV sap treatment machine to kill bacteria yeast, and some other microorganisms in maple sap thereby extending sap shelf life. And since the manufacturer of our Sap Steady unit (FPE, Inc. Ontario, Canada) also makes a machine called the CiderSure for processing apple cider, we wanted to see if our Sap Steady unit would eliminate some of the microorganisms in our cider.

Our goal of using this UV apparatus is not to completely eliminate naturally occurring microorganisms that are eliminated with commercial pasteurization. Rather our goal is to simply extend shelf-life and palatability of the pure apple cider product by reduction of microbes.

When we learned that there has been no documented data of the use of this unit (Sap Steady Junior UV) for apple cider production, we decided to experiment with the unit for possible improvement of shelf-life and extended palatability.

The technical issue in making the effort to experiment with the Sap Steady UV Unit lies with the differences of the relative ability of the UV light to penetrate maple sap vs apple cider. Maple sap is essentially clear as it flows from the tree, and as such, passage of the UV light through maple sap to destroy microorganisms is effectively achieved. By contrast, apple cider is opaque, thus presenting significant hindrance of the UV light to the apple cider passing through the UV column. Opaqueness is because of tiny apple pieces that pass through the straining process above in addition to the natural color of the expressed apple juice from the pressing process.

As cider is passed through the UV light column, the UV light is “bent” or refracted as it passes obliquely through a liquid cider medium of varying density and opaqueness. This presents a barrier in UV light completely reaching all microbes in the cider.

Understanding this issue with the use of the Sap Steady UV in apple cider, we wanted to know if greatly increasing the time our cider is exposed to UV light would be effective in reducing bacterial populations. So we decided to test and measure the Aerobic Plate Count (APC) of our cider before and after extended UV treatment**.**

Note: The Sap Steady unit is rated effective for maple sap at a flow rate of 4 to 8 gallons per minute depending on how clear the sap is. So we decided to pass cider through at a rate of 3.5 gallons per minute. In order to further increase the time exposed to UV treatment we passed the test sample through the machine 5 times. That’s approximately 5 times the normal rate of exposure.

Understanding APC

Aerobic Plate Count (APC) is a food laboratory measurement used as an indicator of bacterial populations on a food sample. It is also called the aerobic colony count, standard plate count, Mesophilic count or Total Plate Count. The test is based on an assumption that each cell will form a visible colony when mixed with agar containing the appropriate nutrients. It is not a measure of the entire bacterial population; it is a generic test for organisms that grow aerobically at mesophilicii (moderate) temperatures (25 to 40°C; 77 to 104°F).

APC does not differentiate types of bacteria.

APC can be used to gauge sanitary quality, organoleptic acceptability, adherence to good manufacturing practices, and to a lesser extent, as an indicator of safety. APC may also provide information regarding shelf life or impending organoleptic (sensory) change in a food.

APCs are poor indicators of safety in most instances, since they do not directly correlate to the presence of pathogens or toxins. A low APC result does not mean the product or ingredient is pathogen free. Certain foods, such as those produced through fermentation, naturally have a high APC. Natural cider ferments over time, and as such, have measurable APC values. Again, low APC numbers do not equate to an absence of pathogens.[iii]

We looked into possible ways to test the effectiveness of UV light on apple cider quality, especially possibly sustaining palatability shelf life…and ultimately contracted with a globally respected laboratory company, Eurofins Microbiology Laboratory, Louisville, KY, to evaluate raw and UV treated apple cider.

The passage of cider through the UV light system was tested to determine if the system could reduce the presence of microbial organisms that are responsible for eventual degradation of non-pasteurized cider to eventual hard cider, rendering it non-consumable. We tested a control sample (raw cider), as well as samples that had been passed through the UV light system.

Cider samples were collected at the time of apple pressing, without delay, frozen, and shipped overnight to the analytical laboratory. Samples were received in acceptable condition (4.2º C), predawn the next day and analyzed that day.

As provided by Murray Brown Laboratories, the table below offers some general guidelines for expected aerobic plate counts on ingredients and finished products. [iii]

Table 1. Typical Commodity Aerobic Plate Counts (CFU/g)

Commodity	Aerobic Plate Count per Gram	Commodity	Aerobic Plate Count per Gram
Almonds	3,000 – 7,000	Pasta	1,000 – 10,000
Baked Goods	10 – 1,000	Prepackaged Cut Chicken	100,000
Breakfast Cereals	0 – 100	Raw Milk	800 – 630,000
Deli Salads	10,000 – 100,000	Refrigerated and frozen dough	100 – 1,000,000
Dry Cereal Mixes	100 – 100,000	Soy Protein	100 – 100,000
Fresh Ground Beef	100,000	Walnuts	31,000 – 2,000,000
Frozen Potatoes	1,000 – 100,000	Wild Rice (before hulling)	1,800,000
Frozen Vegetables	1,000 – 100,000	Wild Rice (after hulling)	1,400

Note: CFU is a Colony Forming Unit. CFU/g is used here as the unit of measurement of APC.

Results

Table 2. Results of UV Light Passage Through Raw Apple Cider

Eurofins Sample Code:	514-2020-11050232	**Sample Registration Date:**	05Nov2020
Client Sample Code:	01 Control	**Condition Upon Receipt:**	acceptable, 4.2°C
Sample Description:	Apple Cider	**Sample Reference:**	

UM7I3 - Aerobic Plate Count - AOAC 966.23	**Reference**	**Accreditation**	**Completed**
	AOAC 966.23	ISO/IEC 17025:2017 A2LA 3329.04	07Nov2020

Parameter	**Result**
Aerobic Plate Count	5,700 cfu/ml

Eurofins Sample Code:	514-2020-11050234	**Sample Registration Date:**	05Nov2020
Client Sample Code:	03 Run 5	**Condition Upon Receipt:**	acceptable, 4.2°C
Sample Description:	Apple Cider	**Sample Reference:**	

UM7I3 - Aerobic Plate Count - AOAC 966.23	**Reference**	**Accreditation**	**Completed**
	AOAC 966.23	ISO/IEC 17025:2017 A2LA 3329.04	07Nov2020

Parameter	**Result**
Aerobic Plate Count	2,400 (est) cfu/ml

As shown below, these results demonstrate that Commodity Aerobic Plate Counts (APC) are influenced by passage of UV light produced by our Sap Steady Junior UV through the our raw apple cider.

Table 3. Aerobic Plate Counts

Product Sample	Commodity Aerobic Plate Count (CFU/g)	% Reduction APC
Control	5,700	
5-Pass UV	2,400	58

Quality and safety guidelines (or specifications) are often applied to raw materials and finished goods. Bear in mind, APC specifications are not always appropriate or relevant. For example, raw agricultural commodities can have widely fluctuating plate counts. In these situations, APC can however provide meaningful data to the processor who has a better understanding of factors that may influence the count, but they provide little value in relation to acceptance criteria.[iii]

Conclusion

These data show simply that specific wavelength UV light passage produced by our (Sap Steady Junior UV) through our raw fresh apple cider did provide a significant reduction of Aerobic Plate count bacteria; but no scientific standard exists for targeted plate counts that positively correlate to food safety or in this case, shelf life and/or extended palatability. One may intuitively infer however, that lowered overall bacterial plate count as a result of safe application of UV light treatment, commonly used in the U.S. food supply chain, may serve to reduce the number of available microscopic organisms that contribute to time-sensitive conversion of fresh apple juice into progressively increasing hard apple cider as natural fermentation occurs converting natural sugars to alcohol.

And at the end of the day…

…we've never been comfortable being in the cider business. But if you're in the neighborhood next cider season drop by for a taste of what apple cider used to be…what apple cider is supposed to be.

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[i] Are Ultraviolet Lamps Part of Your Food Safety Program? April 21, 2016 by Charles Boehme. Updated on February 18, 2020. www.Ultraviolet.com.

[ii] Wikipedia. https://en.wikipedia.org/wiki/Mesophile

[iii] Aerobic Plate Count. MURRAY-BROWN LABORATORIES, INC. https://mb-labs.com/resources/aerobic-plate-count/