

HARD CIDER PRODUCTION: SANITATION, FERMENTATION, & STABILIZATION

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Penn State Extension

Why Sanitation is Important...

- “Garbage-in equals garbage-out”
- Enhances your opportunity to minimize quality (and spoilage) problems
- Allows the cider maker more time to focus on stylistic decisions and creating a good quality cider
- Most problems that occur in hard cider production can be easily prevented with good sanitation practices

Cleaning vs. Sanitizing

- **Cleaning** – [physical] removal of mineral and organic material or debris from equipment surfaces
- **Sanitizing** – *reduction* of microorganisms through such means as addition of chemicals or heat (i.e. steam)

Sterilizing – killing 100% of all viable microorganisms, associated spores, and viruses is rarely achieved in commercial processes)

Cleaning vs. Sanitizing

- Overall Considerations:
 - 1) Clean – Rinse – Sanitize
 - 2) Cleaning equipment does not imply that the equipment has been sanitized
 - 3) Improperly cleaned equipment cannot subsequently be sanitized
 - 4) Must always clean equipment before sanitizing (increases the efficiency of the sanitization step)

FDA Approved No-Rinse Sanitizers

- **Sanitizers** – an agent that reduces viable cell populations to acceptable lower numbers; used in sanitizing steps
 - List of FDA Approved No-Rinse Sanitizers
 - 1) Chlorine (Cl)
 - 2) Chlorine Dioxide (ClO₂)
 - 3) Iodophors
 - 4) QUATS
 - 5) Peroxyacetic Acid

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Blue Represents
Sanitizers
Recommended
for Hard Cider
Producers

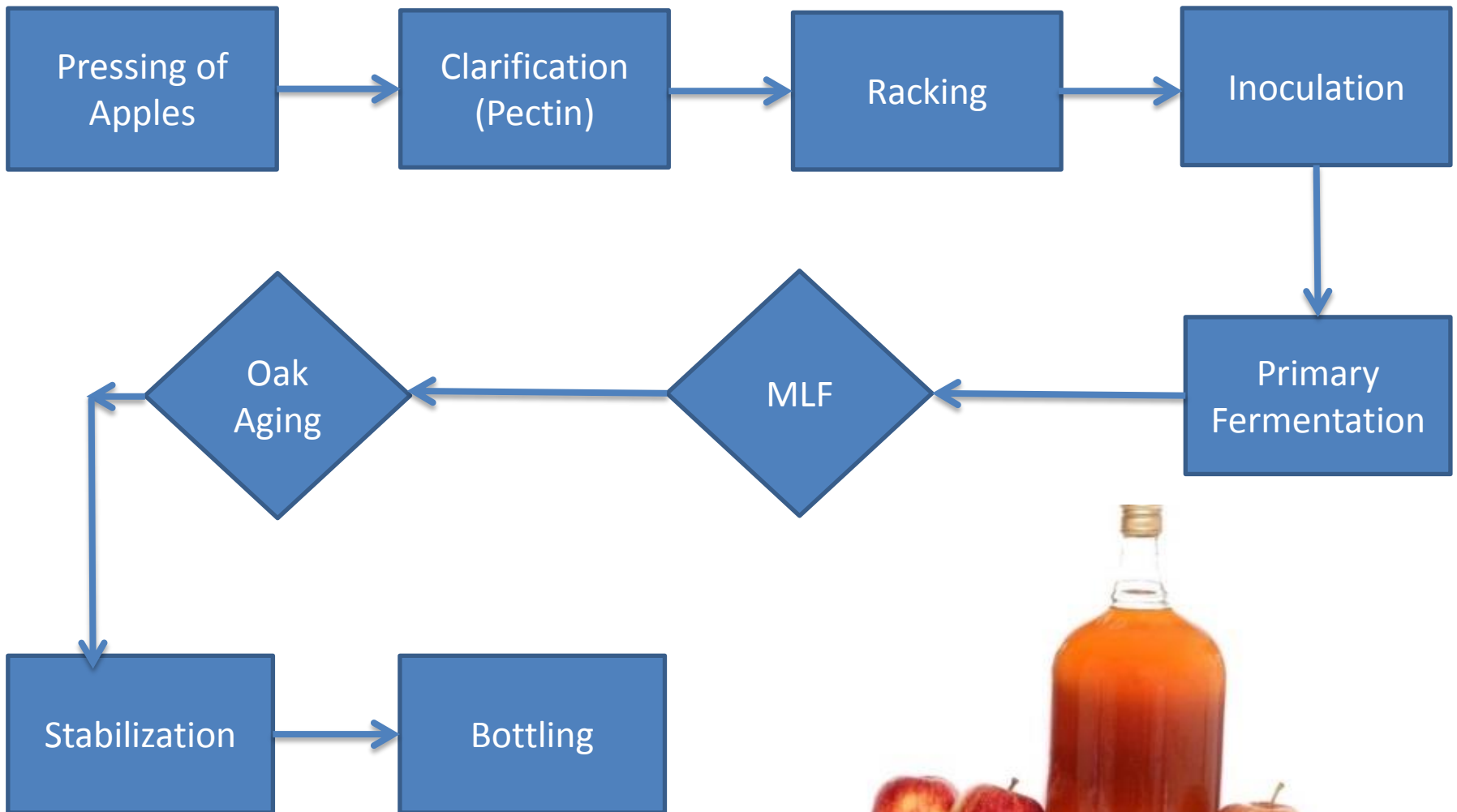
Acidulated SO₂ Sanitizer

- Not an FDA approved sanitizer, but it is an option for cider producers
 - Easy to make regularly
 - SO₂ is a natural preservative found in hard cider
 - Can bring the pH down from equipment treated with a basic cleaning or sanitizing agent (return to an acidic environment)
 - Need proper ventilation

Consideration of Steam

- Hot Water ($>82^{\circ}\text{C}/180^{\circ}\text{F}$): need to apply for **at least 20 minutes**, and the exit temperature of the water must be 180°F
- Steam: quicker than hot water and penetrates more hard-to-reach places (barrels, pores, cracks, behind gaskets, threads, etc.)

Hard Cider Production Flow Diagram



Fermentation: From Juice → Alcohol



- Ideal sugar content:
 - Measure sugar with a refractometer or hydrometer
 - 1.060+ (specific gravity) or 14.74 °Brix (7.67% potential alcohol)

Fermentation: From Juice → Alcohol

- Acid Composition
 - Pre-fermentation: malic (90%), quinic (up to 10%), & citric (1-2%)
 - Post-fermentation: contributes lactic and acetic acids
- Little buffering capacity in apple juice
 - Onset of fermentation can lower the pH (damage yeast, affect efficiency of fermentation)

Fermentation: From Juice → Alcohol

- Acid Content

- Measure of pH: determines stability and chemical properties

- Ideal pH for hard cider is <3.8

- pH <3.0: may want to raise slightly with potassium carbonate

- pH >3.8: lower with addition of FG malic acid or a low pH juice

- Measure of Titratable Acidity (TA): determines sourness or tartness of the cider

- Ideal TA is 4.5 – 7.5 g/L malic acid

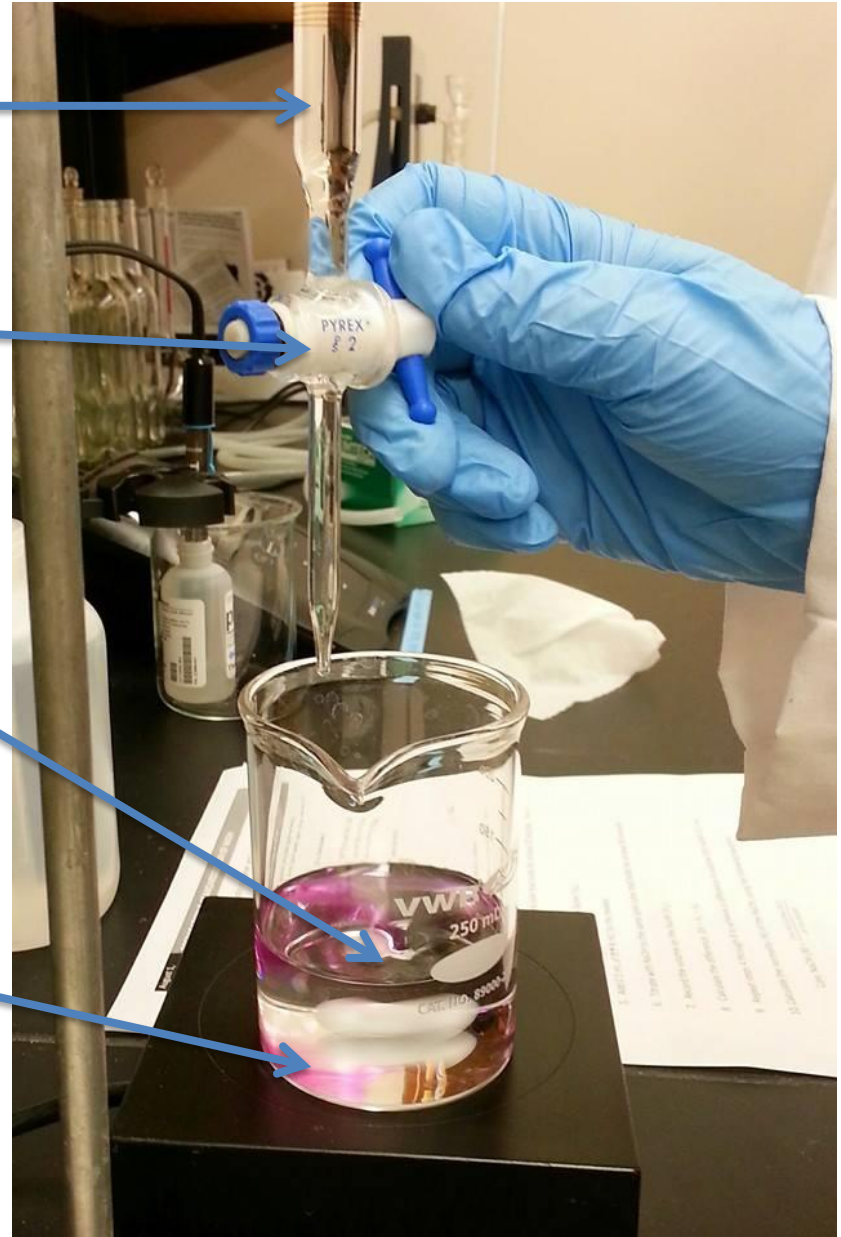
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base (NaOH)

Burette

distilled water with
sample (hard cider or
juice)

color indicator



Fermentation: From Juice → Alcohol

- Nitrogen Content
 - Measure YAN
 - Optimal YAN: between 150 – 200 mg N/L
 - Follow guidelines set by fermentation supplier
 - Consider yeast strain
 - YAN management during fermentation
 - Yeast hydration nutrient (e.g. GoFerm or Nutriferm Energy)
 - Yeast complex nutrient (e.g. Fermaid K or Nutriferm Advance)
 - **Possible** addition of diammonium phosphate (DAP) for low YAN fermentations

Fermentation: From Juice → Alcohol

- Pectic Enzyme Addition
 - Pectinase
 - Debourbage/Depectinization: Pectinase + Sparkolloid
 - Addition before fermentation
 - Ideal temperature: 60°F(15°C) → SO₂ addition required
 - Rack & inoculate
 - Keeving: Use of pectin methyl-esterase (PME) only + Calcium
 - Produces the “brown cap” (*chapeau brun*)
 - Juice under cap is clear & racked
 - Will not ferment fully; creates an off-dry to sweet cider

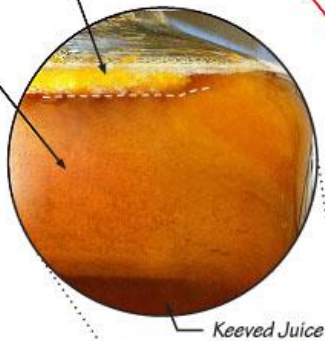
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Allowing Cap Compression

NOT COMPRESSED

The soft-risen Lees make a thick fragile cap that contains tiny trapped gas bubbles giving bouyancy.

At this stage, the Initial Cap was still thick.



Keeved Juice



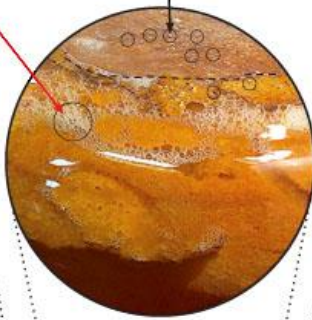
9" (23cm)

Still Warm: 61° F (16° C)

Left carboy out at room temprature of 61° F (16° C) for 2-Hours so remaining chunks of lees built up enough gas and bouyancy to rize and combine with the cap.

IMPORTANT: 2-Hours after Cap surfaced, large gas bubbles formed. Time to cool the juice before the ferment blows the cap apart. When the cap is fully compressed, it will result in a higher yield of keeved juice. However, if there is a risk of the cap sinking or it looks like it is starting to sink, or a runaway ferment is beginning to occur, rack the juice immediately.

At this stage, the Initial Cap and mold dots compressed and became fully supported by the floating cap of Lees.



4" (10cm)

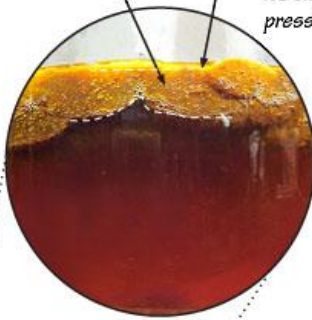
Cool-Down to: 42° F (5° C)

At this point I noticed the large gas bubbles forming indicating an exponential increase in ferment activity. To avoid this increasing ferment rate from blowing the cap apart contaminating and ruining the juice, I returnd the carboy to the pre-cooled refrigerator to cool the juce back to 42° F (5° C) and provide more time for the cap to compress and maximize juice yield.

COMPRESSED

With the juice cooled back to 42° F (5° C), the fermentation was retarded giving the cap enough floa-time to fully compress with a minimal risk of a run-away ferment that would blowthe cap apart.

Note how thin even the Initial Cap became with its thicker particles from pressing.



2" (5cm)

Supurb Keeved Juice



<http://www.cider.org.uk/keeving.html>

Fermentation: From Juice → Alcohol

- Yeast Fermentation and Management
 - Native fermentation (wild yeast) vs. commercial yeast strain inoculation
 - Yeast need oxygen for a healthy fermentation
 - Temperature controlled fermentation
 - Dry vs. sweet stylistic decisions during fermentation
 - Secondary (malolactic) fermentation

Production of Sweet Hard Ciders

- Production Methods

1. Keiving Process
2. Multiple Rackings
3. Chilling & Filtration
4. Pasteurization
5. Addition of Sugar or Artificial Sweeteners

	Dry	Medium	Sweet
Residual Sugar (g/L)	0 – 9	9 – 40	>40
Residual Sugar (%)	0 – 0.9	0.9 – 4	>4

Adapted from: The New Cider Maker's Handbook, 2013

- Sweetness Guidelines

- Beer Judge Certification Program
- Quebec Cider Regulations
- French categories: Brut, Demi-sec, Doux

Use of Oak with Hard Cider

- Use of barrels
 - Difficult to clean & sanitize
 - May allow use of spontaneous fermentations (both primary & secondary)
 - Adds tannin & mouthfeel
 - Aging & oak flavor integration
 - Watch ullage
- Use of oak chips (dosage: 160 g/5 gal)
 - Oak flavor integration
 - Less expensive than barrels

Stabilization of Hard Cider

- Microbiological Stabilization
 - Sulfur Dioxide
 - Addition is based on pH
 - Ideal: 0.85 ppm molecular SO₂ addition
 - Potassium Sorbate (aka “Sorbate”)
 - Maximum dosage allowed in hard cider: 275 ppm of potassium sorbate (200 ppm of sorbic acid)
 - Used in sweet ciders, if used at all
 - Flavor association & degradation
 - Sterile Filtration
 - If done properly, do not need a sorbate addition
 - Test filtration protocols

Stabilization of Hard Cider

- Hazes: try to prevent by properly treating juice pre-fermentation
- Fining agents to treat hazes
 - Pectin: add double dose of pectic enzymes
 - Protein
 - Bentonite
 - Sparkoloid
 - Others...
- Haze may need identified by a certified lab

Stabilization of Hard Cider

- Problematic Ciders – Faults Found in Ciders:
 - Hydrogen sulfide (H_2S)
 - *Brettanomyces*
 - Mousiness
 - Volatile Acidity
 - Oxidation



Additional Production Resources

- US Association for Cider Makers: <http://www.ciderassociation.org/>
- Cider & Perry Academy: <http://www.cider-academy.co.uk/> (Cornell & Washington Production Courses, annually)
- Wittenham Hill Cider Pages: <http://www.cider.org.uk>
- Penn State Wine Quality Improvement Short Course (Defect Identification & Remediation, annually in January): <http://www.cvent.com/d/z4qvqn>
- Hard Cider Production at Virginia Tech: <http://www.arec.vaes.vt.edu/alson-h-smith/treefruit/horticulture/hard-cider/>
- Hard Cider Production & Orchard Mgmt. in the Pacific Northwest: <https://pubs.wsu.edu/ItemDetail.aspx?ReturnTo=0&ProductID=15402>
- Fermentation Protocols for Washington State University: <http://extension.wsu.edu/maritimefruit/Documents/CiderFermentationProtocol2013.pdf>
- Cider Juice Protocol from Washington State University: <http://extension.wsu.edu/maritimefruit/Documents/CiderJuiceProtocol2013.pdf>
- Scott Labs Hard Cider Fermentation Protocol: <http://scottlab.com/uploads/documents/downloads/330/Cider.Perry%20Protocol.pdf>
- Scott Labs Hard Cider Handbook: <http://www.scottlab.com/pdf/2014CiderHandbook.pdf>
- The New Cider Maker's Handbook by Claude Jolicoeur (ISBN: 9781603584739)

Companies that Source Hard Cider Supplies in the Mid-Atlantic

- cidersupply.com
- Aftek (aftekfilters.com)
- ARS (arsenterprises.com)
- BSG
(beveragesupplygroup.com)
- Enartis Vinquiry
(enartisvinquiry.com)
- G&D (gdchillers.com)
- Kaufman Container Co.
(kaufmancontainer.com)
- Laboratoires Standa
(www.standa-fr.com)
- Oesco (oescoinc.com)
- Scott Labs (scottlab.com)
- Vin Table (vintable.com)
- Wine Tapa (winetapa.com)

Questions?

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