Commercial Production of Unpasteurized and Fermented Ciders in Vermont

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Note: This guide was produced in Fall 2010 to fulfill requirements in an independent study course I was enrolled in as part of my M.S. program at the University of Vermont. While I stand by the information as it was relevant at the time of publication, this was not meant to be a regulatory guidance document. Since the time of this writing, several food safety laws, including and particularly the Food Safety Modernization Act, have been implemented in the U.S. which must be understood and considered when planning and operating a juice processing operation.

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Table of Contents

Apple cider is an iconic drink in New England, and an important component to orchard businesses in Vermont. Many orchards either have cider operations included in their offerings, or did in the past; some growers may be considering setting up new mills, and yet other entrepreneurs show interest in establishing independent mills. Sweet and fermented (hard) ciders represent a growing market opportunity with diverse product choices and development (Rowles 2000). With increased interest in cider production in Vermont, mill operators require guidance on setting up a safe mill that meets state and federal requirements while meeting basic safety standards to avoid public health implications.

Note: for this guide the terms 'cider', 'fresh cider', and 'sweet cider' are used interchangeably to refer to non-fermented, minimally processed juice from apples. 'Hard cider' or 'fermented cider' will designate apple juice that has undergone yeast fermentation and includes significant alcohol content.

Why Cidermakers Need to Focus on Safety

Apple cider has had a long history, particularly in Northern Europe and New England, and is a common part of farming traditions in rural areas. Cider has been identified as a wholesome, family drink, served primarily to children (Demong 1998). While it is true that cider has been consumed for decades without establishing a significant negative image from prevalent food safety concerns, illness outbreaks have occurred recently and have driven industry and government regulation of the production methods used by growers and processors.

Food-borne illness is a serious problem in the United States, responsible for 76 million cases, 325,000 hospitalizations annually according to a 1999 study (Mead, Slutsker et al. 1999), with evidence of continued cases to the present day (U.S. Centers for Disease Control 2010; U.S. Centers for Disease Control 2010). Fresh produce has become increasingly of concern as a source of infections, with fresh apple cider implicated in multiple outbreaks of food-borne illness in the United States. Contamination of juices with infectious organisms including *Salmonella, Cryptosporidium,* and *E. coli* has led to recent illness outbreaks, including an infamous case in 1996 where *E. coli* 0157:H7 contaminated juice sickened scores of persons in the western U.S. and killed one child in Colorado (Vojdani, Beuchat et al. 2008). For details on specific the causal organisms implicated in cider food borne illness outbreaks, see Appendix B.

In response to concern over food-borne illness cases in fresh juices, the U.S. Food and Drug Administration in 2001 enacted their juice rule after an extensive comment period (U.S. Food and Drug Administration 2001). Known to many as the 'pasteurization rule', this new regulation affects production and sale of all fruit juices in the United States, including both inter- and intra-state sales. In response to both consumer and farmer commentary on the rule, there was written an exemption from some portions for small retail farms, however some parts of the rule and other federal and state rules still apply for such operations. This guide seeks to explain what regulations a small cider processor must comply with and offers advice on mill setup and operation.

The FDA Juice Rule

The 2001 FDA 'Juice Rule', *Hazard Analysis and Critical Control Point (HACCP); Procedures for the Safe and Sanitary Processing and Importing of Juice*, 66 FR 6137, applies to all processors of juices in the United States (U.S. Food and Drug Administration 2001). The bulk of the rule addresses the HACCP procedure, which is a systematic analysis of potential hazards and associated correction processes for food processors. The hazard analysis is a process of collecting and evaluating information on hazards associated with juice, to determine which hazards are reasonably likely to occur and, thus, should be addressed in a HACCP plan.

A HACCP-directed juice processor is required to produce, for each type of juice processed, a written hazard analysis to determine whether there are food hazards that are reasonably likely to occur and to identify measures to apply to control those hazards. Under US FDA HACCP regulations, the processor is required to perform a 'kill step' under critical control point for the biological hazards. This includes, at the time of this writing, one of two FDA-approved methods, heat pasteurization or ultraviolet (UV) treatment. In order to fulfill FDA requirements, the kill-step equipment must include the following features; 1) automatic real-time temperature or UV-dose recorders with data loggers and paper confirmation output, 2) automatic diversion of product out of the processing stream, either back through the intake of the unit or to the supply tank to be reprocessed or dumped. Units must be calibrated by a third-party at least annually and maintained in original working order. Homemade equipment that does not meet these requirements does not conform to the regulations, nor does canning or otherwise preserving the juice unless the recording and rejection requirements are met.

Wholesale marketing of cider includes *any* sales of juice through a third-party other than the processor. This includes sales to other farm stands other than those owned by the cider mill owner, sales to grocery, convenience, or other stores including restaurants, and sales by the cider mill owner when they are operating as an agent for another business, i.e. if hired by another independent farmstand or other retailer to staff sales. Mills that process fruit they do not own, such as custom pressing for separate orchard, are considered wholesalers and must comply with the HACCP and kill-step treatment provisions of the rule. Information on developing and implementing HACCP procedures for juice operations can be found at the U.S. FDA HACCP Page: http://www.fda.gov/Food/FoodSafety/HazardAnalysisCriticalControlPointsHACCP/default.htm as well as the Penn State University Juice HACCP page: http://extension.psu.edu/food-safety/courses/information/juice-haccp-resources .

Retail Cider Operations

Retail operations, such as orchards that sell cider as a component to their on-farm business, that do not sell *any* juice through a third-party, are exempt from the HACCP provisions of the Juiced Rule, including the kill step (pasteurization or UV) requirement. There are other portions of the Rule that apply to these processors, as well as other Federal and State laws. Furthermore, self-regulation is recommended for areas where such rules are not legislated. Some retail operations may choose to implement HACCP, including kill step processing, to improve product shelf life and safety. *This guide is intended to help* *retail cider mill operators comply with pertinent regulations and food safety standards.*

Vermont Regulation of Cider Mills

A 1997 resolution passed by the Vermont House and Senate in response to potential regulations from the FDA, which developed into the Juice Rule, provided support for sound self-regulation of cider processors, and recommended against mandatory pasteurization requirements (Vermont House of Representatives 1/24/1997; Vermont Senate 1/29/1997). This non-binding resolution did not replace Federal regulations for cider operations, nor did it exempt mills from developing scientifically-sound food safety plans. Given the implications of an illness outbreak, the Vermont Department of Health and FDA still maintain authority to intervene in all cider mill operations in the event of a potential public health threat posed by cider mills and other food processors.

The Vermont Agency of Agriculture has not established regulations for cider mills beyond those required by the FDA. As a food processing facility, cider mills that generate gross sales in excess of $10,000 annually are subject to licensing and inspection by the Vermont Department of Health. It is important to note that gross sales include all processed products including pies, apple sauce, and other such products (Burns 11/10/2010).

The Vermont Department of Health regulates cider mills and other food processors under the 'Health Regulations for Food Service Establishments' (Vermont Department of Health 2005) These regulations are modeled after the 2001 Federal Food Code, with updates from 2003. The Federal Food Code for retail establishments (U.S. Food and Drug Administration 2010) is a list of standards developed by the FDA to address food safety and sanitation in food processing facilities.

Other State Regulations

States other than Vermont have adopted different policies in regards to cider mill regulation in light of new FDA rules. New York, for example, has a similar regulation model as Vermont, but now requires that all cider, whether sold wholesale or retail, be treated by thermal pasteurization or UV light (Adzahan, Worobo et al. 2005). Michigan, on the other hand, continues to allow retail sales of non-treated ciders, but institutes a set of formal regulations specifically addressing cider mill plant setup and operation (Michigan Department of Agriculture 2006). Cider sold in Michigan must be produced by an operator trained under an accredited Food Safety for Cider Makers course, offered by the Michigan Department of Agriculture (http://www.michiganappleassociation.com/OnlineCourses.aspx). This course is available to non-Michigan cider makers, and Vermont operators should strongly consider completing it.

Juice Rule Requirements for Retail Cider Mills

Juice that is not treated through pasteurization or UV processing under the retail exemption must be expressly labeled with the following language: "This product has not been pasteurized and, therefore, may contain harmful bacteria that can cause serious illness in children, the elderly, and persons with weakened immune systems." The labels must be included conspicuously on the front of the package, and pre-made labels can be purchased from many cider mill supply companies. Labeling of juice is regarded as customer education, similar to warnings found on meat, eggs, and shellfish, in that it warns the consumer of potential safety problems with the product and allows them the choice to consume or not. Simply labeling the product however in no way absolves the liability of the cider mill from a food safety standpoint, and does not replace use of good sanitary practices. Many Vermont consumers prefer unpasteurized cider over treated juice, and as such the warning label may be a marketing tool for some producers.

CFR - Code of Federal Regulations Title 21

The Code of Federal Regulations is the complete listing of applicable laws in the U.S. Title 21 that Manufacturing Practice in Manufacturing, Packing, or Holding Human Food, and Part 120 addresses HACCP requirements for food establishments. These rules apply to food sold over state lines. (U.S. Food and Drug Administration)

Insurance Requirements

All processors of food products, whether or not they operate under a HACCP or retail exemption system, must consider the insurance product requirements for their operation. Facilities open to the public will require general liability insurance, which covers for claims made against general access and use considerations on the property. Producers of farm products should also carry product liability insurance which covers for claims made against product safety or quality, a primary concern for cider processors. Another type of insurance to consider is business interruption coverage, which would cover against lost income in the event of an interruption in normal operation of the business from product recall, damage to the facility, or other reasons. Finally, fruit growers may wish to consider enrolling in crop insurance coverage which covers losses due to crop damage or volume loss from weather or other production events. Crop insurance information is available through the University of Vermont Crop Insurance web page (http://agrisk.blog.uvm.edu/). Other coverage should be discussed with a commercial insurance broker that specializes in farm or business needs.

Relevance to HACCP Plan and SSOPs

If any hazard is determined "reasonably likely to occur" in a particular juice product, that hazard should be addressed in a food safety plan for the product by applying control measures as part of a properly designed and implemented HACCP plan, except that some hazards for which you could reach this conclusion may be controlled under your Standard Sanitary Operating Procedures (SSOPs). SSOPs are the written training and processing procedures which are routinely followed in the processing of juice products in a particular mill. These procedures cover plant design, fruit sourcing, mill sanitation and operation, and product handling. For a HACCP-exempt plant which does not treat juice through pasteurization or ultraviolet technology, SSOPs represent the primary method of minimizing food-borne pathogens in the juice. Included in SSOPs is a detailed recordkeeping system to track compliance with the program. A HACCP-exempt cider mill should carefully and systematically go through the entire facility including fruit and supply sourcing, plant layout and operation, bottling, storage, and sales of juice, and address each component in light of the food safety rules addressed below. Each procedure should be clearly and succinctly written on a laminated sheet held near the equipment or process concerned, and a set of records developed to document compliance. See

Appendices C and D for sample SSOPs and record forms.

Specific Requirements for Cider Operators in Vermont

Growers and cider makers who operate under the retail exemption must comply with the following list of items, as collated from the Federal Food Code, the FDA Juice Rule, and recommendations from Michigan Department of Agriculture. The following guidelines are summarized in the *Unpasteurized Apple Cider Processing Guidelines And Generic HACCP Plan* from the Maine Department of Agriculture (Maine Department of Agriculture Food and Rural Resources *unknown*) and have been adapted for this publication. An important distinction exists in the wording of these rules, where *must* or *shall* indicate actions that a processor is required to do, while *should* indicates an optional but strongly recommended tactic.

Orchard Management

Good Agricultural Practices

Cider mill operators must ensure that raw materials (apples) used for juice are produced in a safe manner. Many cider mills are associated with an orchard, so the grower and processor are the same business. Whether independent or part of another business, orchard production practices must follow food safe guidelines and documentation of safe practices must be kept by the grower and cider processor. Many orchards have adopted formal Good Agricultural Practices (GAPs) in recent years to address food safety issues associated with their products. Growers should consider adoption of a GAP program, which formalizes many production and safety practices which reduce food safety risk. Extensive information on GAPs standards and compliance can be found at the Vermont Vegetable and Berry Association Food Safety web page: http://www.uvm.edu/vtvegandberry/foodlinks.html.

A primary means for introduction of foodborne pathogens into orchards is via animal waste (domestic and/or wild). As much as possible, a means of excluding domestic and wild animals from the orchard should be used (i.e. fencing). Where bird roosting is a problem, a means should be used to scare and prevent birds from roosting and soiling the fruit. To reduce the risk of foodborne illness, neither animal manure nor human waste should be used in an orchard. Research on pathogen survival in manure treatments and on assessing the risk of cross-contamination of food crops from manure under varying conditions is largely just beginning. Composting and other treatments may reduce but may not eliminate pathogens in manure. The best defense is to develop a keen awareness of potential manure entry pathways into the production system, and develop means of avoidance.

Water used to dilute pesticides and irrigate orchards should be of an acceptable microbiological quality. This water can be a source of microbiological contamination, therefore growers should be aware of conditions that make the water source more susceptible to microbiological contaminants and follow control practices to ensure that water quality is sufficient for its intended use. The grower should maintain records of pesticide and fertilizer applications.

Harvesting Practices

Sound ripe fruit should be picked and placed into clean bins suitable for transportation directly to a storage facility, sorting station or juice/cider plant, as appropriate. Adequate training and supervision should be provided to ensure fruit is undamaged. Pickers must be free from communicable diseases (diseases which can be passed on to humans) and trained to practice personal hygiene and must be provided with adequate washroom facilities including a means to wash and dry hands. Employees having boils, open cuts or wounds must not handle food or food contact surfaces unless the injury is completely protected by a secure waterproof covering (e.g.., rubber gloves).

Dropped fruit should not be used for unpasteurized apple cider. While not expressly prohibited from using dropped fruit for cidermaking in Vermont, cider mill operators must understand that contact of fruit with the ground greatly increases chances for biological contamination (Uljas and Ingham 2000). This contamination can carry over to the juice product and/or build up on processing equipment and contaminate future products. Diseased, rotten fruit, fruit with damaged skin (with flesh exposed) and fruit with dirt or animal/bird excrement must be rejected during fruit inloading as well as during mill operation.

Rotten fruit should be removed before storage since some molds produce patulin, a toxic fungal metabolite; wholesome fruit for pressing should be kept in clean, dry bins. Runners on full fruit bins must be inspected and cleaned of soil contamination before stacking. Fruit bins should be labeled or coded to show orchard location, picking date and picking crew. Records must be kept for all orchard, harvest, and shipping procedures.

Intermediate Operations

Transportation Practices

All potential sources of fecal contamination of bins and fruit must be minimized during handling and transport. If possible picking boxes or bins should be loaded on a trailer or bin carrier, rather than directly on the orchard floor. Workers handling fruit must practice good hygiene and vehicles used for transportation should be clean. Care should also be taken to avoid physical damage to the fruit.

Fruit Storage Practices

Ideally, fruit should be pressed as soon as possible after picking to avoid increases of pH that would favor growth of pathogens during storage. The lower the pH, the worse the conditions will be for the growth and survival of pathogens. Low fruit pH cannot be relied on solely as a control measure against target organisms, because *E. coli* 0157:H7 is especially tolerant of acidic conditions (Miller and Kaspar 1994). However, if fruit needs to be stored, rapid cooling to as close to 32° F as possible (32° to 41°F) and achievement of adequate storage conditions will assist in maintaining fruit condition. Storage facilities must be clean, secure from rodents and insects and suitable for storing food.

Fruit should be handled as gently as possible; every effort should be made to minimize physical damage at all stages of post-harvest handling prior to pressing. After removal from cold storage, fruit should be pressed as soon as possible.

Fruit Sorting

Fruit should be inspected in a clean, dry, well-lit environment by workers who have been trained in inspection and personal hygiene. Only sound whole fruit should be used. Decayed, wormy, damaged (with flesh exposed), soiled (excrement) fruit should be culled to prevent contamination of juice/cider. Fruit sorting should be carried out dry to prevent cross contamination from such culls.

Fruit Cleaning

All fruit should be subjected to effective washing, brushing and rinsing procedures that are adequate to remove any field contamination that may exist. Included in the washing may be a food grade sanitizer such as chlorine, acetic acid, or peroxide that is specifically labeled for such use. Sanitizers should be rinsed from the fruit unless otherwise instructed by the manufacturer's directions. Sanitizer levels should be monitored at appropriate intervals and recorded.

Water supplies for fruit cleaning must be potable. Well water must be checked annually for microbiological quality and safety no more than 60 days prior to the start of the season. Records of potable water quality checks must be kept. Flume, wash and rinse water should not be recycled without first effectively being disinfected with a labeled food-grade sanitizing agent. Wash water should be at least 10° F warmer than the fruit to be pressed otherwise, microbial contaminants present in the wash water could be drawn into the flesh of the fruit (Burnett, Chen et al. 2000).

Fruit Inspection

On arrival at the processing facility, fruit should be inspected for quality. The processor should specify the maximum proportion of supplied fruit which can have any sign of spoilage, taking into account the capability of the processor to remove rotting fruit during pre-processing inspection. If this proportion is exceeded, the whole consignment should be rejected. Fruit being received should be accompanied by information on the orchard location, picking date and picking crew. Records should be kept to relate this information to the juice/cider container code.

Processing apples, in cold storage, should be kept as close to 32°F as possible (32° to 41° F).

Processing apples in controlled atmosphere (CA) storage should be kept at the recommended atmosphere and temperature for the variety.

Fruit Processing

The pressing, filling and sealing area must be enclosed, clean, well-lit, dry, well ventilated, and screened to keep out pests. This area should be separate from the area where the fruit is sorted and washed to reduce the risk of cross-contamination.

Filter cloths must be specifically designed for this purpose, made of durable materials and replaced frequently. Filter cloths and press racks must be washed, rinsed, sanitized and dried after each day's operation in a screened well-ventilated area. They must be kept at least six inches off the floor in a clean place when not in use.

All tubing carrying juice/cider must be transparent and approved for food use. It should be as continuous as possible with couplings kept to a minimum. It should be kept away from the floor and any drains. Tubing and couplings must be cleaned, rinsed and sanitized at least after each day's run. Sanitizers should be rinsed from the tubing unless otherwise instructed by the manufacturer's directions. Flexible tubing must be stored in a self-draining position.

Custom processors should clean and sanitize presses between batches.

Sodium benzoate may be effective against low microbial loads at low pH. If used, it should be added immediately after pressing, according to the manufacturer's directions, and in accordance with the manufacturer's recommendation in accordance with good manufacturing practices allowed by the Food and Drug Administration.

Packaging

The apple cider should be dispensed into containers which are new, non-porous, non-corrosive, made of food grade materials and should be cleaned and inverted prior to use. New caps must be used. Glass containers may be reused if they have been properly cleaned, sanitized and rinsed prior to reuse. Extra care must be taken when using glass containers including documented control measures to prevent potential glass breakage and adulteration of the juice with dangerous shards. Reusable raw product bulk containers must be cleaned, sanitized and rinsed prior to reusing. All unpasteurized juice/cider must immediately be refrigerated (between 32° to 41° F) or frozen (less than 0° F) and should be held at those temperatures until ready to consume. Refrigeration and freezing units should be properly maintained on a regular basis and must be equipped with thermometers that are easy to read.

Labeling

Juice that is not treated through pasteurization or UV processing under the retail exemption must be expressly labeled with the following language: "This product has not been pasteurized and, therefore, may contain harmful bacteria that can cause serious illness in children, the elderly, and persons with weakened immune systems." The labels must be included conspicuously on the front of the package, and pre-made labels can be purchased from many cider mill supply companies. Labeling of juice is regarded as customer education, similar to warnings found on meat, eggs, and shellfish, in that it warns the consumer of potential safety problems with the product and allows them the choice to consume or not. Simply labeling the product however in no way absolves the liability of the cider mill from a food safety standpoint, and does not replace use of good sanitary practices.

Records

Records must be available and be supplied on demand as evidence to establish food safety. These records should be legible, permanent, accurate and be signed and dated by the individual(s) responsible. They should include procedures, controls, limits, and subsequent follow-up documents. They must be retained for at least one year after the expiration of the durable life date (best used before date) or, for frozen juice/cider, at least two years after the food has been released to the consumer.

Necessary records should include fruit sources, water analysis checks, food additives, consumer complaints, sanitation checks, pest control monitoring, lot codes, production volumes, storage temperature monitoring and product distribution.

Recalls

Every processor should maintain an effective system of control so that they are able to notify all their affected customers to quickly recall any product posing a health risk. The Department (and the Food and Drug Administration if involved in interstate sales) must be notified of all health recalls.

Apple Cider Storing and Retailing

Containers of unpasteurized apple cider should be stored or displayed in a clean, dry place, appropriate for food, at the appropriate refrigeration or freezing temperatures (as above). Any badly dented, cracked or leaking containers should be immediately disposed of. The shelf life date (best used before date) on juice/cider containers must be respected. All apple cider should be marketed in a prompt first-in first-out manner.

Processing Facilities and Operations

Premises

The juice/cider processing facility must be thoroughly cleaned and sanitized before seasonal startup. The sanitation must be maintained during the processing season and should be according to a written sanitation program. Records must be kept of sanitation steps taken before and after juice processing.

Animals (domestic and pests) must be excluded from the processing facility and surrounding area. The processing facility must be adequately screened to eliminate insect and rodent entry. A written pest control program should be followed and the results recorded.

Floors should be smooth, non-porous, impervious to water and properly drained. Floor drains must discharge into an approved septic or other wastewater system. Walls, doors and ceilings should be smooth, non-porous, non-chipping and impervious to water. Doors should be close fitting, and self-closing where appropriate.

Lighting in the pressing and filling areas must be adequate. Light bulbs and fixtures should be protected to prevent contamination of the juice/cider with glass shards in case of breakage. The sewage system and garbage storage/removal must meet all of the requirements of the regulatory authorities having jurisdiction.

Equipment

Equipment should be made of stainless steel as it is easier to clean, sanitize and maintain than equipment made from other materials. Other satisfactory materials for food contact surfaces included laminates, plastics, or wood treated with a food-grade sealer such as paraffin wax. Galvanized buckets, pipes or sheeting should not be used. Equipment that comes into contact with fruit juice/cider should not be made of a material that could lead to undesirable or unacceptable migration or leaching of chemicals into juice/cider, for example, brass equipment should not be used since the acidity of the juice/cider could leach the copper out of the brass.

All equipment and utensils used in the processing and filling of juice/cider must be cleaned, rinsed and sanitized at least daily (post operation) according to a written sanitation program. Sanitizers must be used according to manufacturer's directions. For best results, sometimes two different sanitizers may be alternated. Sanitizers should be rinsed from the equipment and utensils unless otherwise instructed by the manufacturer's directions. Equipment must be visually inspected to determine adequacy of cleaning and a record should be kept.

Water Supply

Water used in processing establishments must be potable unless it is used solely for fire protection or auxiliary services and there must be no connection between the system for that water and the system for potable water. Pressurized hot and cold water must be available in the production facility in sufficient quantity for cleaning and other uses. Water that does not come from a public water system must be tested by an independent laboratory for potability annually, and no longer than sixty days prior to commencement of processing activities for a given season.

Personnel Hygiene

All workers must be free from communicable diseases. They should be trained not only for their task, but also to keep the premises clean and to practice good personal hygiene. Written requirements for personal hygiene should be available. Workers must have ready access to clean washrooms and proper hand washing (hot water and soap) facilities with disposable towels and closed trash containers. All persons must wash their hands upon entering food handling areas, before starting work, after handling contaminated materials, after breaks, and after using toilet facilities. Where necessary to minimize microbiological contamination, employees should use disinfectant hand dips. Use of sanitizing lotions or dips does not replace proper hand washing facilities and practice. Washroom facilities must be provided with proper signage to remind workers to wash hands. Washrooms must be segregated from production and storage areas.

Employees having open cuts or wounds must not handle food or food contact surfaces unless the injury is completely protected by a secure waterproof covering (e.g.., rubber gloves). All persons entering food handling areas should remove jewelry and other objects which may fall into or otherwise contaminate food. Protective clothing, hair covering, footwear and/or gloves, appropriate to the operation in which the employee is engaged should be worn and maintained in a sanitary manner. Any behavior which could result in contamination of food, such as eating, use of tobacco, chewing gum, or unhygienic practices such as spitting are prohibited in food handling areas.

Developing the Food Safety Plan for a Retail Cider Mill in Vermont

Cider mill sanitation procedures can reduce microbial load in finished juice by a factor of 2-log, but pathogens can of concern can also become established on surfaces of processing equipment despite those control measures (Keller, Merker et al. 2002). SSOPs for harvest, storage, and fruit sorting significantly reduce microflora in apples and processed cider (Keller, Chirtel et al. 2004), so a combination of thoughtful and sanitary plant design, operation, ingredient and material management, and storage and shipping comprise the food safety plan for small, non-HACCP cider mills. Each operation must develop a specific food safety plan tailored to their facilities and processes; there is no generic, one-size-fits-all solution.

The best method for developing your individual plan will begin with a flow chart of all operations in the process stream, from harvest to selling the finished jug of cider. At each step in the process, the cidermaker will need to consider potential hazards and entry points, and address those in an SSOP. For example, fruit coming onto the loading dock in bins may be contaminated with soil from the forklift tines or above bin during field stacking. An SSOP for this might include use of bin trailers in the orchard so bins do not rest on the ground or a chlorinated fruit wash when bins are dumped. It is helpful to have a third-party that is not familiar with the operation help assess the product flow, in order to catch processes that the operator may take for granted. The plan should be clear but detailed, without extraneous detail but with logical facility layout and clear procedures the end result. Each SSOP should have a standardized documentation record that can easily be completed and filed for each shift in the facility. Some example SSOP's and records can be found in Appendices C and D.

Because the non-pasteurizing cider operation rely solely on this analysis and resulting procedures to ensure food safety, due diligence and commitment to process quality and improvement are critical. Cider mill operators should continually seek to find ways to improve their food safety program. Often, doing do makes the mill more efficient and cost-effective.

Appendix A. Fermented Cider Production in Vermont

Fermented cider or wine productions present a unique opportunity for marketing diversification. Fermented cider production is different from fresh juice processing in many ways, but both require the operation of an efficient and clean milling system, so the above considerations should apply. Because fermented cider contains significant alcohol, it enters a new realm of state, federal, and local regulation that go beyond the scope of this document. General regulatory and production guidelines are included in the guide 'Making & Marketing Vermont Ice Cider' (Leger 9/2010). This comprehensive publication describes general licensing requirements for wineries in Vermont, as well as detailed production methods to make ice cider. Ice cider, developed in Quebec, is made by fermenting highly concentrated apple juice that has been subject to freezing and partial thawing to remove substantial amounts of water. Because ice ciders must be frozen naturally by outdoor weather conditions, it can only be made in a limited area subject to winters of sufficient cold and length, yet with a reasonable local apple industry.

Standard fermented cider is an historic beverage in Vermont and New England, with production and marketing of craft ciders increasing in recent years (Rowles 2000; Mainville and Peterson 2005; Trechter, Hadley et al. 2008). The basic information on cider making presented here was originally published at http://www.lostmeadowvt.com/cider.htm (Bradshaw 2010)

This section is not a definitive tutorial on fermented cider and its making. Anyone looking for a basic yet very thorough primer on cidermaking should visit the excellent Wittenhan Hill Cider Portal, a British site maintained by Andrew Lea. There is also an email list, Cider Digest, where cidermakers can share and acquire knowledge on the subject. Two commonly used books on cidermaking include:

Proulx, Annie and Lew Nichols. *Cider: Making, Using, and Enjoying Sweet & Hard Cider. 2nd Edition.* Pownal, VT: Storey Publishing, 1997.

Watson, Ben. *Cider Hard and Sweet: History, Traditions, and Making Your Own.* Woodstock, VT: Countryman Press, 1999.

Facility Design for the Cider Making

A cider making facility will require the same considerations for design and sanitation as a fresh juice operation. This includes cleanable walls, floors, and ceilings, with sloped floors and drains anywhere wet processing or cleaning will occur. Beyond the juicing facility, whose general needs are described above, there are another set of basic spaces that are needed for fermenting operations. Some of these considerations assist in keeping spoilage organisms down to a minimum population, while others are designed to meet federal and state regulations for segregation of product and inventory management.

The fermenting room should be conveniently accessible to the pressing facility, and have access to loading facilities. This space will either require temperature control for the whole room, or possibly a cooling system integrated into jacketed fermenters which allow for pumping of cooled glycol solution through them. Fermenters should be elevated enough to drain all contents when emptying. Floor drains must be tied into an approved wastewater system. All outlets should have waterproof connections and all surfaces be washable. Access to running hot and cold water is necessary.

The bottling space may be in the same room or separate from the fermenting room. Again, this space needs to be fully cleanable. Consideration should be made for dry bottle and case storage to avoid soaking boxes and labeled bottles during cleaning. Bottles ciders to be sold must be stored in a secure space and inventory tracked for taxation and reporting requirements.

Craft Ciders for the Small-Scale Producer

'Hard' cider in northern New England has taken on two very different meanings, sometimes referring to a substandard product. The first refers to the New England farmhouse cider tradition which has waned in the past century. As we lost our farmhouse orchards and neighborhood mills we lost the knowledge and infrastructure to continue to make great farmhouse ciders. Some home producers who carried on continue to use questionable equipment and poor apples gleaned from commercial orchard culls or drops. Much of the lore behind this style of cider lives on only in oral tradition, where legend of potent products known for their headache potential lives on. Often this impression is spread by succeeding generations of people who have never tasted the product themselves. The myth behind the old cider tradition and its substandard product is a real impediment to finding appreciation of good craft ciders.

On the other hand the modern commercial ciders may offer a sweet, fizzy product often made from apple juice concentrates with substantial other ingredients. These ciders fill a market segment, and a very competitive one at that. Small cider mils and orchards will likely face difficulty in competing with these ciders due to economies of scale and market positioning problems.

Fermented *craft ciders*, those made from fresh-pressed juice, pose the most likely product category for the small-scale producer who already has access to orchard fruit and milling facilities. The ciders consist of the fermented juice of the apple, with relatively little addition of concentrates, water, or other flavorings. There are numerous techniques that can be used to develop styles of cider, which will be discussed.

Juice for Cider

It cannot be stated enough that good cider is made from good apples. While any fresh juice will ferment out into cider, some apples will make a better finished product than others. Typically a slow fermentation produces the best ciders. Fruit from well-fertilized orchards may have excess nutrients in their juice that allow for a rapid fermentation and reduced phenolic (flavor) development (Lea and Beech 1978). For this reason fruit from trees where nutrition, especially nitrogen, is not applied on excessive quantities may perform better than over-fertilized trees. That said, most commercial orchards do not tend to over-fertilize and juice from their fruit can make good ciders. Clean fruit are important to cidermaking as well. Because the apples are ground and squeezed we are not talking about cosmetics here, but rather crap in or on the fruit. Any rotting or severely bruised fruit should be discarded, because they often carry bacteria and other microflora that will reduce cider quality.

Fermented cider is not subject to the FDA Juice Rule requirements of HACCP and pasteurization treatment. Because the fermentation process itself is an effective means of reducing pathogen load and patulin contamination (Stinson, Osman et al. 1978; Semanchek and Golden 1996), there is less concern for traditional food safety considerations compared to fresh juice. Many microorganisms, however, can still affect cider quality and stability, so SSOPs and product stabilization should still be addressed in the production plan. A clean and food-grade milling operation are critical to making quality hard ciders, and in fact a mill that produces juices for both fresh and fermented use must maintain the full quality standards referenced above.

Apple Varieties for Hard Cider

There are numerous apple varieties that make good cider, and the variety can be very important based on the style you are looking for. Typical Vermont dessert apple varieties may be used for cider production, but their phenolic profile is fairly limited(Valois, Merwin et al. 2006). Consider that when fermenting the juice you are removing the sugars, so the underlying flavor profile behind the sweetness alone needs to stand on its own. That said, many good ciders are made from dessert fruit when well-blended and fermented. Many of the best ciders are made from blends rather than single varieties. Fruit can be grouped into sweet, aromatic, tart, and astringent and a general blend of those used for cidermaking. While sweet, tart, and aromatic apples are included in standard dessert varieties, it is the astringent part which is hard to find. This character refers to the tannin level of the fruit which helps develop mouthfeel and body in the cider. Think of the drying sensation of a cup of unsweetened tea, or a full-bodied red wine. Many cidermakers use wild or cultivated crabapples in their blends to get this flavor, maybe 5-10% of the total pressing.

Another entire class of fruit is the European cider apples from France, England, and Spain. These fruit are generally grown specifically for cidermaking, as they taste bad to horrible fresh off the tree. They are classified by tannin and acid content and tend to have high levels of fermentable sugars. While grown fairly extensively in their countries of origin, these fruit are fairly rare in North America. Growing interest in real ciders, both commercial and amateur, are creating an increased demand for these fruit which need to be tested in the locations they are being planted. Many nurseries now offer varieties of cider apples, and cider fruit can be sourced from some local Vermont and New Hampshire orchards. Fruit varieties and blends are one of the primary areas for experimentation amongst cidermakers.

Cider Styles

Like beer and wine, there are numerous 'styles' of cider, and divergent styles may not resemble one another at all. With the common denominator being that the base juice is fermented apple, there is a lot of leeway in technique, varieties, orchard conditions, and other ingredients that will produce different styles.

In 2008 the Beer Judge Certification Program, who develop guidelines for beer styles for home brewing competitions, redesigned their guidelines for cider competitions. The resulting guidelines reflect fairly accurately the styles of cider found worldwide. The full style guidelines can be found at: http://www.bjcp.org/2008styles/catdex.php

A summary of those guidelines for the major styles of cider includes:

Common Cider
This category would represent most ciders made

in North America. Common ciders are often made from culinary fruit or a mix of culinary and wild apples or crabapples. There is a wide range of ciders that would fit here, from sweeter to drier, pale yellow to amber. Aroma and flavor may range from strongly apple to estery/winey. Generally this is the 'default' category to put a cider in, unless the ingredients and techniques below are followed to put it in another style category. Two potential sub-categories include:

Farmhouse cider: These are ciders that are typically made from culled fruit from either commercial or old 'farmhouse' orchards. Generally these ciders are fermented to dryness, often from wild yeasts found on the cider mill or the press itself. Some can be pretty sharp, even acetic (smelling of vinegar), similar to harsh English scrumpy cider.

'Draught' cider: This was a standard category in the old BJCP guidelines, and reflected the prevalence of commercial ciders in the marketplace. Commercially these are made by addition of sugar to the juice to ferment out to 11-12% alcohol, watering the resulting base cider back to 4-5%, then back-sweetening with apple juice concentrate to develop a sweet-cider character. On a small scale these ciders can be imitated by fermenting to juice dryness and back-sweetening with a can of apple juice concentrate at the end of fermentation. These ciders need to be pasteurized or heavily treated with sulfites and sorbates to avoid refermentation in the bottle. The resulting ciders generally lack flavor complexity and body.

English Cider

Ciders made in the British style tend towards the drier side of sweetness, and in fact many are served completely dry. The real standout characteristic of these ciders is the presence of bitter tannins obtained from specific cider apples such as Dabinett, Kingston Black, Tremlett's Bitter, and Chisel Jersey. These tannic compounds along with sometimes wild fermentation strains can allow for some odd flavors compared to what many expect in a cider, with 'bacon', 'barnyard', and 'smoky' often used to describe them. English style ciders very well may not smell of apples at all, but then again there are many wines which do not suggest grapes in their flavor and aroma profiles. Many traditional English ciders may be too much for the typical American cider consumer. Ciders in this style may be improved by blending the juices from culinary and traditional cider apples makes for a more pleasant drink, as well as an easier to manage fermentation. Many of the English 'bittersweets' tend to be low in acid and prone to microbial infection; addition of some Liberty of Haralson juice will make the lot easier to manage.

French Cider

Considered by many to be the pinnacle of cidermaking, French-style ciders have a rich, full fruit flavor/aroma and profile, and always have residual sweetness. This is still achieved through keeving in the traditional production regions in the north of France and some parts of Britain, and an increasing number of North American cidermakers are successfully using this technique. The fruit profile of the cider develops from a combination of fermentation flavors and residual sweetness left over from an arrested fermentation. This technique goes completely against traditional winemaking thought where a strong, complete fermentation is usually preferred. Some cidermakers may use other techniques to mimic this style, including sterile filtration and chemical addition to stop fermentation. The defining characteristic of this type of cider is that residual sugars are not added, but rather result from the original sweetness in the apple. Fruit used typically include at least a portion of European bittersweet fruit, usually low in soluble nitrogen. Due to the lower alcohol levels and residual sugars in these ciders, microbial stability can be an issue, and producers should address this in their production SSOPs.

Ice Cider

This style originated in Quebec in the last twenty years. It is made by freezing pressed juice, or sometimes pressing whole frozen apples. After partial thawing, much of the water in the juice is left behind as ice crystals, with the resulting juice being very rich, syrupy, and sweet. This juice is then fermented and the fermentation is halted by increasing alcohol levels in the cider. One primary difference between ice ciders and French cider is alcohol content, the former being in the 8-12% range, the latter 3-6%. A complete production guide for making ice ciders is available here: Making & Marketing Vermont Ice Cider (Leger 9/2010)

New England Cider

Arguably the only distinct cider style to originate in the United States, New England are made from late-pressed fruit and ameliorated with sugars to increase their alcohol content and microbial stability. These ciders very often have unsulfited raisins added to the ferment which serve as a source of sugars, tannins, and yeasts. Typically a New England cider would be made in an oak whiskey cask, and may have a hint of that liquor in its final flavor profile. Modern cidermakers can imitate the oak cask by soaking oak chips in the fermenter. There are few commercial examples of this cider style, although it remains popular with home cidermakers.

Fermentation Basics

Alcoholic fermentation, in its simplest sense, is the conversion of sugar in a solution into alcohol and carbon dioxide by yeast metabolization. A cider fermentation is a simple process compared to beer brewing and winemaking.

Steps in Making a Basic Hard Cider

1. Start with fresh-pressed apple cider without preservatives. Most apple cider for hard cider should be a blend of varieties with a balance of sugar, acid, tannin, and aromatic components. Many cidermakers will ferment single-variety juices and blend after fermentation.
2. Test juice for original sugar content (specific gravity) with a hydrometer, and pH. Titratable acidity readings should also be collected at this time. Ideal pH of juice during fermentation should be between 3.0-3.6 to ensure yeast stability.
3. Fresh cider should be in clean containers- stainless steel is best; plastic tanks work well for initial fermentation. Glass carboys, available in 5-6 gallon sizes, work well for small trial batches or odd lots left over after racking (siphoning or pumping the fermented cider off the bed of dead yeast cells). At the onset of fermentation, space should be left at the top of the container to allow for normal frothing associated with yeast activity.
4. Depending on cider style or original sugar content, you may wish to add sugar before fermentation. To raise the specific gravity by 0.01 (or add ~1.5%

potential alcohol), add 5.7 ounces of sugar per gallon of juice. Do not expect this sugar to be there after fermentation. Unless something is done to stun the yeast, they will eat all of the sugar and leave you with a dry cider. Raisins, molasses or honey can also be added for sugar.

5. Juice should be treated with 50-150 ppm of sulfite based on initial pH. This initial sulfite dose will dissipate or become bound to organic compounds within 24 hours, and represents a minimum level for microbial safety in the juice. Modest sulfite additions at the pressing stage are the single most important step in making a problem-free cider. Information on sulfite formulations and additions can be found at: http://www.cider.org.uk/sulphite.html
6. Natural yeast in the juice may ferment the sugar to alcohol, but often tends to produce off-flavors and inconsistent results(Beech and Davenport 1970; Cabranes and Blanco 1996; Laplace, Apery et al. 1998; Morrissey, Davenport et al. 2004; Valles, Bedriñana et al. 2007). A selected white wine yeast is most often used in cider production. Typical yeasts include Pasteur Champagne, Epernay 2, and Cotes des Blancs. Each yeast strain may have different fermentation properties including temperature, nutrient, pH requirements and contribute different flavors to the finished cider. Yeast selection is an important area of experimentation for each cider maker.
7. Put air lock on container and keep cool, preferably 50-60 °F or as dictated by the selected yeast strain. Lower temperatures take longer for product to change from sugar to alcohol, but also help to maintain fruity aromas in the cider. Rapidly fluctuating temperatures should be avoided. It is important to eliminate air contact with the cider after fermentation has commenced.
8. After fermentation is complete the cider should be siphoned or pumped out of the container, into a waiting, clean vessel. Siphon with the hose or racking cane above the sediment layer in the fermenter. Take care to avoid splashing while racking.
9. After racking, top up the tank to exclude oxygen and store at 40 - 60F for proper aging for 6 months to 2 years. The cider may be racked as sediment falls but keep the container full and fitted with an airlock. Oxygen is cider's worst enemy!

The above outline will produce a basic, dry, farmhouse-style cider. Other techniques may be used to produce sweeter or carbonated ciders, typically through blending these base ciders and addition of sugars (back sweetening) and/or pressurized carbon dioxide gas. Any ciders that are not completely dry must be treated with pasteurization, chemical preservatives, or sterile filtration to ensure that fermentation does not continue in the bottle.

Advanced Processes in Cidermaking

As mentioned in the, a basic cider fermentation where juice is placed in the tank and fermented quickly with a solid yeast culture may often produce a cider with little fruit aroma and no residual sugars. This is especially true if the standard wine- and mead-maker's practice of adding yeast nutrients at the beginning of the ferment is followed. The best ciders, in my opinion, are made from the slowest fermentations. This philosophy goes against standard winemaking rules where fermentations may last a week or less, albeit with extended maturation times. A long, slow fermentation allows the cider to retain delicate fruit aromas. The way I see it is that if you can smell fruit aroma coming out of the airlock, as happens in a vigorous ferment, those aromas will not be left behind in the finished cider. Following are a number of techniques that can be used to improve a cider or give it certain desired (or undesired) characteristics.

Cold Fermentation

Ciders, like white wines, typically are meant to retain fruity esters and other compounds which give a note of freshness to the product. Fermenting at low temperatures encourages development of complex fruity esters and may allow for greater species diversity of fermenting microflora (Erten 2002). Typically ciders are fermented between 45-65°F. Facilities such as glycol cooling systems may be necessary to maintain these temperatures during the fermentation process.

Low Nutrient Juice

This was mentioned in the previous section on juice selection. Generally speaking juice from underfertilized trees may have lower natural levels of nutrients which yeasts may use to multiply and therefore reach a level where they can ferment the cider to completion. The sweet cider should have sufficient original starting sweetness (specific gravity 1.055 or higher) for one to rely on just this to leave residual sweetness in the cider. Typically a cidermaker looking for sweetness in the final cider who uses low nutrient juice would need to use other techniques as well. Low juice nitrogen levels can also contribute to off-flavors during fermentation, so experimentation and monitoring are important. Development of hydrogen sulfide compounds (rotten egg smell) especially appear to be related to low nutrient fermentations with certain yeast strains.

Multiple Rackings

Racking is simply the siphoning of fermenting juice off from the layer of spent yeast cells at the bottom of the fermenter. Yeast, like most living creatures, use carbohydrates as their energy source and nitrogen-bearing proteins for reproductive processes. When the initial yeast inocula reproduce at the beginning of a ferment, they tend to use up most of the free nitrogen in the solution. Each individual yeast will do its job eating a little sugar and producing a little alcohol and carbon dioxide, then it will naturally die off. The remaining yeast, as they reproduce, 'feed' off of the decaying dead yeasts, thereby recycling the nitrogen in the juice. If the juice is siphoned off of this layer of dead yeast cells several times during fermentation, the nitrogen load can be diminished, thereby keeping the total yeast population low and maintaining a slow ferment. Care must be taken during rackings to ensure that the cider is not oxygenated in the process. Siphons should be slow and splash-free. Sometimes a pressurized tank of carbon dioxide, argon, nitrogen, or a mixture of these inert gases will be used to purge any headspace or even the cider itself of any oxygen.

Cold Stabilization

After the cider has dramatically slowed or stopped fermentation, it can be transferred to a cold (28-32°F) location for a few days. This will 'shock' the yeast out of suspension, settling them onto the bottom of the fermenter from which they can be siphoned off.

Chemical Addition

There are two main chemicals used in cidermaking which help to manage fermentation, sulfite and sorbate. Sulfites are used to reduce populations of yeast and bacteria in the cider. When added at low levels at the start of the ferment, they can clean the juice of unwanted microflora while allowing sulfite-tolerant yeasts to build up in the juice. At higher levels they can 'strip' the juice of virtually all yeast, allowing you to add the cultured yeast of your choosing. Used only at the beginning of the ferment, there will be little to no remaining added sulfites at bottling time. Commercial cidermakers should test their products for free and total SO_2 and maintain levels at 25-35 ppm free and under 150 ppm total. Winemaking supply companies will stock necessary testing equipment for this. Sulfites are also used later in the process to prevent oxidation and to maintain a preservative effect in the cider. Finally, high levels of sulfite can halt an active ferment while there is still sugar left in the solution, particularly when combined with other techniques such as cold stabilization and filtering. Maximum sulfite use is regulated in finished ciders, so producers must know and follow current regulations. Ciders that will undergo malolactic fermentation (see below) should have no more than 35 ppm free sulfite during that process.

Sorbates are used to prevent regrowth of yeasts in sweet cider and wine. Sorbates will not stop a ferment on their own, and their use may lead to undesirable flavor changes in the cider. It is especially important to avoid sorbate use in coders that are or will undergo malolactic fermentation, because the bacteria that carry out that process will metabolize the chemical to produce a characteristic geranium odor.

Filtration

Filters are used at various stages of the cidermaking process to remove solids, yeasts, and even bacteria down to 0.5 microns in size. Filters must be sized and designed for a certain flow rate and maintained to ensure their effectiveness and safe use. Many filters have an integrated pumping system to push juice through at a certain pressure. Centrifugal or other non-displacement pump types should be used in these applications to minimize pressure buildup should a filter plug. Dangerous pressure can develop in a plugged filter system, and the facility design and SSOPs should address pump and pressure hazards posed to operators.

Filtration is generally performed based on a known pore size , as determined by the type of material to be removed. Most filters use interchangeable pads that can be adapted to the need at hand. Rough filters (3-5 microns) remove solids and bulk yeast suspension, and may be used in a two-stage process to feed into a tighter pore unit. Polish filters (1 micron) remove most yeast cells and hazes, but cannot be relied upon for sterile filtration of cider. So-called ‘sterile’ filters (0.5 micron) may remove most microorganisms from cider including bacteria, but they cannot be relied upon solely for stabilization unless rated as ‘absolute’ in design, which indicates that no cells below the filter rating will pass. Filtered ciders will easily pick up microorganisms downstream, so every surface must be scrupulously sanitized and product kept in a closed-system environment until the last cap or cork is driven home. Many cider makers follow filtering up with pasteurization or addition of sorbate to reduce buildup of spoilage organism in the bottle.

Pasteurization

Pasteurization is confused by new regulations applying to *sweet* cider which is sold wholesale in the U.S. Many people to whom I talk of cider think that the fermented type cannot be sold unless it is pasteurized. This is untrue, but many ciders, especially the fizzy, 'draft' six-pack type are pasteurized before or even during bottling. Pasteurization is the process of heating the cider for a sufficient time and temperature to kill any microorganisms that may referment or otherwise spoil the cider after packaging. Pasteurization is done on ciders with residual sweetness, and rarely is performed on dry ciders. The heating process, especially when residual sugars are present and done at excessive temperatures or for extended time, can produce a cooked or caramelized flavor in the final product.

Proper pasteurization may be performed with units used for sweet cider, but the machine must be calibrated for cider spoilage organisms. Any pasteurization process after treatment but before bottling must be performed under sterile conditions, as any microbe introduction will contaminate the treated cider. Successful in-bottle pasteurization, where filled and sealed bottles are immersed in a heated water bath, can be performed post-bottling if temperatures are carefully monitored. Care must be taken to ensure that the cider heats up enough for long enough to properly treat it without 'cooking' it. Another important item to be aware of is the potential for pressurized bottles to break with the heating.

Malo-Lactic Fermentation

Many ciders, like many wines, have a natural 'sharpness' or acidity that can be unbalanced by the end of fermentation and even maturation. Malo-lactic fermentation is a process where a type of bacteria, rather than yeast, is introduced to the cider either during or after fermentation. These *lactobacillus* bacteria convert malic acid, the primary acid component in apple juice, to lactic acid, which is significantly less 'sharp' in flavor. MLF occurs at warmer temperatures (50-60 deg F) than are often found in cold cider cellars, and often barrels of dry cider would 'reawaken' in spring when the room they were in warmed up. There are both natural and commercial/selected MLF strains available for use in wine and cidermaking. Not all ciders will benefit from MLF, but I have made some particularly sharp ciders which, after MLF, took on a very smooth, buttery flavor. Excess sulfite levels will inhibit MLF in wine and cider.

Carbonation

There are a number of ways to carbonate your cider, the first being to bottle-condition. This is done by fermenting the finished cider again in the sealed bottle. The carbon dioxide produced is trapped in the container and goes into solution. Care must be taken to use only strong bottles and closures which can take the pressure, up to 4 atmospheres, generated. People have been hurt before by exploding bottles, so SSOPs must be developed to protect workers from glass shards. One drawback to bottle conditioning is the yeast haze which will develop in the bottle. The traditional *methode champenoise* technique is used to remove yeast cakes from such bottled ciders, as well as traditional champagnes. The process is historic and labor-intensive but can develop desirable 'biscuity' flavors from contact with the yeast for an extended period.

Another system for carbonating ciders involves storing the cider in stainless steel tanks and either allowing the carbonation to develop naturally or adding it with pressurized CO_2. Transferring carbonated cider to a bottle would involve a counterpressure-filler which fills the bottle under pressure. Good bottles and closures are a must, as is good bottle sanitation and in the case of sweet ciders, a little sulfite/sorbate may be called for. One potential system would be a carbonating tank followed by sterile filter and counterpressure bottle filler. The resulting ciders could therefore be bottled with natural carbonation and sweetness without the yeast sediment that often goes along with bottle carbonation.

Maturation

This step is pretty simple but often overlooked by beginning cidermakers. Fresh out of the ferment the cider may be a bit rough, with the acid or alcohol notes being overbearing. A little time will allow to flavors of the cider to meld. By doing this, the finished cider tends to be more balanced. Cider can also be matured after bottling by letting the filled bottles to sit in a cool place for 3-4 months before selling. Ciders should be matured for at least 3-4 months before serving, but should also generally be drunk within a couple of years.

Bottling and Storage

Once the cider is finished, it is now ready for packaging in some sort of container. Bottle choice is up to the cidermaker and is partially dependent on cider style and marketing needs. For any type of carbonated cider a bottle capable of holding pressure is called for. For lightly sparkling ciders crown-capped or flip-top ('Grolsh-style') beer bottles work well, but for highly carbonated Champagne styles only sturdy, new Champagne bottles can be used with special stoppers and wire hoods. These make for a nice presentation but can be expensive and laborious. For uncarbonated, still ciders, the container of choice is the standard 750 ml wine bottle. Bottle color and shape vary, and a producer should experiment with the presentations offered by the various bottles on the market. Closures, including corks and caps, should be purchased in sufficient quantity and stored in a clean, dry place in a sealed container until use.

Bottles should be rinsed with a sulfite solution before filling, then filled and stoppered immediately. Professional bottling lines can automate this process, but also are very expensive and require significant maintenance. Small-scale cidermakers, at least initially, can get started with bottling and corking equipment available from home winemaking shops. Kegging is another option for cidermakers with bulk draft accounts. This entails another set of equipment and supply inventory, but a lot of cider can be efficiently sold though bulk channels. Conditions in the storage area for any bottled or kegged cider should be cool without any major swings in temperature.

Sales and Distribution of Cider

Because fermented cider is an alcoholic beverage, its production sales are regulated by multiple federal, state, and local authorities. An adult of legal drinking age may produce 100 gallons of home fermented wine, cider, or beer per year, up to 200 gallons if there is more than one adult in the household. This exemption will typically be used in the product development and testing phase, but none of it may be sold. A commercial operation, with product for sale, must have all permits in place before fermentation begins. Finished cider must be sold through a distributor in the U.S., unless the cidery holds a retail license. All cider sold through a third party must go through an independent distributor channel. In some cases, the cider maker may license themselves as a distributor and self-distribute their product. This may seem like a good idea at first, but alcohol distribution is a specialized and competitive market, so a lot of research should be done before going that route.

Appendix B. Potential Hazards in Fresh Cider

The following information originally appeared in "Guidance for Industry: Juice HACCP Hazards and Controls Guidance First Edition", from the U.S. Food and Drug Administration. (http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/Juice/ucm072557.htm)

A food safety plan for an operating cider mill should address each of these hazards. Hazards are categorized as biological, chemical, or physical in nature.

Biological Hazards

Pathogens that may Occur in Acidic Juices (pH 4.6 or less):

Acidic juices (pH 4.6 or less) containing enteric bacterial pathogens such as *E. coli* O157:H7, various Salmonella species, and the protozoan parasite *Cryptosporidium parvum* have caused serious foodborne illness outbreaks. Some of the illnesses associated with juices have been very severe (e.g., cases of long-term reactive arthritis and severe chronic illness). In one case, consumption of contaminated juice resulted in the death of a child and in another case, consumption of contaminated juice contributed to the death of an elderly man. These microorganisms inhabit the intestinal tracts of animals; when animals and their manure or feces share proximity in an environment, produce can become contaminated, either directly or indirectly through such means as contaminated irrigation water or runoff. The use of contaminated produce to produce the juice, and the ability of some of these pathogens to survive in acidic foods like juices, along with use of inadequate controls for these pathogens during juice processing, are believed to be among the causative factors for these outbreaks. Illness-causing organisms that are ubiquitous in nature, such as *Listeria monocytogenes*, have also been identified as possible contaminants in juice.

Viruses

Juices contaminated with viruses have been implicated in foodborne illness outbreaks. Contamination of food by viruses is most likely to be caused by an ill individual, such as a farm worker or food handler. Thus, contamination of juice by viruses is not likely to occur in a processing facility that controls, under its SSOPs, employee health and hygiene conditions that could result in the microbiological contamination of food, food packaging materials, and food contact surfaces. SSOPs must outline basic worker hygiene and prohibit mill operation by employees while ill.

Chemical Hazards

Patulin

Patulin is a mycotoxin that is produced by fungi commonly found on apples. High levels of patulin can be produced in rotting or moldy apples. Fallen fruit, apples that have been damaged, e.g., by insects or birds, or bruised, e.g., during handling, are more susceptible to the growth of patulin-producing molds. Storage of apples under conditions that are not inhibitory to the growth of molds also can lead to high levels of patulin in the apples. If fallen fruit, moldy, rotten, bruised or damaged apples, or improperly stored apples, are used to make juice, high levels of patulin may occur in the juice, including pasteurized juice, because thermal processing does not destroy patulin.

Exposure over time to high levels of patulin may pose a health hazard. FDA has established an action level for patulin in apple juice of 50 micrograms per kilogram (50 parts per billion) as determined on single strength apple juice or reconstituted single strength apple juice. In fact, if one rotten apple (containing >10,000 parts per billion (ppb) patulin) is used along with 200 sound apples to make juice, the resulting patulin level in the juice could exceed FDA's action level for patulin.

Undeclared Food Allergens in Juice due to Cross-Contact from Shared Processing Equipment

Juice processors that handle other foods containing allergenic food ingredients in the same facility should consider the potential for hazards from cross-contact of your juice by other food substances that can cause allergic reactions. No other products than fruit juice are typically processed on most small-scale cider processing equipment. Operators who use equipment for other purposes must specifically address cross-contamination issues in their respective SSOPs and Hazard Analysis procedures.

Pesticide Residues

Pesticides are used widely to treat (e.g., for insect control) fruits, vegetables, grains, and other foods, and may be present in small amounts as residues on these foods. Before a pesticide may be sold in the United States, the Environmental Protection Agency (EPA) evaluates the pesticide and determines whether or not to grant a registration that permits its sale and use. For pesticides used on foods, EPA also must establish a tolerance, which is the amount of residue legally permitted to remain in or on each treated food commodity, or an exemption from the requirement of a tolerance for the pesticide residue on the particular commodity.

Residues from unapproved pesticides, or residues in excess of pesticide tolerances, are illegal and could pose a potential hazard in juice warranting control in a HACCP plan. Growers of all fruit used for fresh juice must maintain applicable agrichemical use records to ensure compliance with EPA residue limits.

Physical Hazards

Adulteration of processed juice by physical materials poses potential choking or other threats that must be addressed. Mill construction should ensure that closed containers and transfer systems are used to prevent entry of debris from ceilings, floors, walkways, and other areas.

Juice in Vermont cider mills is typically bottled in new plastic containers. Container sourcing, reception, and storage must be addressed in SSOPs to prevent contamination. Facilities that utilize glass bottles must address bottle sourcing, storage, and filling processes that prevent introduction of glass fragments to the juice. Glass fragments originating from facility-related sources and not from glass containers, e.g., from a broken light bulb, must be addressed under plant design (i.e. caged bulbs) and inspection included in SSOPs. Control measures must include procedures for cleanup of broken glass when it occurs.

FDA recommends consideration of potential hazards associated with metal fragments be a part of hazard analysis if operations such as the grinding of fruit, or cutting operations, where metal fatigue or metal to metal contact can occur in processing equipment are conducted. Metal fragments and other gross physical objects in the juice typically are prevented by utilizing a suitable screen or filter just prior to filling the bottling tank. Use and maintenance of the screen must be addressed in SSOPs.

Appendix C. Sample Standard Sanitary Operating Procedures

General Operation:

1. Crushing and pressing equipment is cleaned and sanitized prior to start-up and at the end of each day of operation at a minimum. Equipment is dismantled or disassembled as needed to insure adequate cleaning and sanitizing.

2. Press cloths are specifically designed for cider production, made of durable materials, and be replaced when necessary. During processing, the cloths are handled in a sanitary manner, which includes hanging the cloths on a line or placing them in a clean container off the floor between runs. At the end of each day's operation, all press cloths are washed, rinsed, sanitized, and dried. The cloths may be dried by spreading them on a clean line in a well ventilated and screened area away from flies and vermin. Press racks are made of food-grade plastic or hardwood, which has been maintained free of excessive cracks or crevices. Poorly maintained equipment can be impossible to clean and sanitize adequately. Press racks are kept off the floor at all times. At the end of each day, all used press racks are cleaned, sanitized, and allowed to dry.

3. During fresh sweet cider production all doors are closed until the last cap is placed, no customers or sales allowed in facility.

Cleanup

1) General
    a. Break down last rack, hang cloths on line and move to washing machine as soon as possible. Cloths will be washed with ¼ cup Tide detergent, followed by potable rinse cycle. A second wash with ½ cup 5% bleach followed by potable rinse will follow. Washed cloths are to be hung on the line in the mill and air dried.
    b. Pump fresh star-san solution (1 oz/ 5 gallons) through all hoses and pump plumbing. This rinse can be circular with solution returned to pump bucket.
    c. Rinse buckets into stock tank down open drain.
    d. Roll all equipment out into drive (press, carts, bucket table, grinder) leaving open floor space.
2) Floors and Walls
    a. Rinse wall behind grinder.
    b. Shovel excess pomace into truck, squeegee all gross debris to collection point. Remove to pomace truck
    c. With pressure washer, apply floor and wall soap to all surfaces, allow to soak 5 minutes
    d. Pressure wash ceiling, walls, tarpaulin curtains, floors thoroughly.
    e. Squeegee standing water to drain.
    f. Apply bleach solution (500 ppm chlorine) via hand sprayer to walls and ceiling. Pour from bucket onto floors, push with wet broom to wet all floor surfaces, let stand 5 minutes. Squeegee excess water from floor surface.
3) Implements
    a. Clean all jack blocks in wash box on cart, set aside.
    b. Wash (brush and pressure wash) wash box. Drain.

c. Racks.
    i. Pressure wash racks in stock tank. Carefully wash each side, applying water pressure with rack orientation.
    ii. Set aside in oak box. Fill with 5 gallons Star-San mix, soak five minutes, drain.
    iii. Place racks on end on bottom of box cart.

d. Bottling stand
    i. Remove valve, clean, place in star-san bucket.
    ii. Clean bottling tank in stock tank, using brush and soapy water. Rinse.
    iii. Attach valve to tank, place in tub, fill with 5 gallons star-san and brush to wet all surface.
    iv. Rinse all bottling hoses incl. screen filter, soak in star-san in tank.
    v. Pressure wash bottling stand using soap injector. Apply Star-san with brush or sprayer.
    vi. Invert tank over sink on stand, allow hoses and fittings to drain in bottling sink.
    vii. Roll stand to back of mill

e. Press
    i. Tilt stainless pan out of press, rinse in stock tank. Pressure wash with soap into tank, rinse with water.
    ii. Pressure wash press frame with soap.
    iii. Apply star-san to all surfaces of press pan and frame. Invert pan on frame, roll back into mill.

f. Grinder
    i. Remove hopper box, prop on end of box support, hanging by hopper box. Rinse.
    ii. Remove chute, gross rinse on drain slope. Place in stock tank.
    iii. Rinse all exterior surfaces of grinder with pressure washer. Be sure to clean from all sides and all angles. Inject detergent, allow to sit/
    iv. Rinse inside chute with low pressure hose, catch debris in bucket for field dumping. Scrub with brush. Inject detergent with pressure washer.
    v. Pressure wash all surfaces. Apply star-san to all steel parts. Wood parts may receive 100 ppm chlorine mix.

4) Bleach concentrations:
    a. 250 ml/19 l = 8.3 oz / 5 gal = 1.66 oz / gal = 500 ppm
    b. 30 ml / 3.8 l = 1 oz / gal = 100 ppm
    c. Star-San: 1 oz /5 gal = 300 ppm dodecylbenzenesulfonic acid
    d. NEVER MIX STAR-SAN AND BLEACH SOLUTIONS

Appendix D. Sample SSOP Records

Date	Extra Record?								
Pre Operation									
Prep and label jugs									
Visual check of area	non conformities								
Sanitize walls, floor	san used								
Sanitize grinder, buckets,, heat exchanger, press	Star san								
Lay out stations									
Check cider pump prescreen for integrity									
Post-Press Sanitation									
Press Cloths	san used								
Rinse buckets, incidentals									
Rough equip rinse outdoors									
Clean Walls									
Clean Floor									
Sanitize Walls	san used								
Sanitize Floor	san used								
Clean Free Incidentals									
Wash & Sanitize bucket table									
Wash & Sanitize Buckets	san used								
Oak Wash Box & Cart									
Racks	san used								
if Cl, rinse racks	soak time								
Bottling tank/stand									
stand	san used								
Press and box	san used								
Wash grinder									
Inspect grinder									
Sanitize grinder	san used								

Appendix E. Resources

General Information:

U.S Food and Drug Administration Guidance for the Juice Industry: http://tinyurl.com/nsb8pm

Good Manufacturing Practices for Michigan Cider: http://tinyurl.com/3xvxac5

Vermont Department of Health 108 Cherry Street, Burlington, VT 05402
802-863-7200, In Vermont 800-464-4343 http://healthvermont.gov

> Current Rules for Food Service Establishments -
> http://healthvermont.gov/regs/03food_estab.pdf

University of Vermont GAP Program – Ginger Nickerson, virginia.nickerson@uvm.edu, 802-656-5490

US Food Code: http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FoodCode/FoodCode2009/
Operations that design facilities and procedures according to these requirements will generally be in good compliance with state, federal, and private (insurance) regulations.

HACCP Information:

U.S. FDA HACCP Page:
http://www.fda.gov/Food/FoodSafety/HazardAnalysisCriticalControlPointsHACCP/default.htm

Penn State University Juice HACCP page:
http://extension.psu.edu/food-safety/courses/information/juice-haccp-resources .

Hard Cider Information:

Cider Digest – email discussion group

Wittenham Hill Cider Portal – Andrew Lea

Making & Marketing Vermont Ice Cider – Eleanor Leger, Eden Ice Cider Company

Considerations for Starting a Winery in Tennessee:
http://www.utextension.utk.edu/publications/pbfiles/pb1688.pdf

Sources for Cider Equipment:

Day Equipment – www.cidermillsupplies.com Goshen, IN
Racks, cloths, labels, cleaning supplies

OESCO – http://www.orchardsupply.comConway, MA

Good Nature, Inc. – http://www.goodnature.com Buffalo, NY

Sources for equipment and wine supplies:

G.W. Kent – www.gwkent.com Ypsilanti, MI
Tanks, pumps, hoses, lab equipment, bottling equipment

St. Patrick's of Texas – www.stpats.com Austin, TX
Tanks, pumps, hoses, lab equipment, bottling equipment

Presque Isle Wine – www.piwine.com North East, PA
Full line of equipment and supplies, including yeasts, cleaning and sanitizing, lab equipment and supplies, bottles, corks, capsules, etc.

More Wine Pro – www.morewinepro.com Concord, CA
Smaller scale winery equipment, and supplies

Scott Laboratory – www.scottlab.com   Petaluma, CA
Full line of yeasts, yeasts nutrients and winemaking supplies

Sources for laboratory equipment and supplies:

Flinn Scientific, Inc. – www.flinnsci.com   Batavia, IL

AFAB Enterprises – www.refractometer.com Eustis, FL

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